

# Introduction to Botany. Lecture 7

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# More about plant classification

- Mosses (Bryophyta)
- Ferns and allies (Pteridophyta)
- Seed plants (Spermatophyta)
  - Conifers (Pinopsida)
  - Other classes of seed plants
  - Angiosperms (Magnoliopsida)
    - Monocots (Liliidae)
    - Other subclasses of angiosperms (“dicots”)

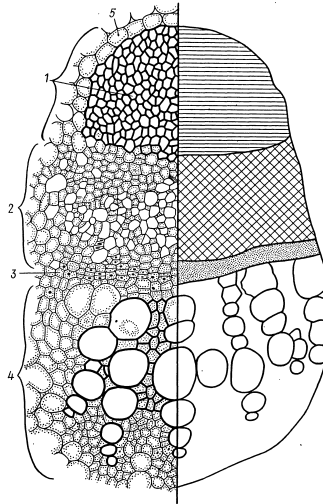
# Outline

- 1 Anatomy of stem: secondary structure
  - Anatomy of mature stem
  - Structure of wood

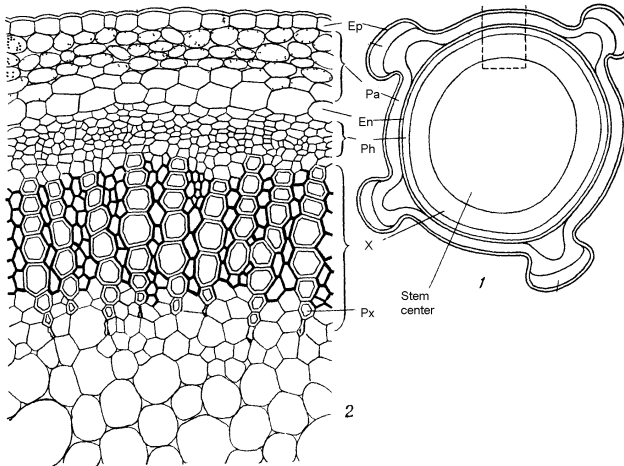
# Vascular cambium

- In many plants, residuals of procambium transform into fascicular cambium
- Parenchyma cells between vascular bundles produce inter-fascicular cambium

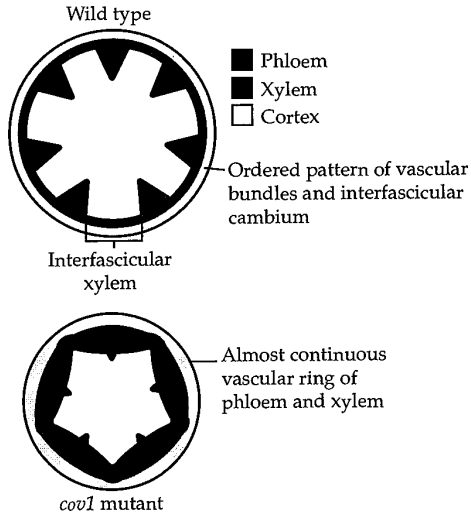
# Vascular bundle



# Vascular cylinder



# Gene alternates cylinder and bundles



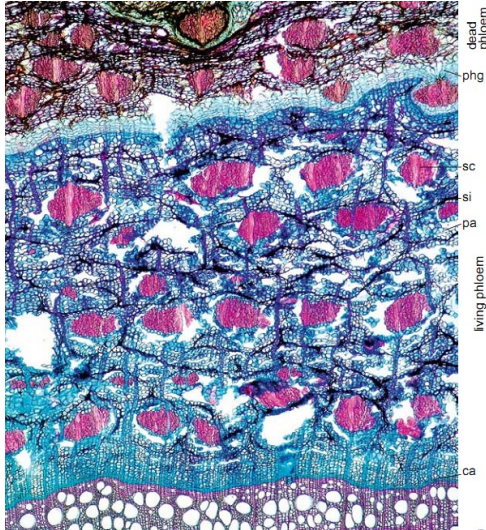
The COV mutant of Arabidopsis (after Parker et al., 2003)

# Cork cambium and origin of bark

- **Bark** is everything outside vascular cambium, therefore, bark = secondary phloem + periderm
- Each year new layer of cork cambium appear from parenchyma cells of secondary phloem
- Consequently, bark consists of multiple and mostly uneven layers



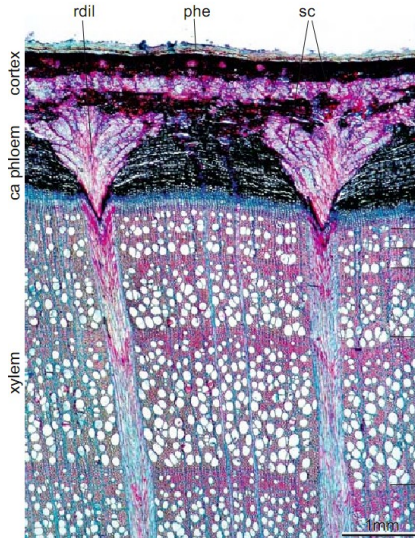
# Renewal of bark in sea buckthorn (*Hippophaë rhamnoides*)



# Secondary phloem

- Forms outside vascular cambium
- Rich of fibers
- Does not form annual rings
- Has rays of parenchyma cells, sometimes wedge-shaped (**dilated**)

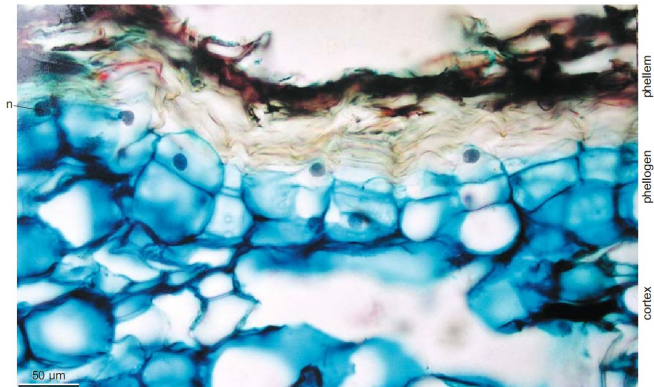
# Dilated rays of beech (*Fagus* sp.)



# Periderm

- Periderm is the product of cork cambium
- 99% of periderm is a **phellem** (cork cells), thick outside layer
- **Phelloderm** is a tiny layer of living cells inside of cork cambium

# Formation of bark zone in medlar (*Mespilus germanica*)



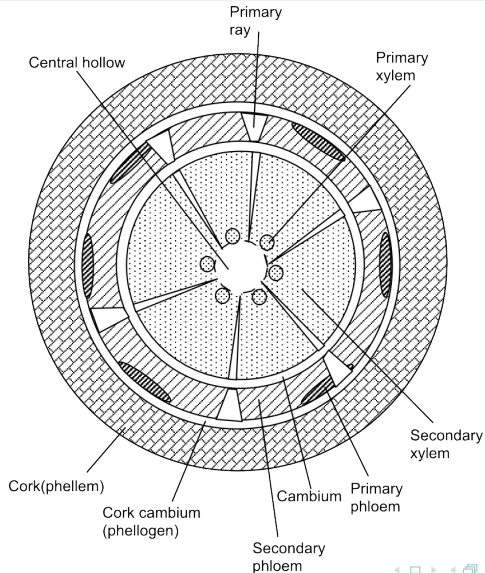
# Lenticels

- **Lenticels** are specialized regions of periderm; they supply stem cells with oxygen
- In order to produce lenticel, some cells of cork cambium divide and grow much faster than others

# Lenticel of elderberry (*Sambucus* sp.)

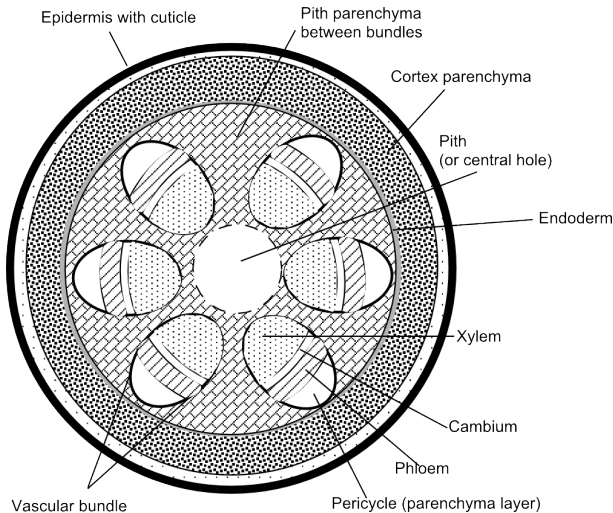


# Secondary structure

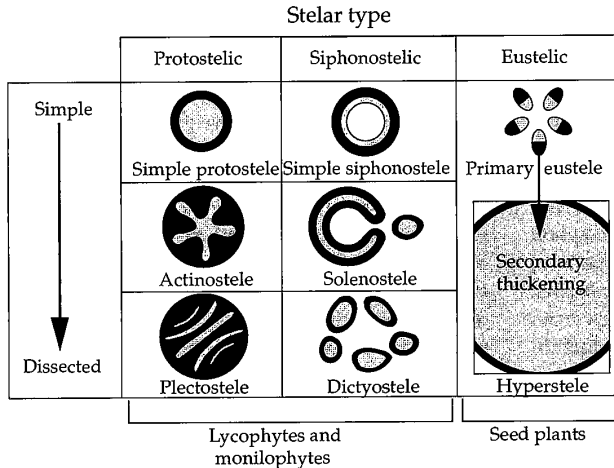




# Primary structure (from previous lecture)

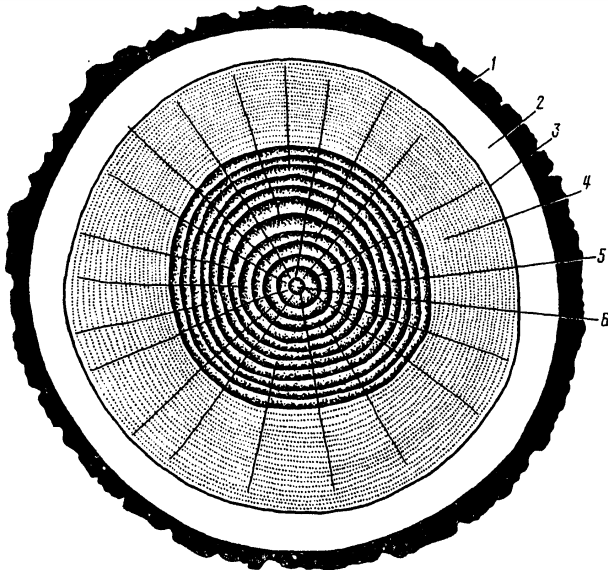


# Hyperstele



Mature stem with secondary structure often called “hyperstele”  
(Cronk, 2009)

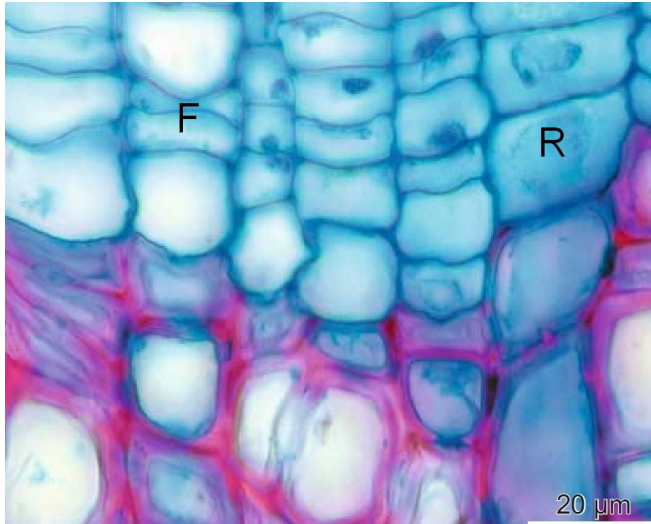
# Bark and wood



# Secondary xylem and rays

- Secondary xylem, or wood, is the product of vascular cambium
- Some cambium cells are **fusiform initials**; they form axial vessel elements
- Other cambium cells are **ray initials**; they form rays (parenchyma + tracheids)
- **Rays** provide horizontal transport of water; **axial system** provide vertical transport

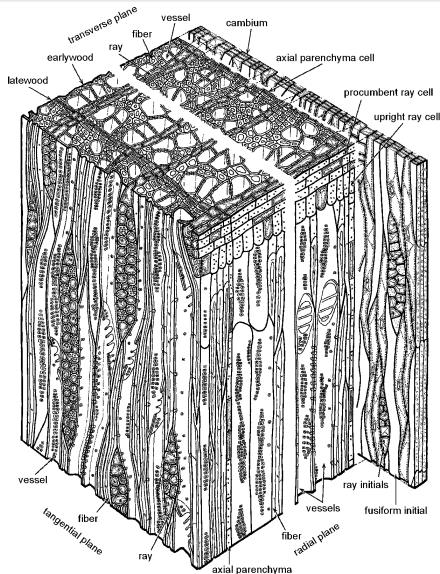
# Fusiform and ray initials



# Three planes of view

- **Transverse\*** (cross-section)
- **Radial** (longitudinal section from center to periphery and perpendicular to stem surface)
- **Tangential** (longitudinal section parallel to stem surface)

# Three plains of maple (*Acer* sp.) stem



# Earlywood and latewood

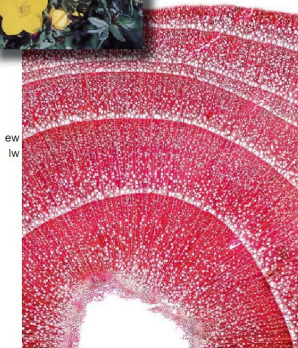
- **Earlywood** (springwood) contains more parenchyma and often have larger vessel elements
- **Latewood** (summerwood) often have small vessel elements and looks darker



# Diffuse and ring porous wood

- In **ring porous** wood (like in red oak) bigger vessel elements concentrate in earlywood
- In **diffuse porous** wood larger vessel elements spread across early- and latewood (American elm)

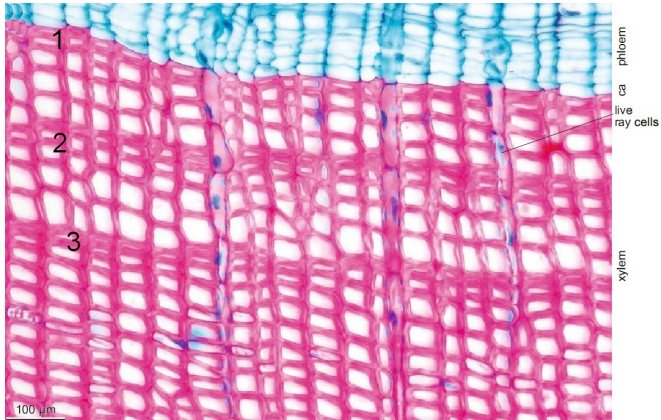
# Diffuse and ring porous wood in two species of cinquefoil (*Potentilla* spp.)



# Annual rings

- Interleaving early- and latewood from to sequential years form an impression of annual ring
- “Ring” is just a layer of darker (i.e., smaller) cells
- Tropical trees do not form annual rings

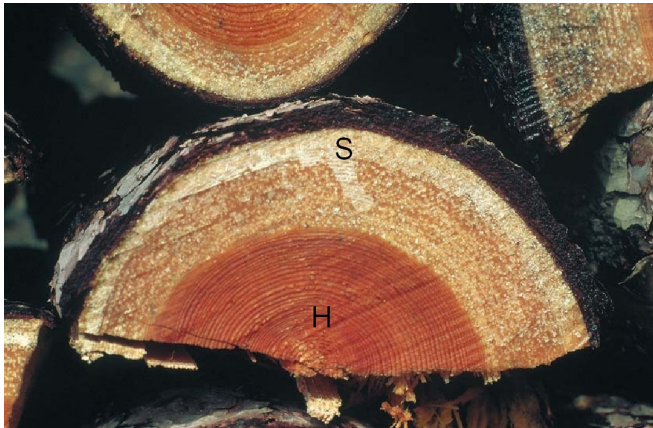
# Annual rings in juniper (*Juniperus* sp.)



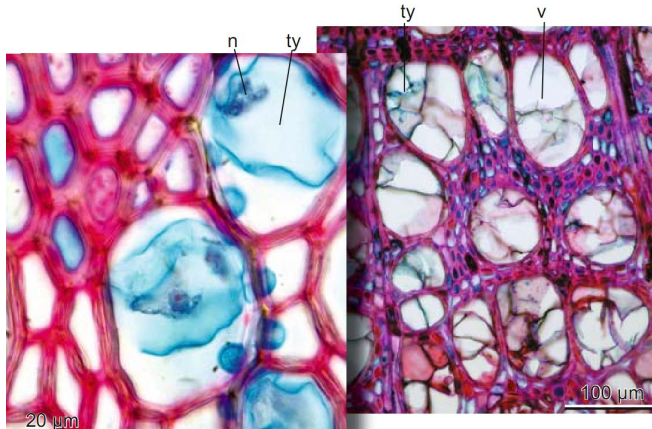
# Sapwood and heartwood

- **Sapwood** is a peripheral layer of working xylem, it usually has relatively light color
- **Heartwood** is a central, non-functional, old, dark-colored xylem

# Sapwood and heartwood of European pine (*Pinus sylvestris*)



# Tyloses



Tyloses control the winter functioning of vessels

# Summary

- **Bark** consists of secondary phloem and cork
- **Wood** is a secondary xylem
- Interleaving early- and latewood form **annual rings**
- **Heartwood** is a non-functioning xylem



# For Further Reading



Th. L. Rost, M. G. Barbour, C. R. Stocking, T. M. Murphy.  
*Plant Biology*. 2nd edition.  
Thomson Brooks/Cole, 2006.  
**Chapter 5.3.**