

Introduction to Botany. Lecture 32

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Outline

1 Questions and answers

- Quiz

2 Branching, thickening and the origin of seed

- Branching
- Secondary stem



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Questions and answers

Quiz



Final question (1 point)

Name one heterosporous fern.

- In greenhouse, you were shown *Marsilea* and *Isoëtes*. Also, there is *Salvinia* and *Selaginella* in greenhouse.



Branching, thickening and the origin of seed

Branching

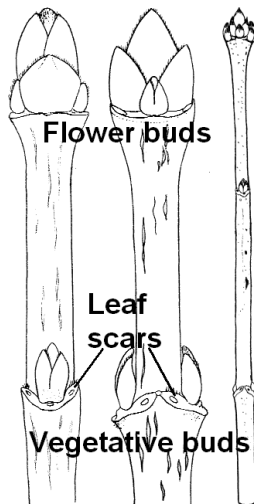


Where to see branching: winter shoot

- 1 Vegetative, flower, and mixed buds
- 2 Leaf and bud scars
- 3 Leaf traces



Winter shoot of maple (*Acer platanoides*)

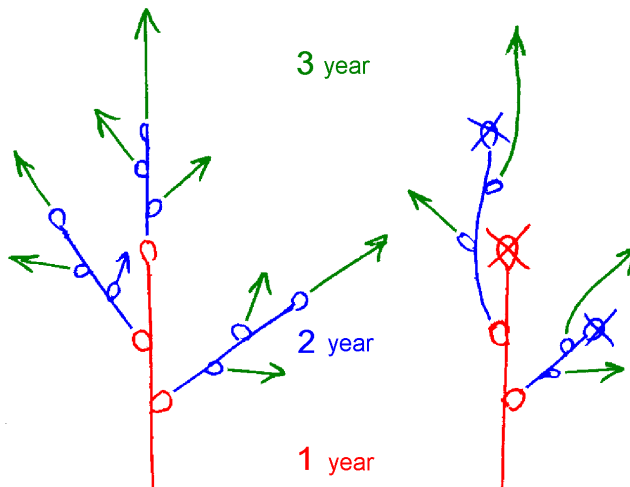


Types of branching

- **Monopodial:** buds do not degrade, all shoots continue to grow
- **Sympodial:** terminal buds degrade, the lateral shoot closest to terminal bud becomes terminal shoot



Monopodial (left) and sympodial branching

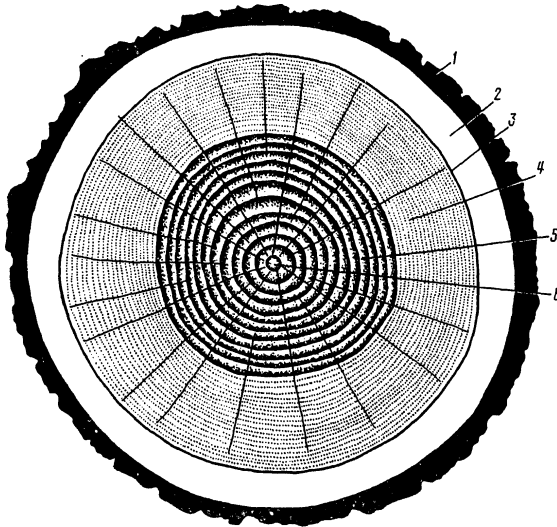


Branching, thickening and the origin of seed

Secondary stem



Secondary stem = bark + wood



1 cork, 2 bast, 1 + 2 = bark, 3 cambium, 4 + 5 wood, 4 **sapwood**, 5 **heartwood**, 6 pith (if any)



Bark, cork, periderm and wood

- **Bark** is everything outside vascular cambium, i.e. **bark** = secondary phloem + periderm [optionally, also primary phloem, cortex and epidermis]
- **Periderm** = [phelloderm] + cork cambium (phellogen) + phellem (cork)
- **Wood** = trunk – bark, or secondary xylem + [all remnants of central primary tissues]

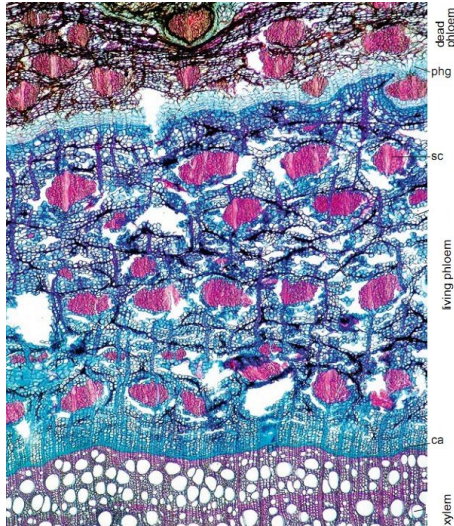


Cork cambium and origin of bark

- Initially, cork cambium appears in cortex, works some time and then dies out
- Each year new layer of cork cambium appears from parenchyma cells of secondary phloem
- Consequently, bark consists of multiple and mostly uneven layers



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



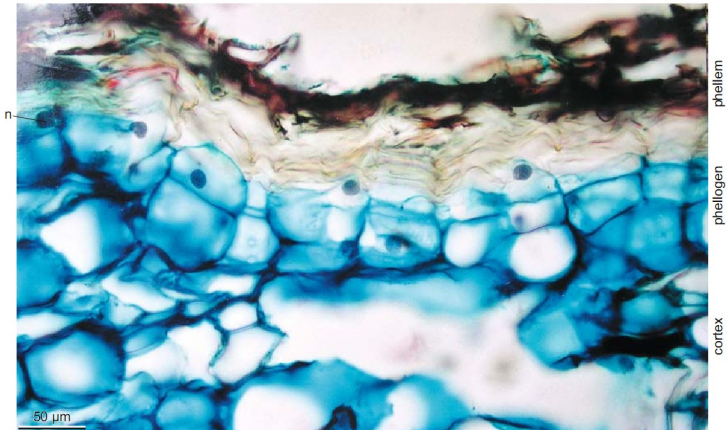
phg phellogen, ca cambium, sc sclerenchyma

Periderm

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



Formation of periderm zone in medlar (*Mespilus germanica*)



No phelloderm



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.)

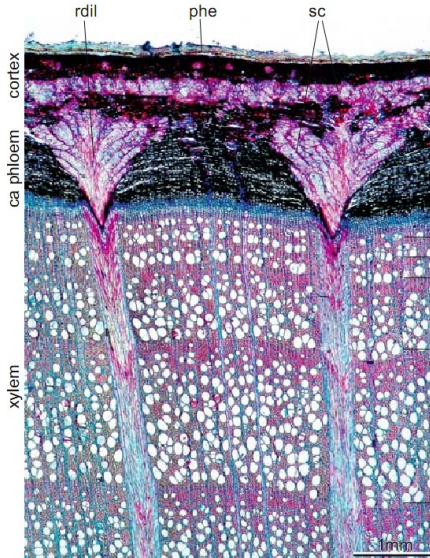


Secondary phloem (bast)

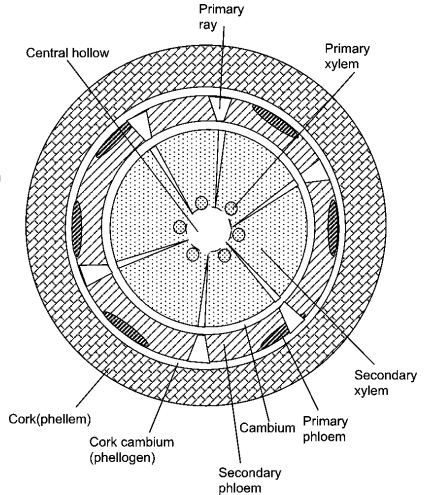
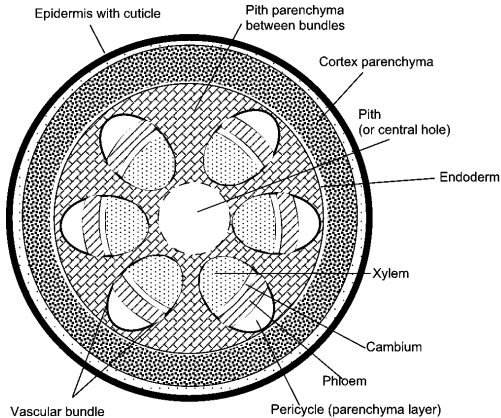
- Forms outside vascular cambium
- Rich of fibers
- Does not form annual rings
- Has rays of parenchyma cells, sometimes wedge-shaped (**dilated**)



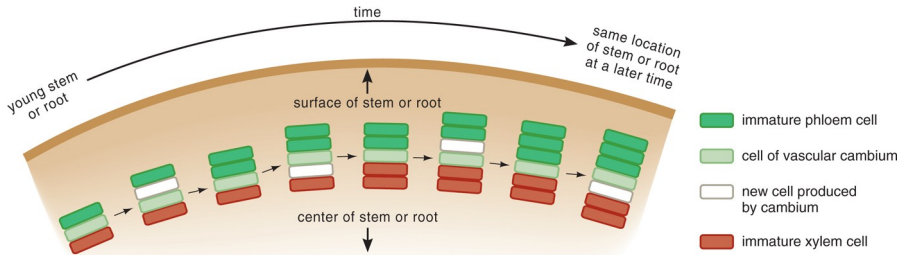
Dilated rays in beech (*Fagus* sp.) stem



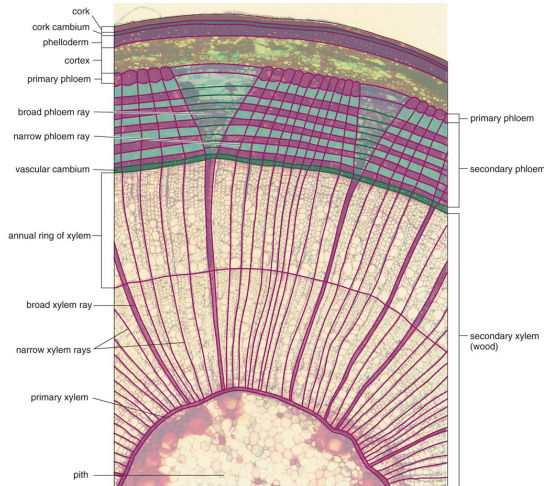
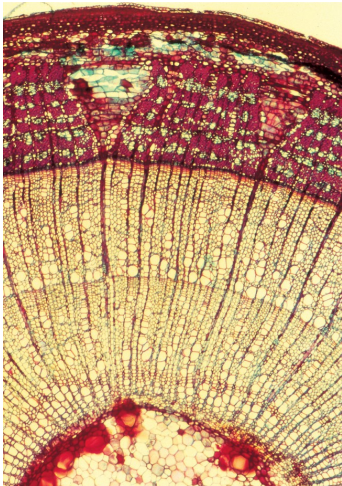
Primary and secondary stems (scheme)



How cambium works



Secondary structure of stem (photo and explanations)

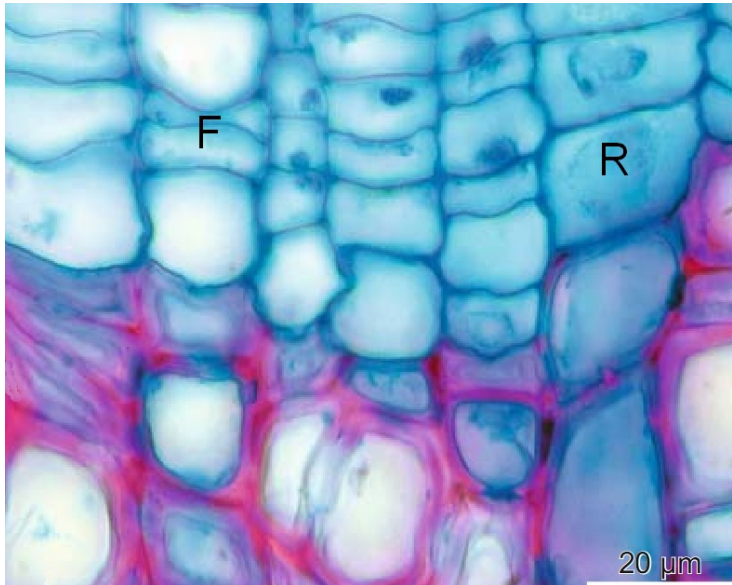


Secondary xylem and rays

- 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

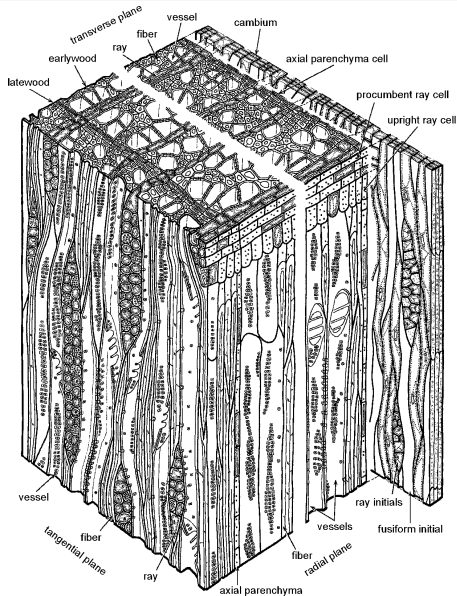


Three planes of view

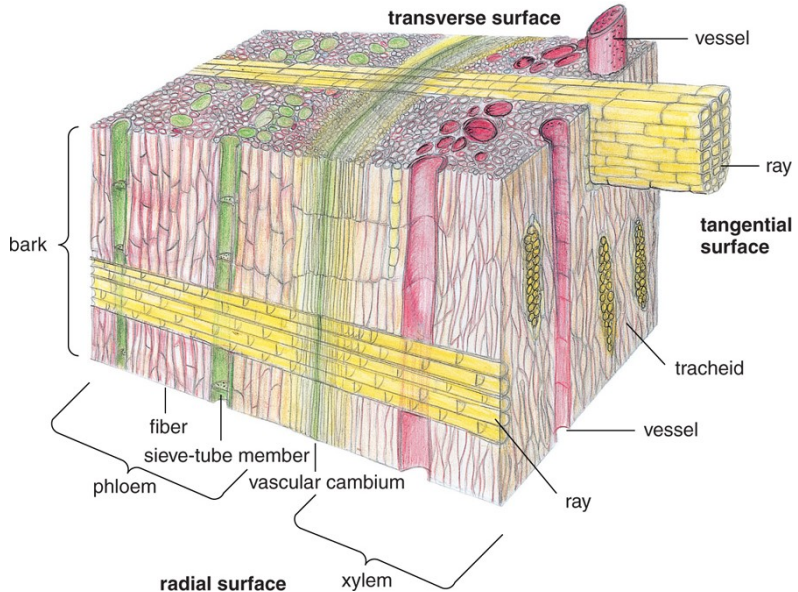
- **Transverse** (cross-section)
- **Radial** (longitudinal section from center to periphery and perpendicular to stem surface)
- **Tangential** (longitudinal section parallel to stem surface)



Three plains of maple (*Acer* sp.) wood



Three plains again (the scheme)



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.)



ew
lw

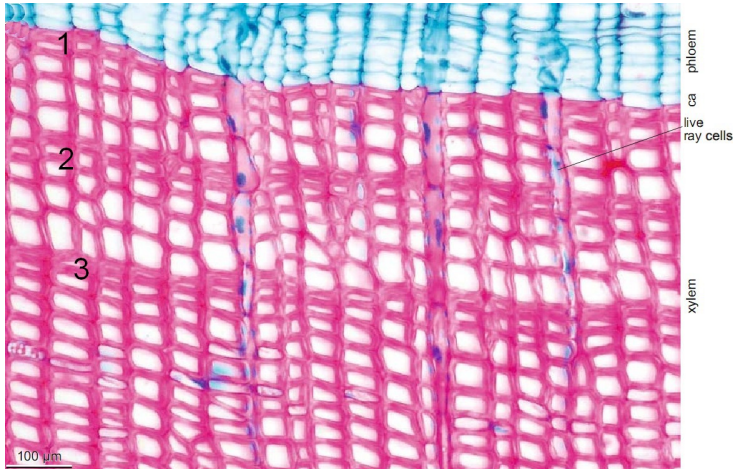


Annual rings

- 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.)

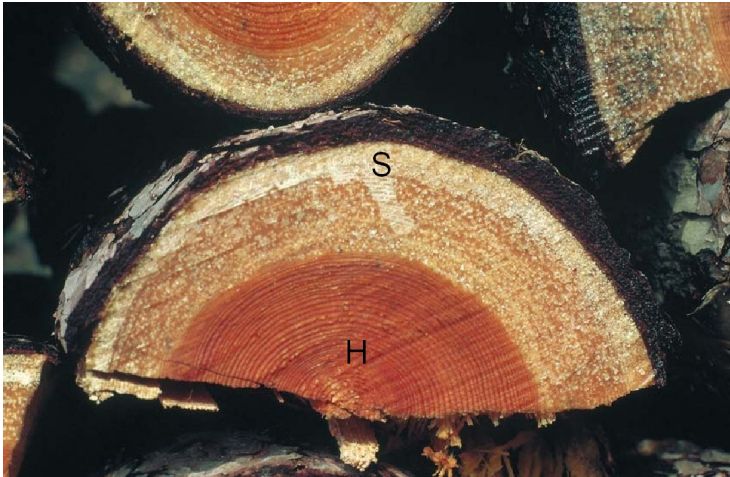


Sapwood and heartwood

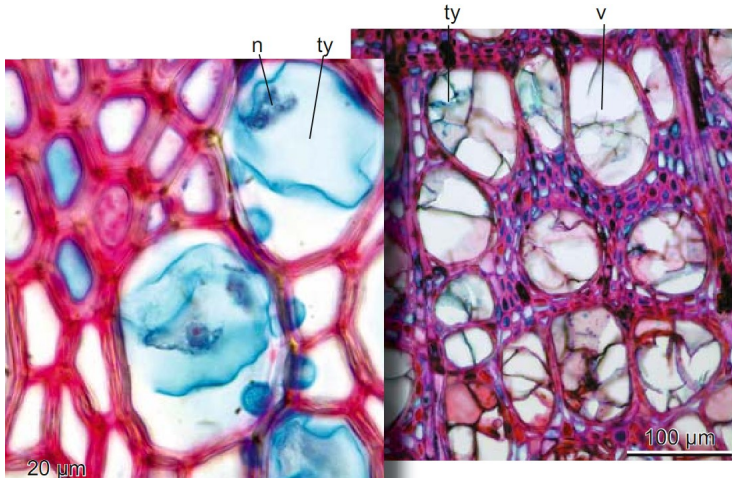
- **Sapwood** is a peripheral layer of working xylem, it usually has relatively light color
- **Heartwood** is a central, non-functional, old, dark-colored xylem



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



Tyloses



Tyloses control the winter functioning of vessels



Summary

- Sympodial growth and secondary thickening are both evolutionary advantages.



Final question (2 points)



Final question (2 points)

Define the bark.



For Further Reading



A. Shipunov.

Introduction to Botany [Electronic resource].

2016.

Mode of access:

http://ashipunov.info/shipunov/school/biol_154

