

Softwood Anatomy

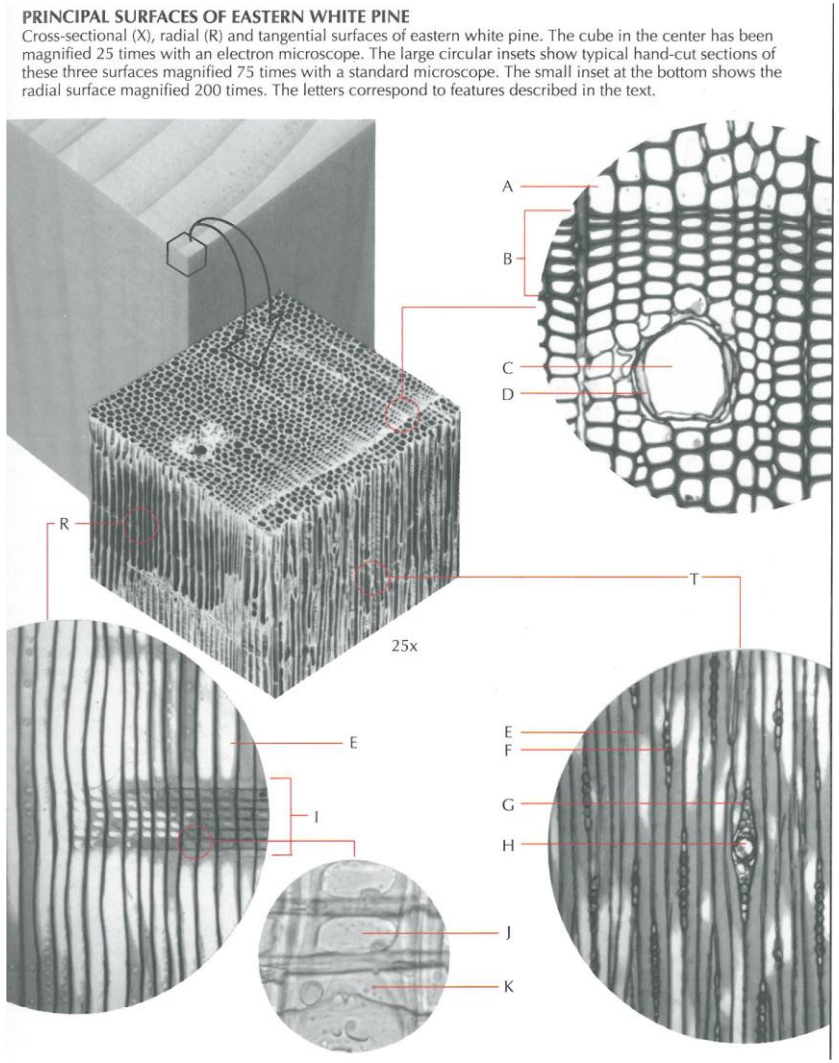
Wood Technology

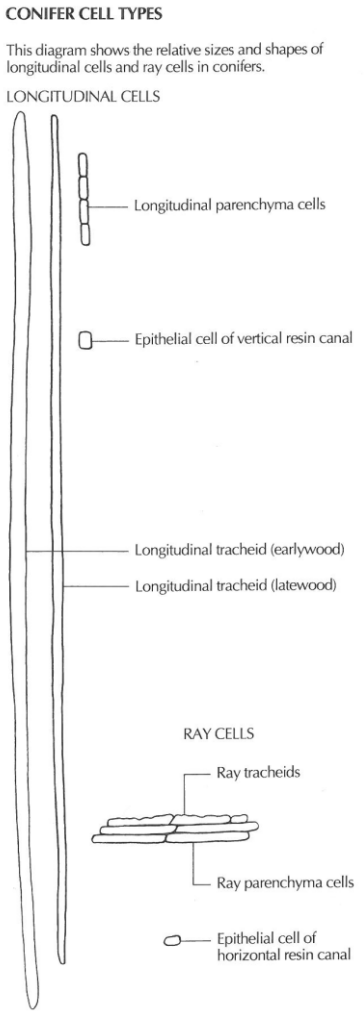
Matthew Schwarzkopf

Softwood anatomy

- Learning objectives
  - Identify the macro- and microscopic features of softwood xylem
  - Visually identify and be able to explain the function of the types of cells in softwoods
  - Recognize the features of softwoods useful in wood identification

Softwood structure

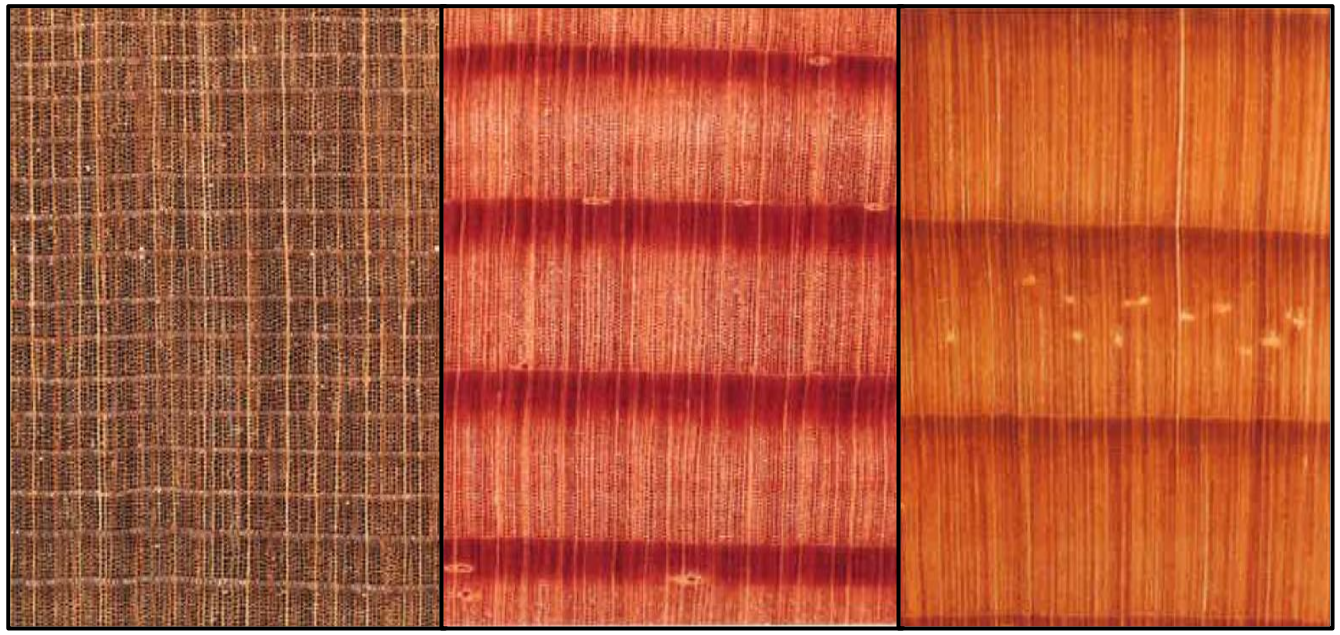




Source: Hoadley

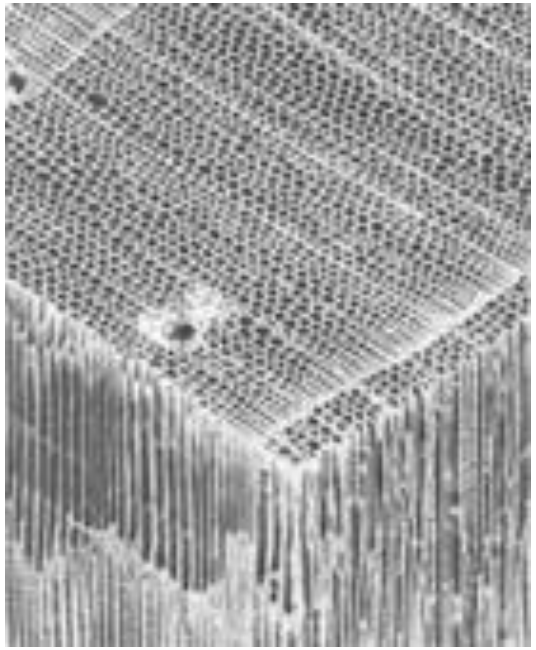
Softwood texture

- Texture refers to cell size
- Coarse texture
  - *Sequoia sempervirens* – left image
    - 50-80 µm, can see with naked eye
- Medium texture
  - *Pseudotsuga menziesii* – middle image
    - 35-55 µm, easily seen with hand lens
- Fine texture
  - *Picea* – right image
    - 23-35 µm, can see with a hand lens

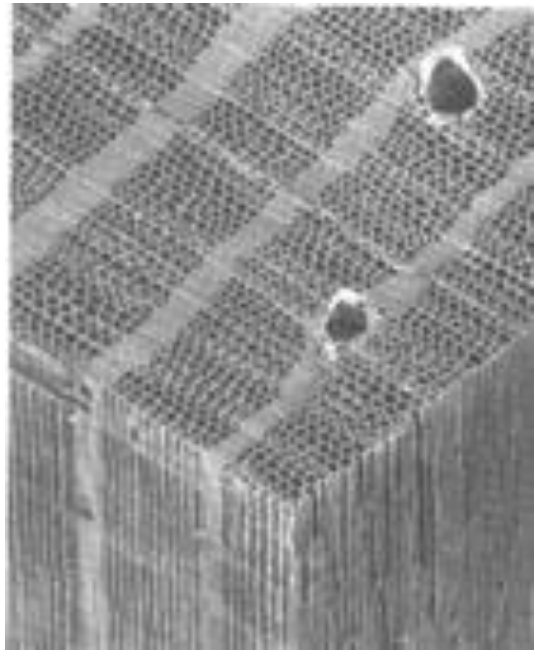


Source: Hoadley

Softwood transitions



Gradual transition
Pinus strobus

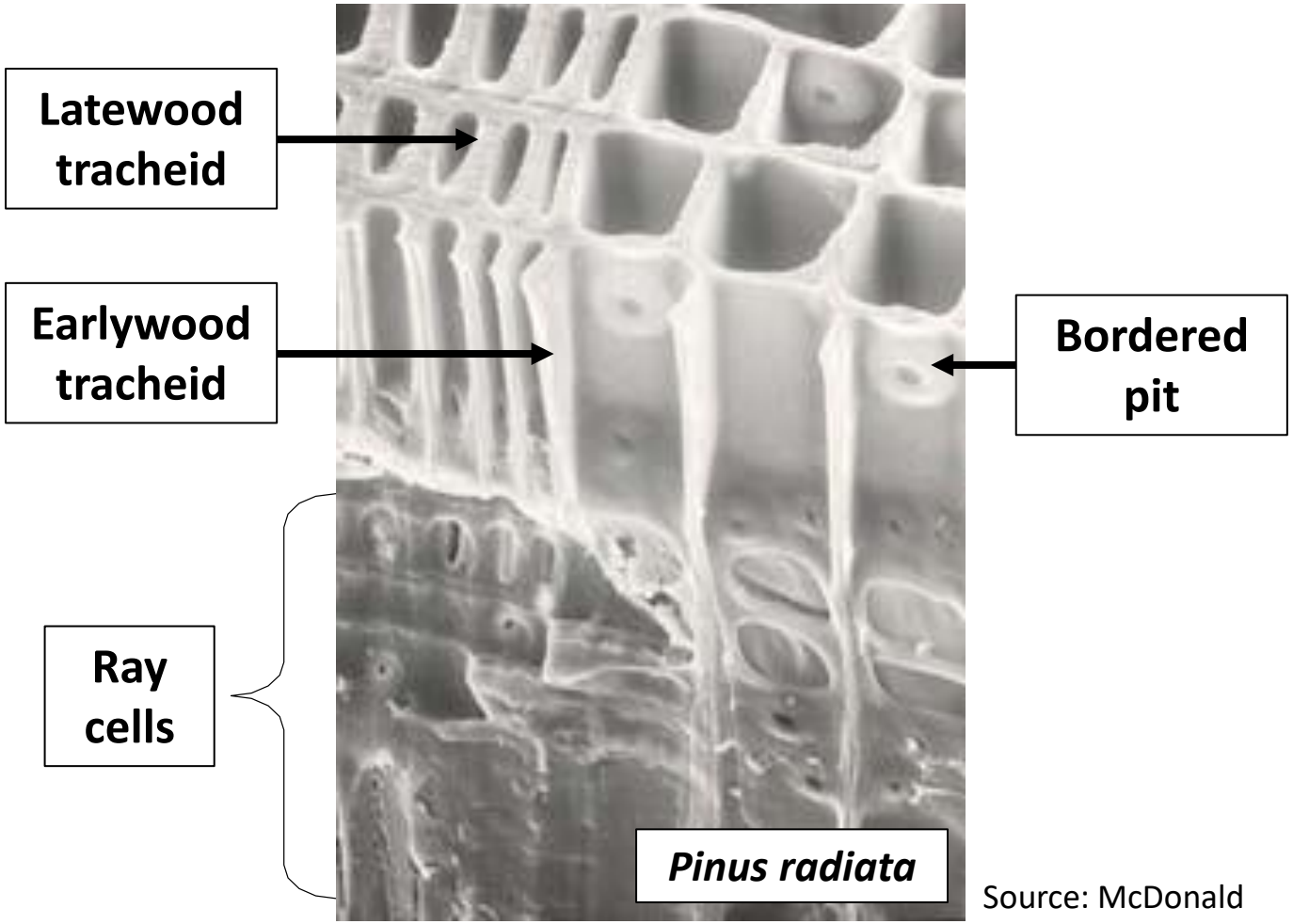


Abrupt transition
Pinus taeda

Source: Core

Softwood cell types

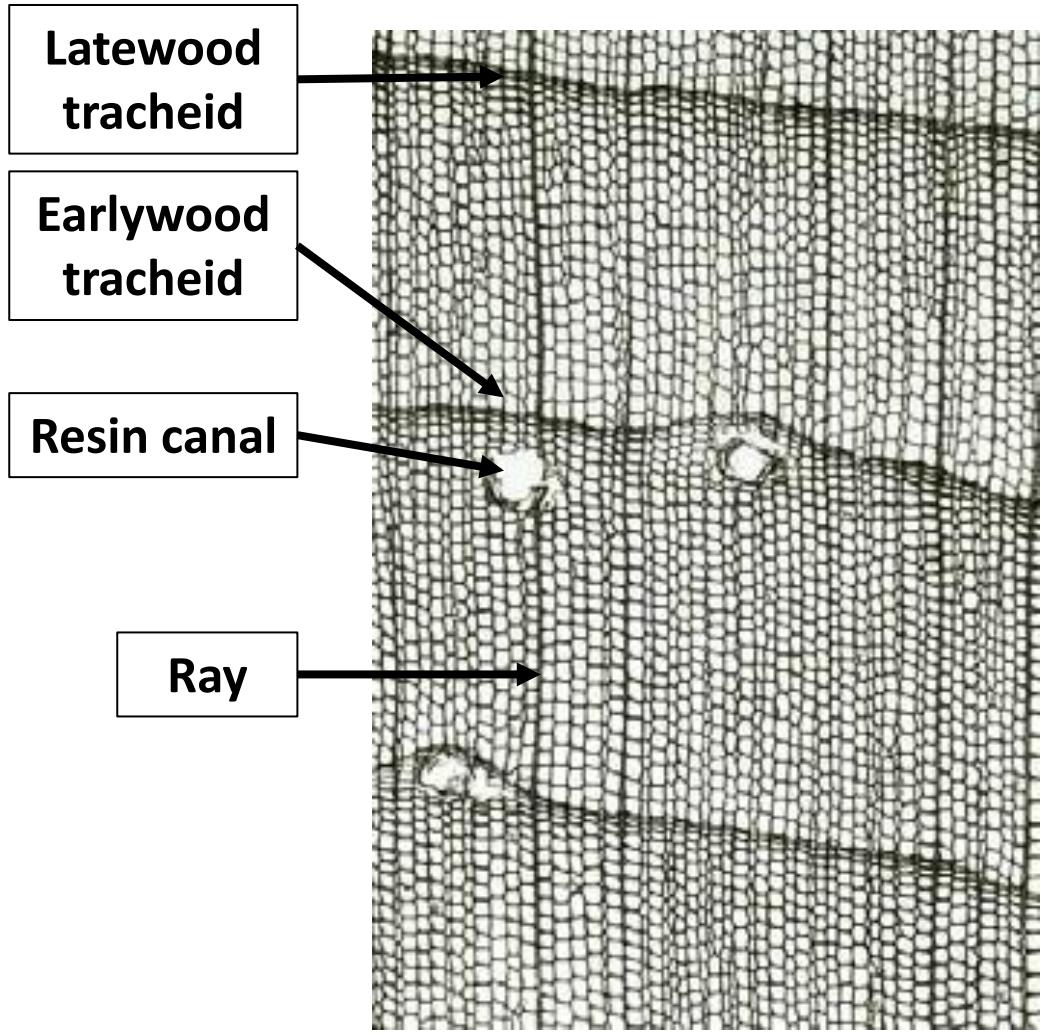
- Tracheids
- Parenchyma
- Ray cells
  - Ray tracheids
  - Ray parenchyma
- Epithelial cells



Source: McDonald

Softwood cell types - transverse

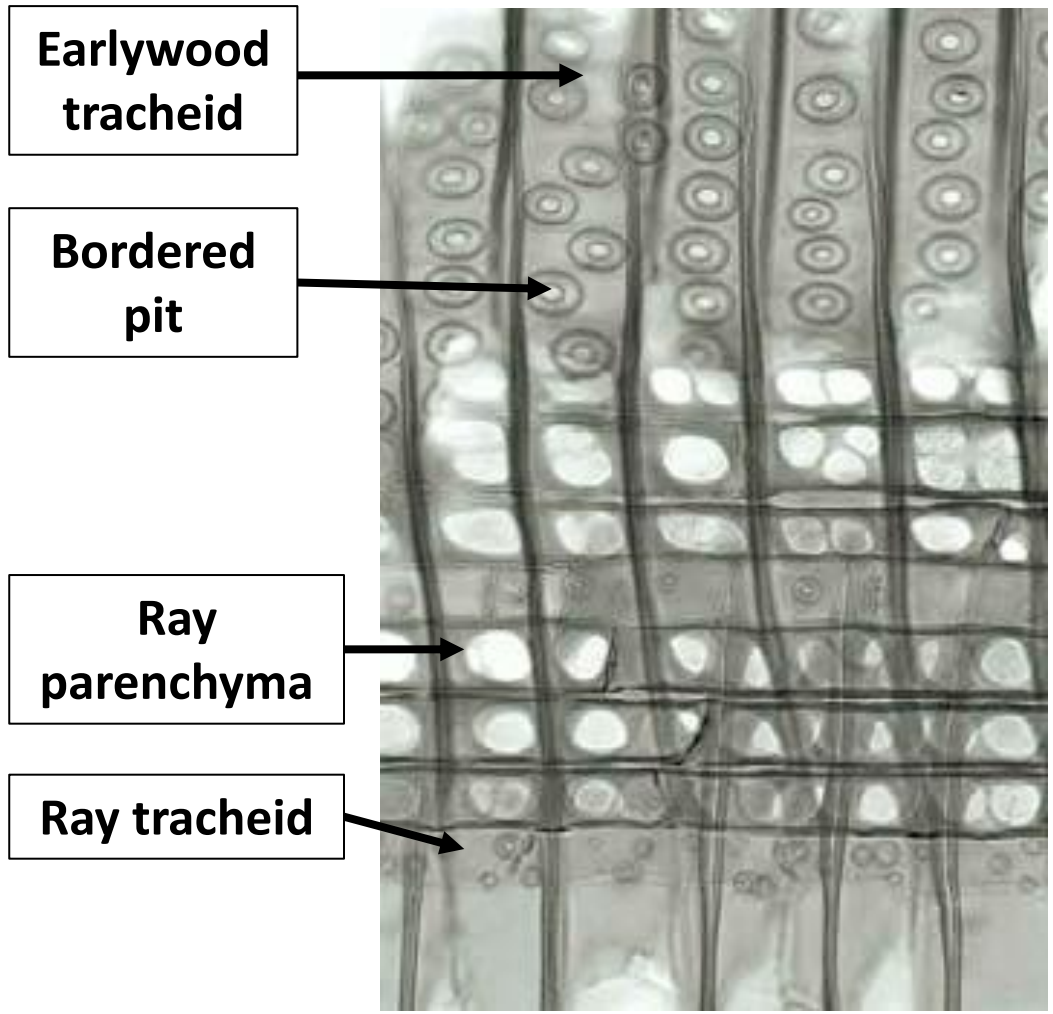
- Tracheids
- Parenchyma
- Ray cells
  - Ray tracheids
  - Ray parenchyma
- Epithelial cells



Source: Schoch

Softwood cell types - radial

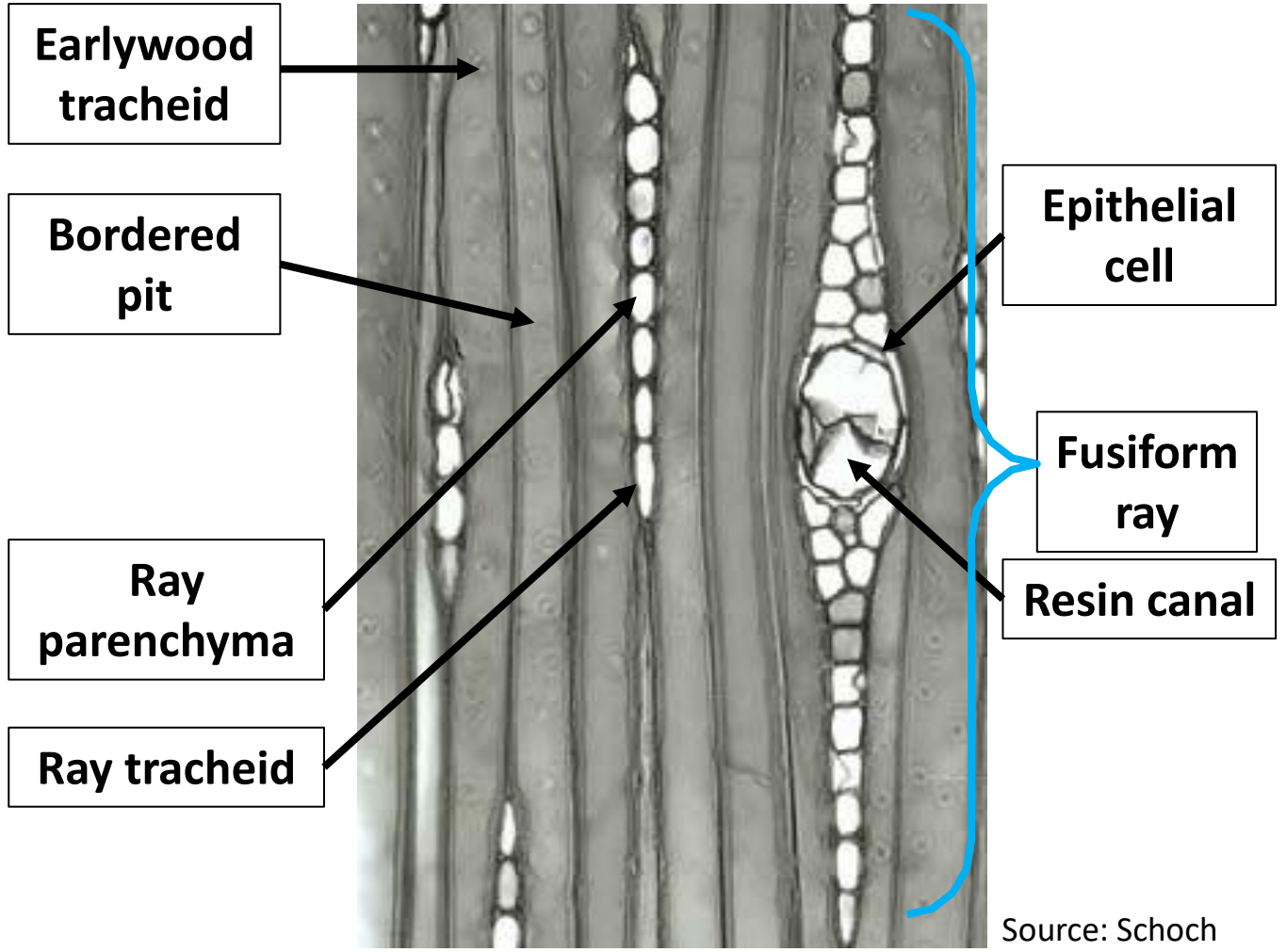
- Tracheids
- Parenchyma
- Ray cells
  - Ray tracheids
  - Ray parenchyma
- Epithelial cells



Source: Schoch

Softwood cell types - radial

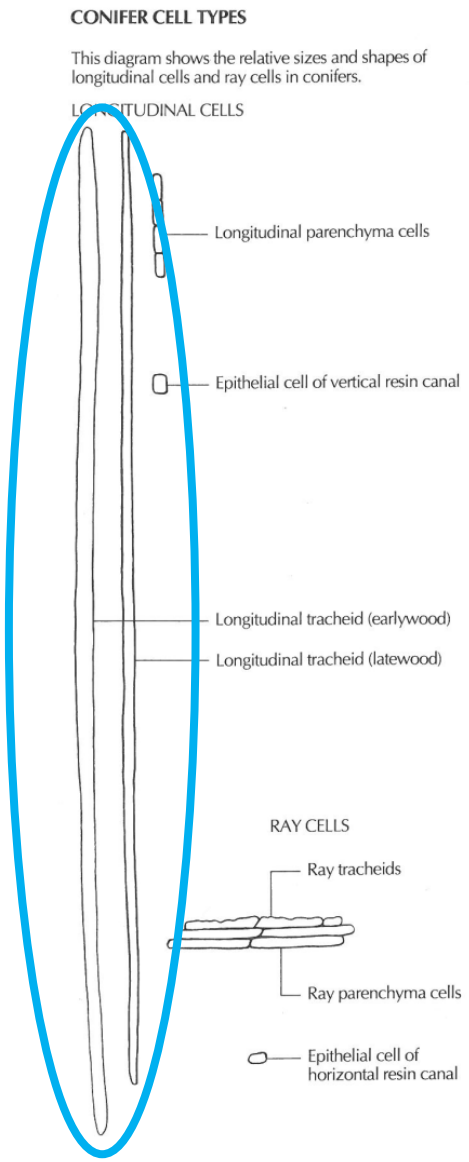
- Tracheids
- Parenchyma
- Ray cells
  - Ray tracheids
  - Ray parenchyma
- Epithelial cells



Source: Schoch

Longitudinal tracheids

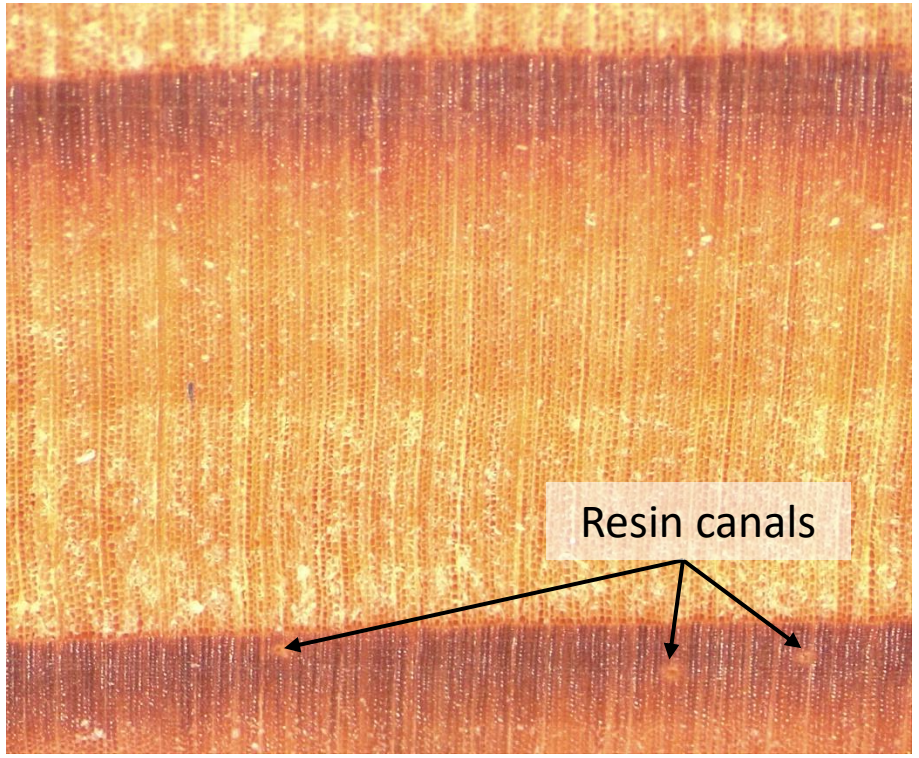
- 95 % of the volume of softwoods
- Closed ends
- Fluids pass through pits to other tracheids and through cross-field pits to ray cells for radial transfer
- **Function: longitudinal fluid transfer and support**



Source: Hoadley

Longitudinal tracheids

- 95 % of the volume of softwoods
  - Picture to right is almost entirely tracheids
- **Function: longitudinal fluid transfer and support**

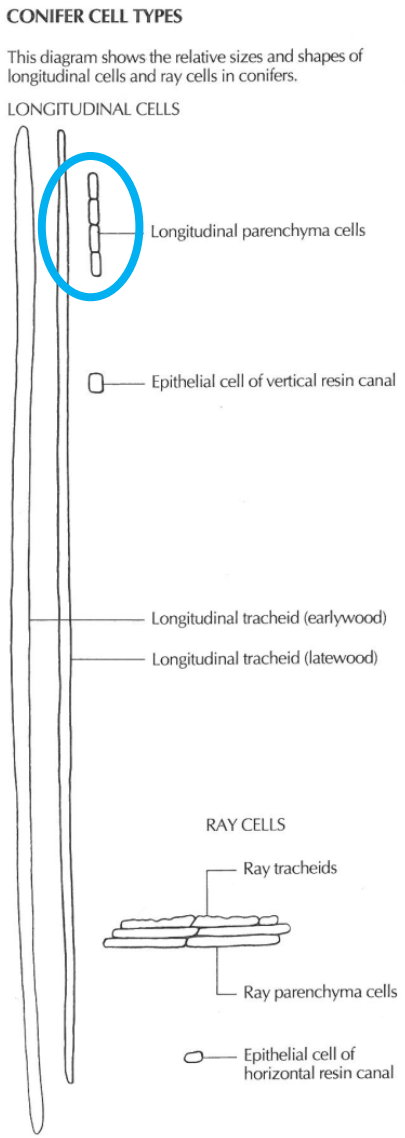


Source: Hanka Remšová, 2017

Pseudotsuga menziesii

Longitudinal parenchyma

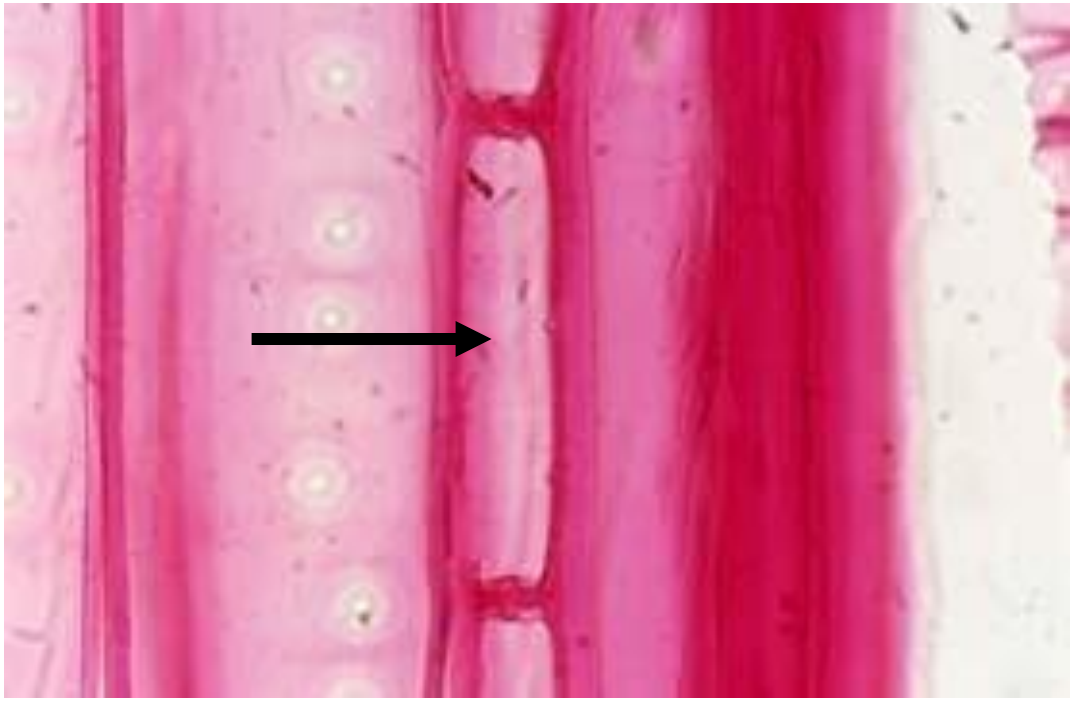
- Looks like hardwood parenchyma
- **Function: Carbohydrate storage when in sapwood**



Source: Hoadley

Longitudinal parenchyma

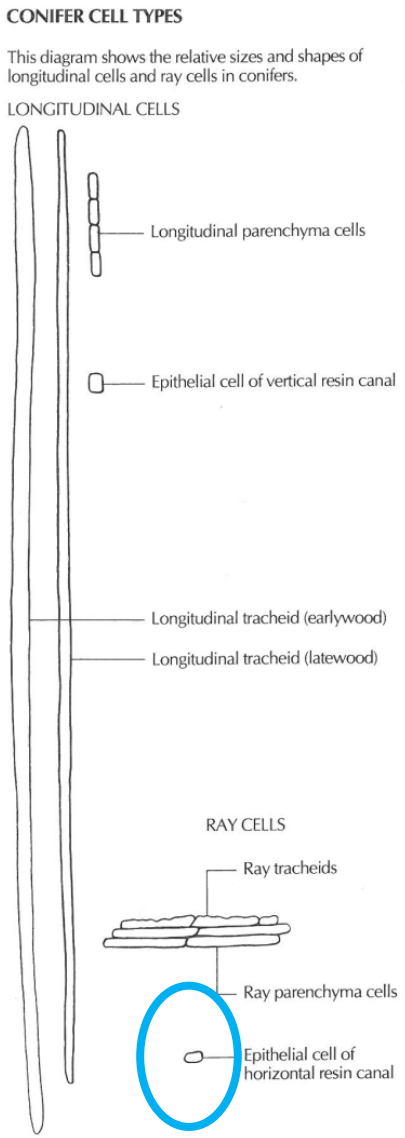
- Looks like hardwood parenchyma
- **Function: Carbohydrate storage when in sapwood**



Source: McDonald

Resin canals

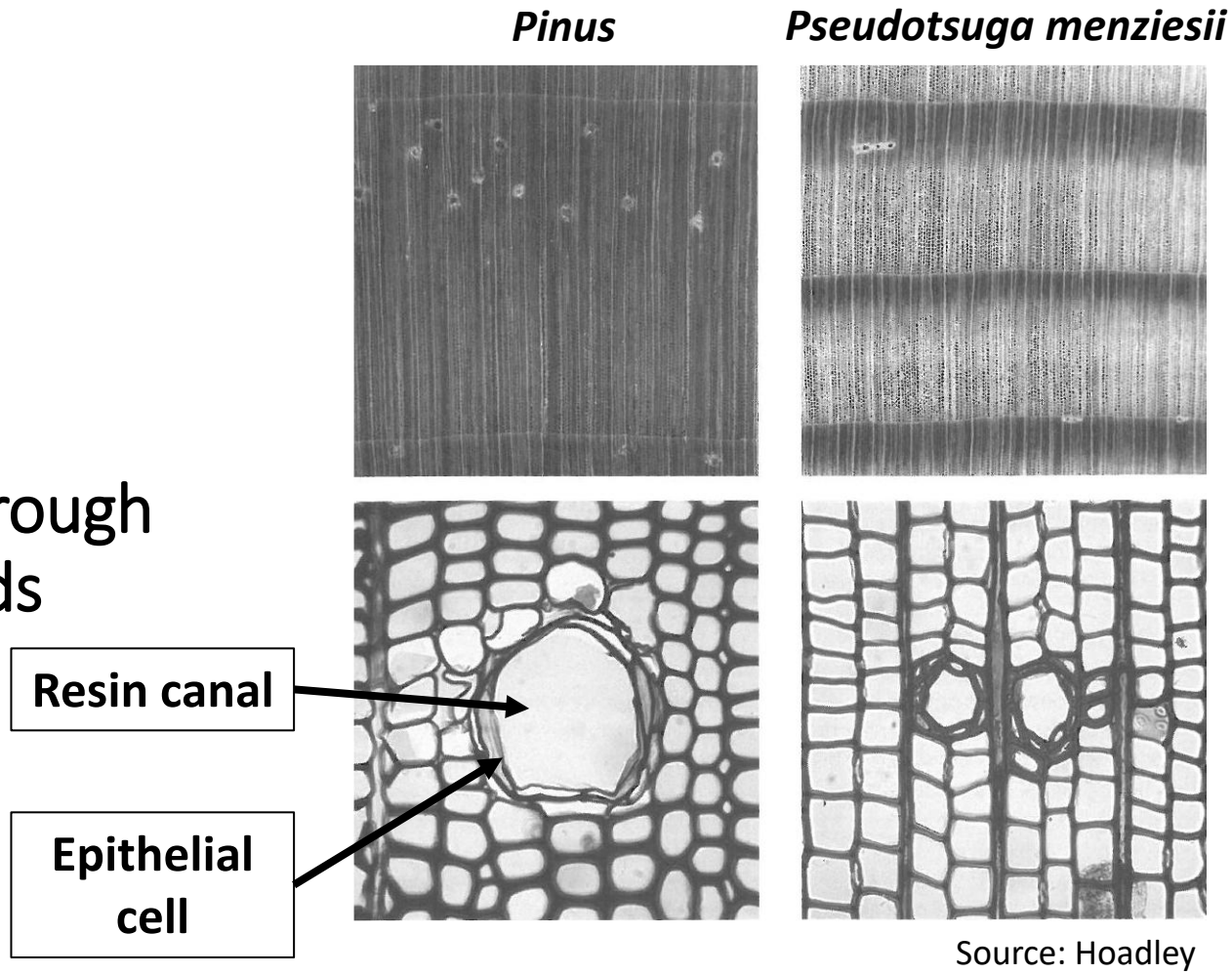
- Tubular passages
- Surrounded by special parenchyma cells called, epithelial cells
- **Function: transfer resin through canal for sealing off wounds**



Source: Hoadley

Resin canals

- Tubular passages
- Surrounded by special parenchyma cells called, epithelial cells
- **Function: transfer resin through canal for sealing off wounds**



Source: Hoadley

Resin canals

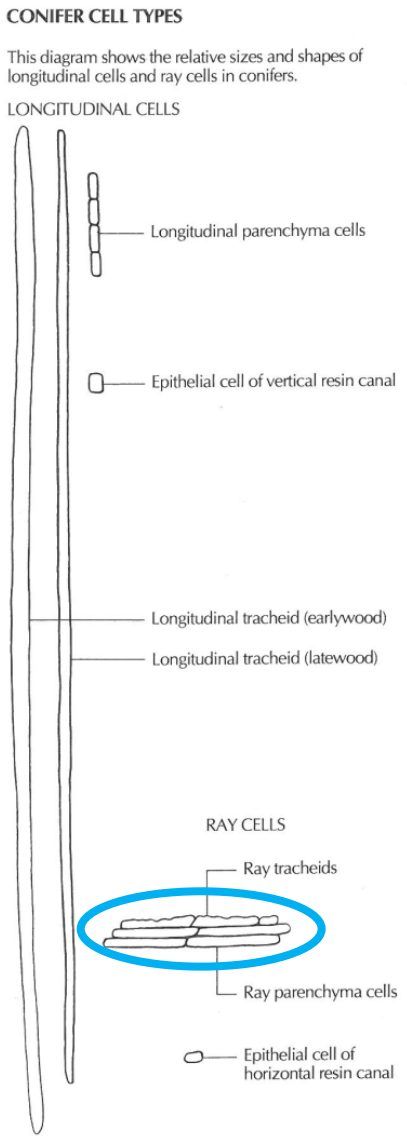
- Tubular passages
- Surrounded by special parenchyma cells called, epithelial cells
- **Function: transfer resin through canal for sealing off wounds**



Source: Mike Milota, OSU, WSE 521

Rays

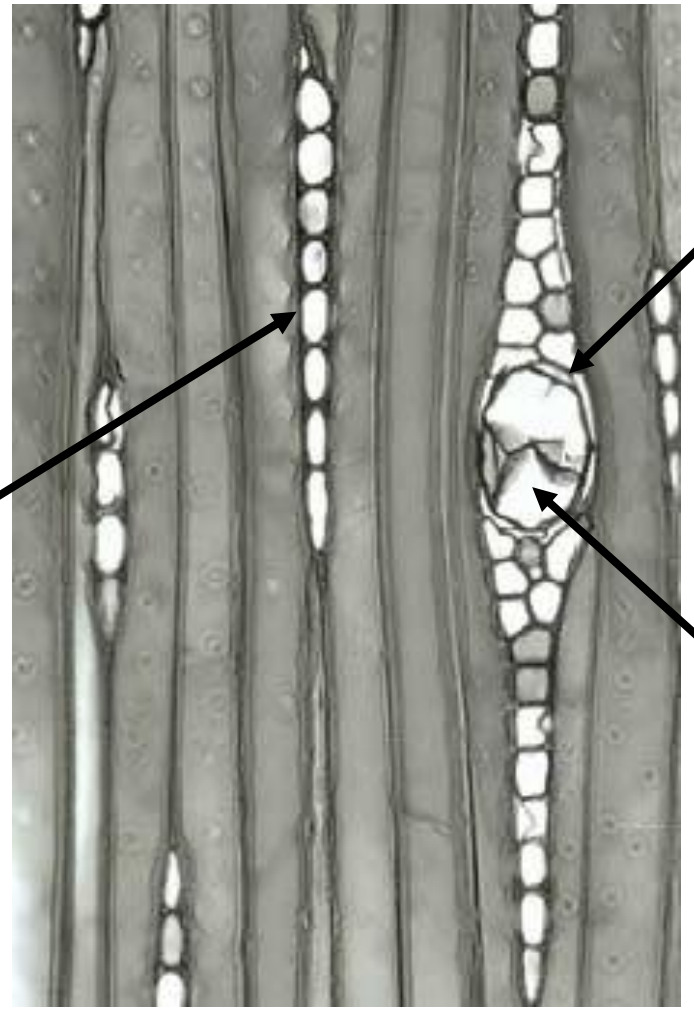
- Parenchyma cells *and* tracheids
- **Function: Horizontal transfer of fluids and storage of food**



Source: Hoadley

Rays

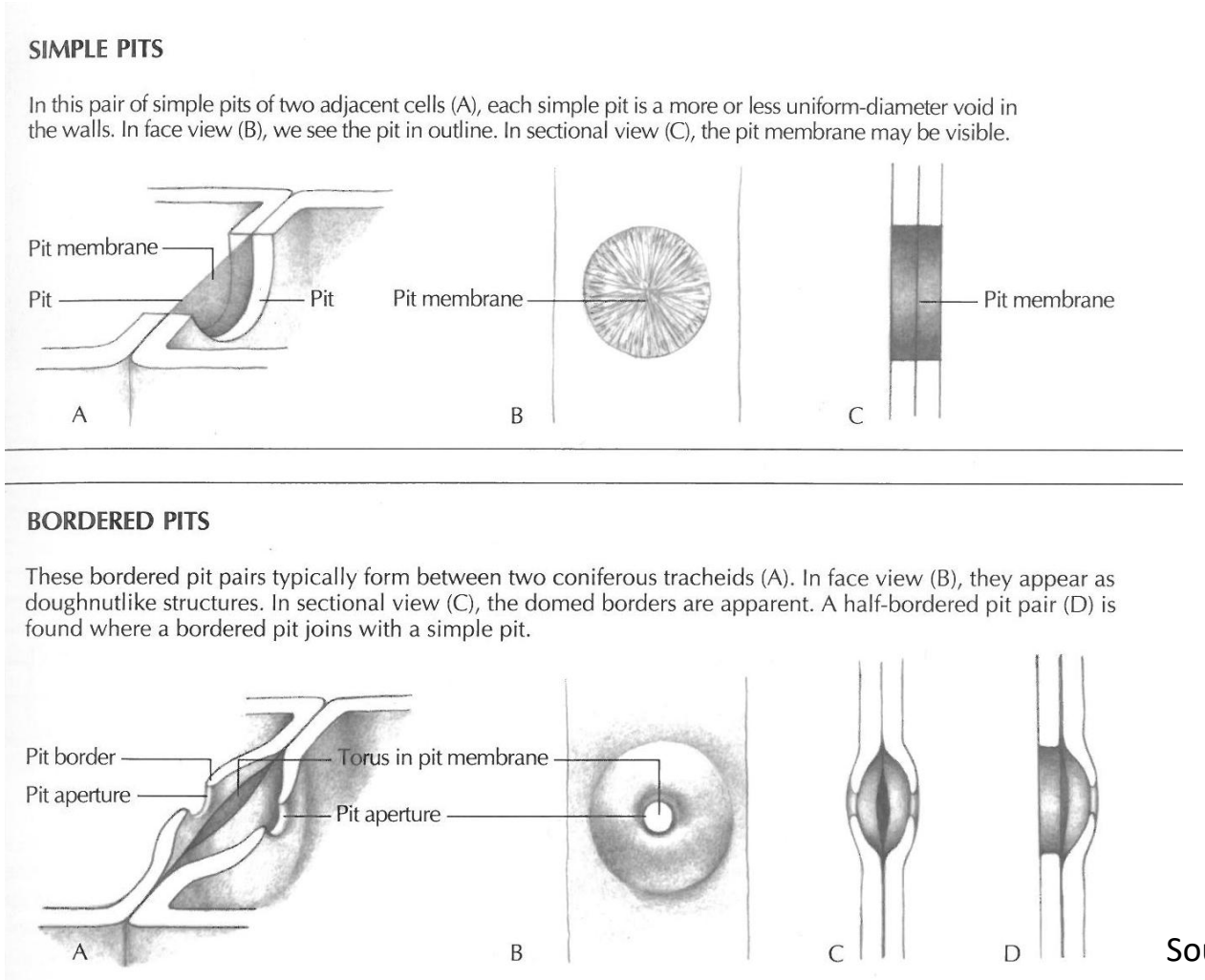
- Contain both parenchyma cells *and* tracheids
- **Function: Horizontal transfer of fluids and storage of food**



Source: Schoch

Pitting

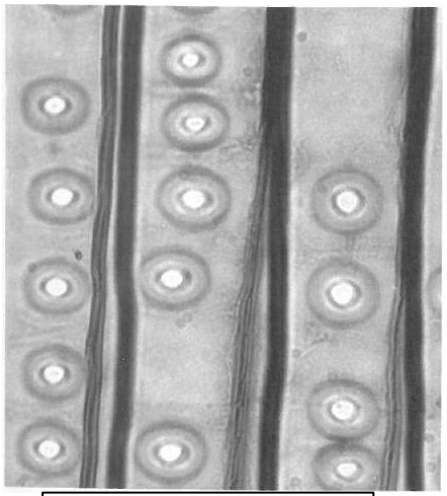
- Pit types
  - Simple
    - Found in longitudinal and ray parenchyma
  - Bordered
    - Along tracheids
- **Function: fluid transfer between cell walls**



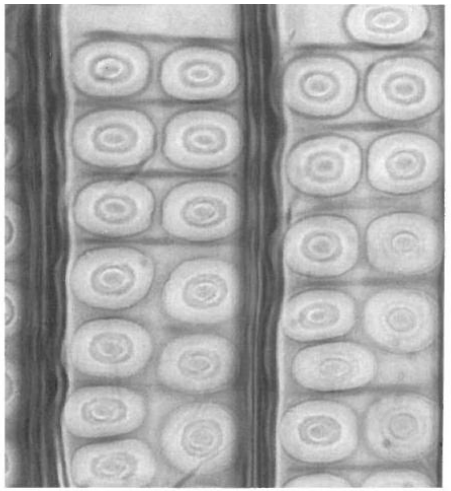
Source: Hoadley

Pitting

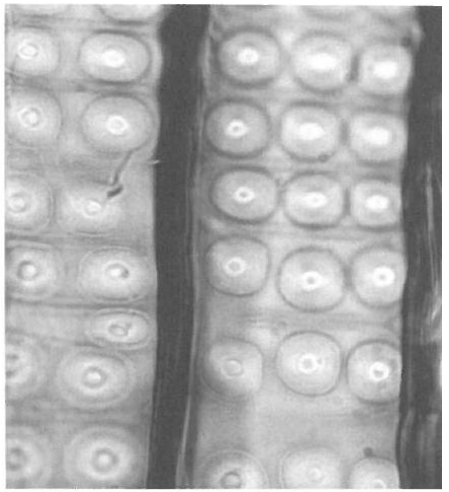
- Pit types
  - Simple
    - Found in longitudinal and ray parenchyma
  - Bordered
    - Along tracheids
- **Function: fluid transfer between cell walls**



Picea



Larix

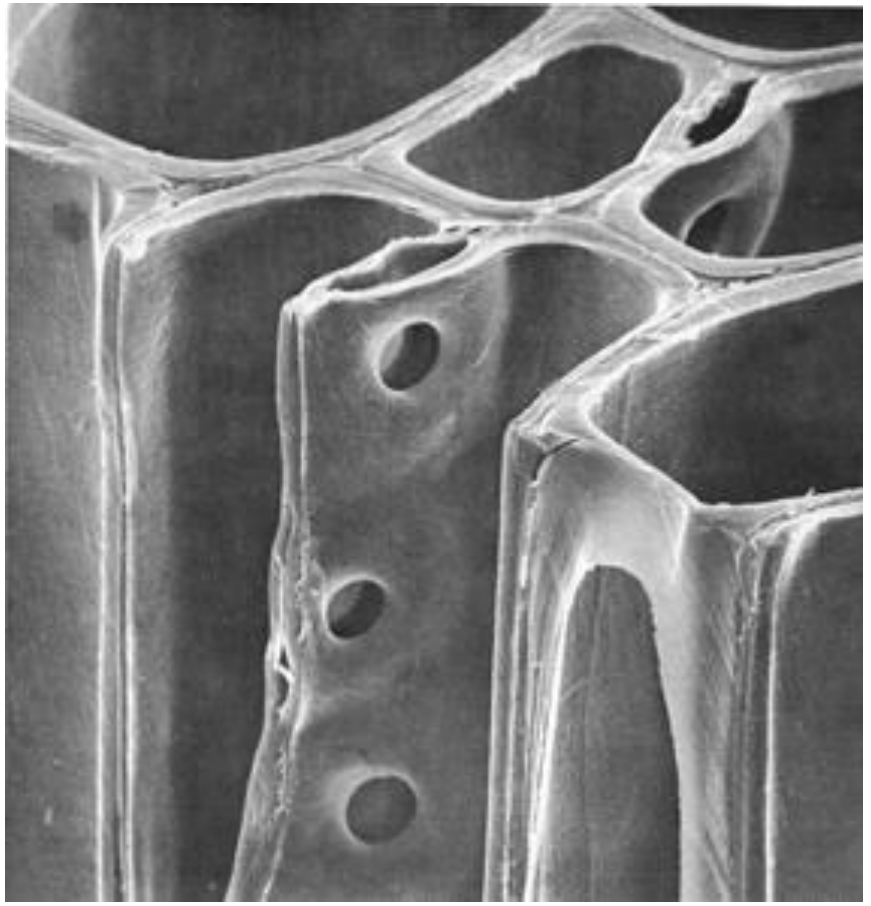


Sequoia

Source: Hoadley

Pitting

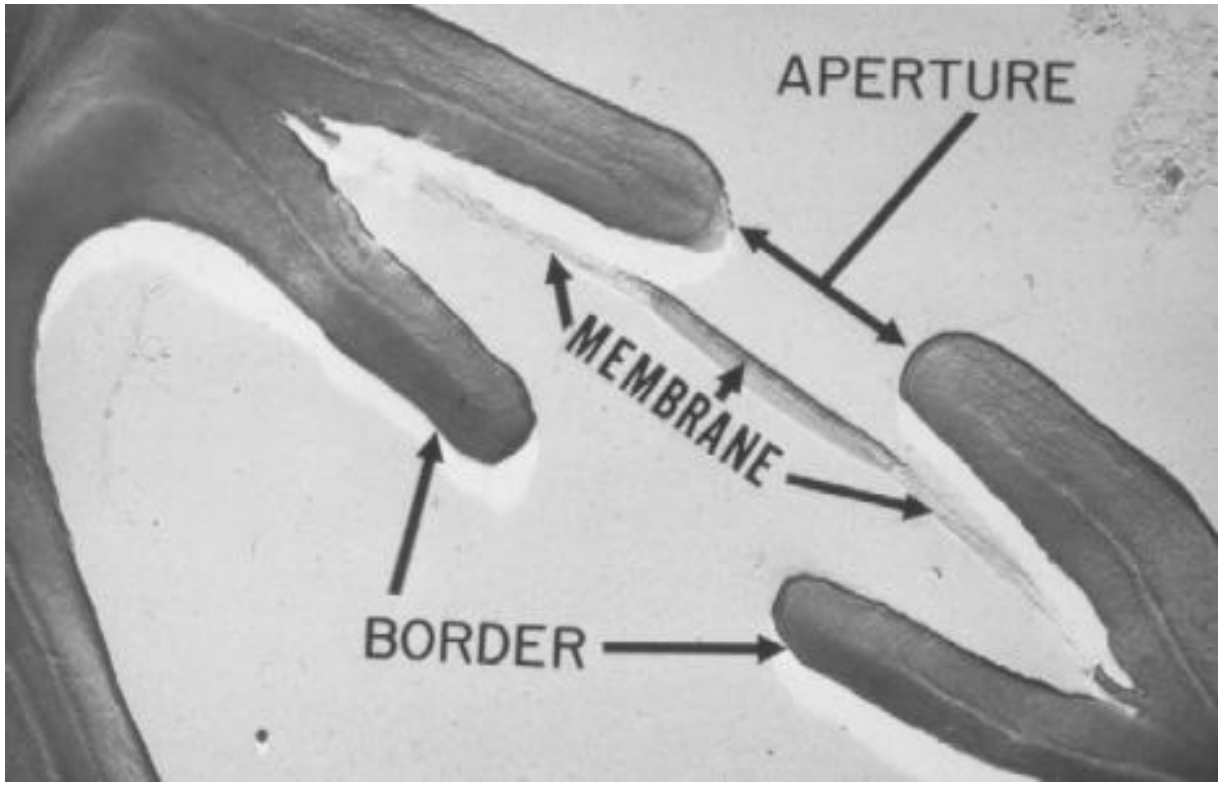
- Pit types
  - Simple
    - Found in longitudinal and ray parenchyma
  - Bordered
    - Along tracheids
- **Function: fluid transfer between cell walls**



Source: Meylan and Butterfield

Pitting

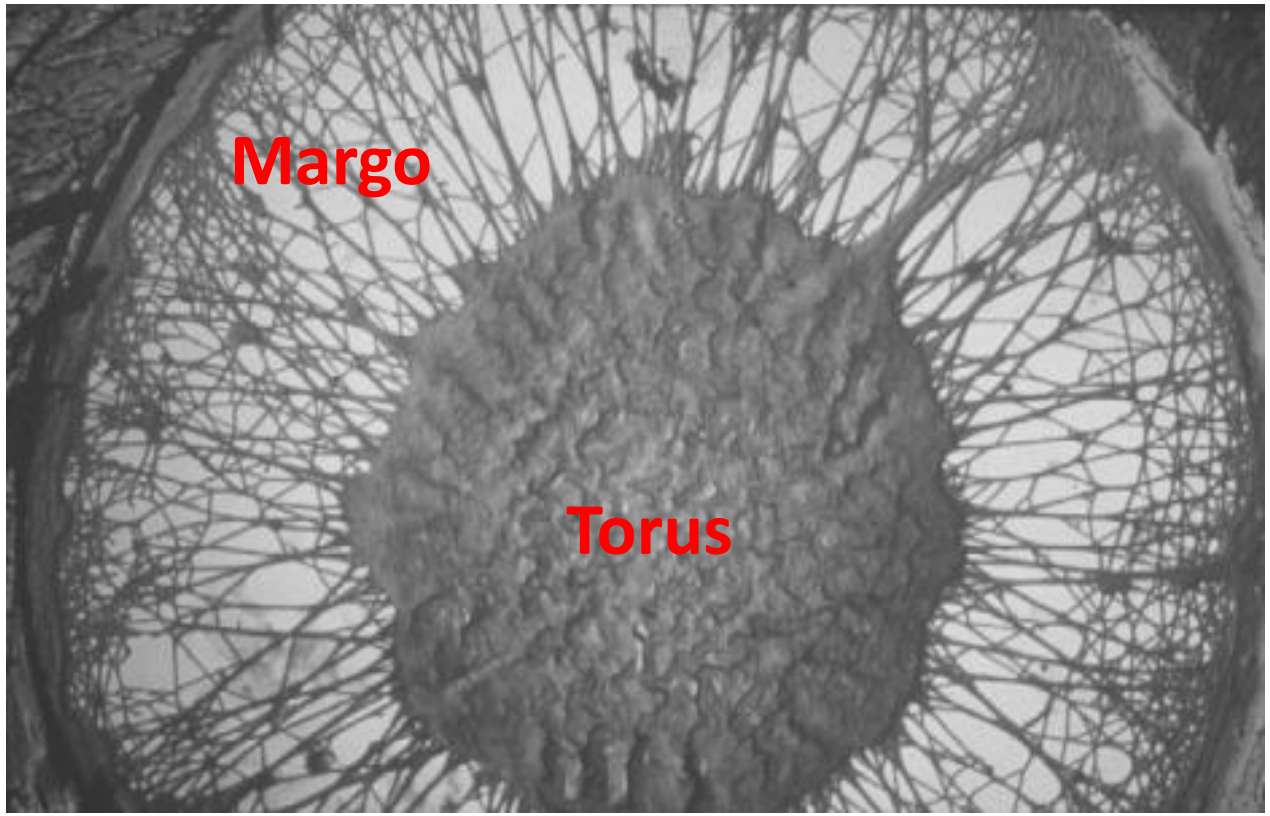
- Pit types
  - Simple
    - Found in longitudinal and ray parenchyma
  - Bordered
    - Along tracheids
- **Function: fluid transfer between cell walls**



Source: Core

Pitting

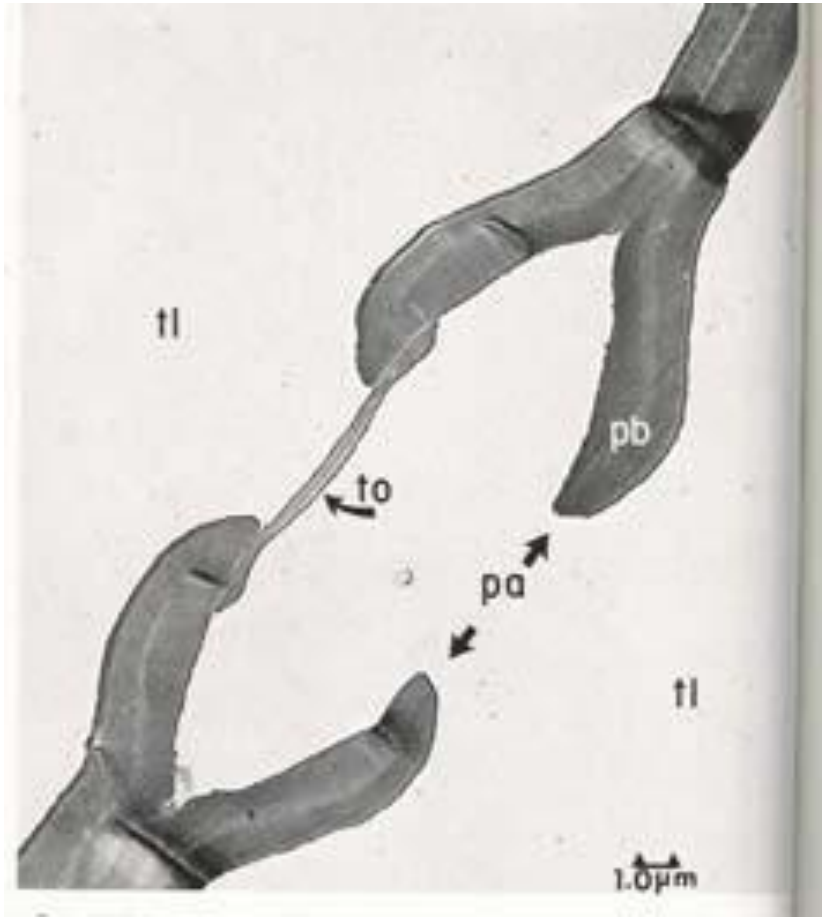
- Pit types
  - Simple
    - Found in longitudinal and ray parenchyma
  - Bordered
    - Along tracheids
- **Function: fluid transfer between cell walls**



Source: Barb Gartner, OSU

Pitting

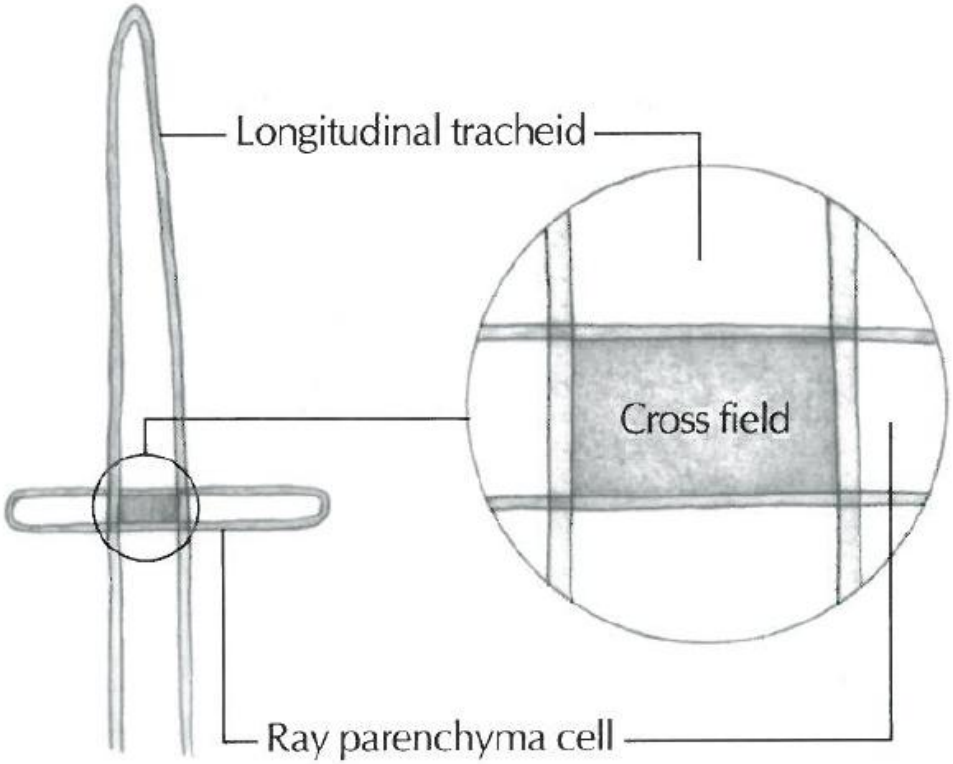
- Pit asperation
  - Reduces drying rate
  - Stops water transfer
- Asperation occurs when transferring from sapwood to heartwood



Source: Core

Cross-field pits

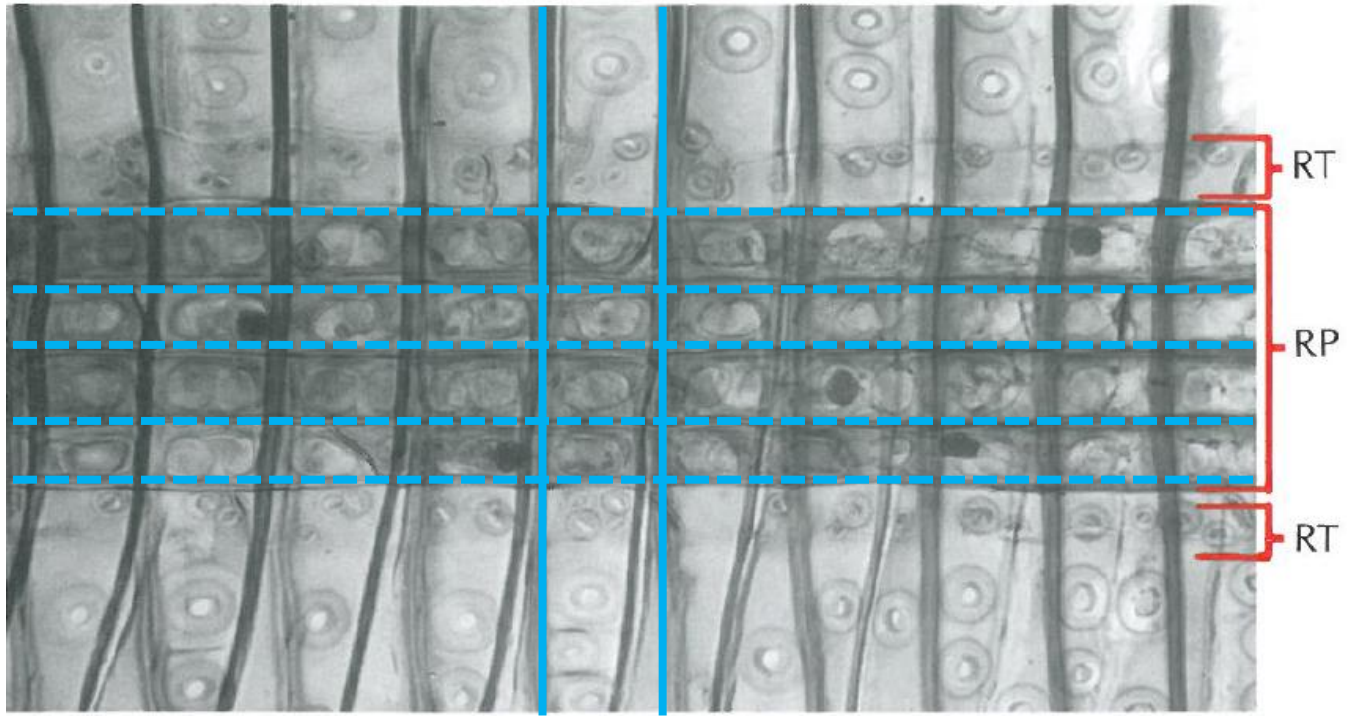
- Located at the intersection of ray parenchyma (dotted line - RP) and longitudinal tracheids (solid line)
- Can be helpful with some ID



Source: Hoadley

Cross-field pits

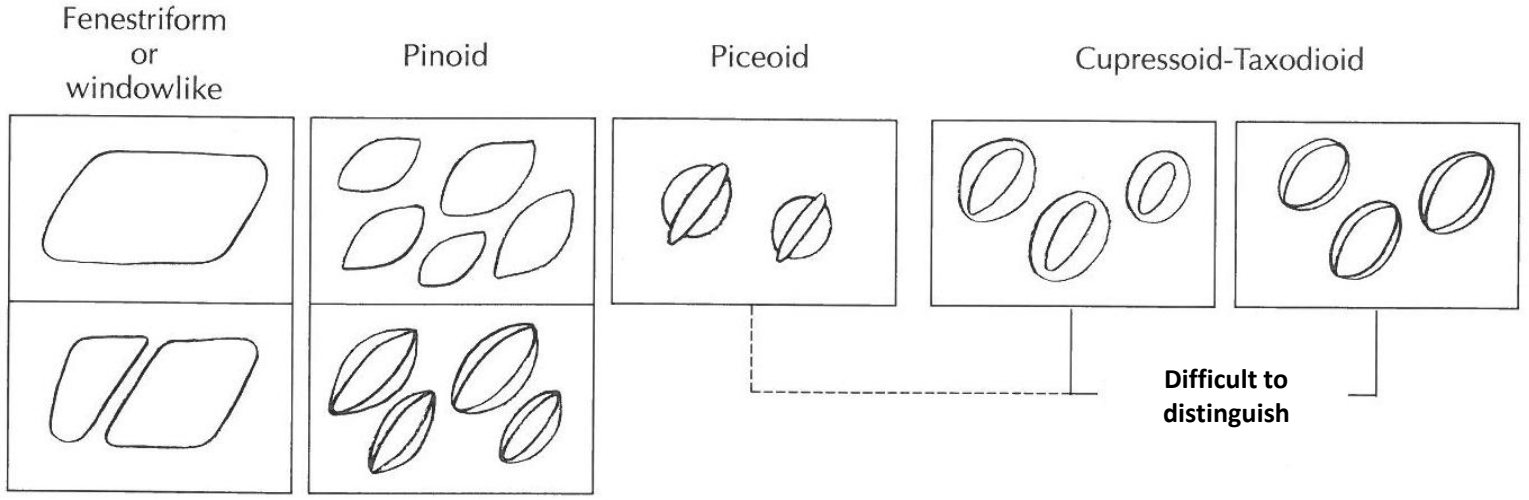
- Located at the intersection of ray parenchyma (dotted line - RP) and longitudinal tracheids (solid line)
- Can be helpful with some ID



Source: Hoadley

Cross-field pits – summary

- Fenestriform
  - Open and “window like”
- Pinoid
- Piceoid
  - Looks like a hot dog
  - Aperature extends beyond the border
- Cupressoid
  - Aperature is within the border
  - In species with no resin canals
- Taxodioid
  - Hard to differentiate from cupressoid
  - No resin canals

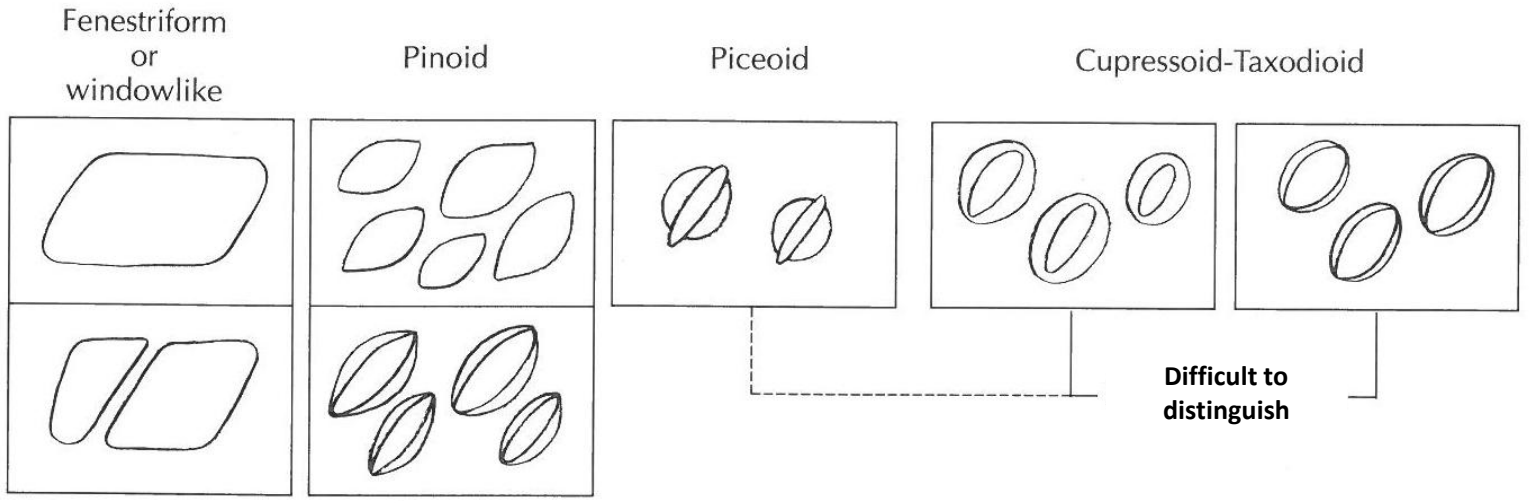


Source: Hoadley

Cross-field pits

Some associated species

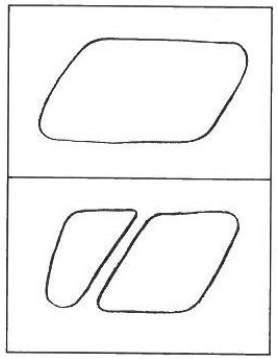
- Fenestriform
  - *Pinus sylvestris* – Scots pine
  - *Pinus strobus* – Eastern white pine
  - *Pinus resinosa* – Red pine
- Pinoid
  - *Pinus echinate* – Shortleaf pine
  - *Pinus taeda* – Loblolly pine
- Piceoid
  - *Pseudotsuga menziesii* – Douglas-fir
  - *Larix spp.* - Larch
  - *Picea spp.* - Spruce
- Cupressoid
  - *Juniperus virginiana* – Eastern redcedar
- Taxodioid
  - *Sequoia sempervirens* - Redwood
  - *Abies concolor* – White fir

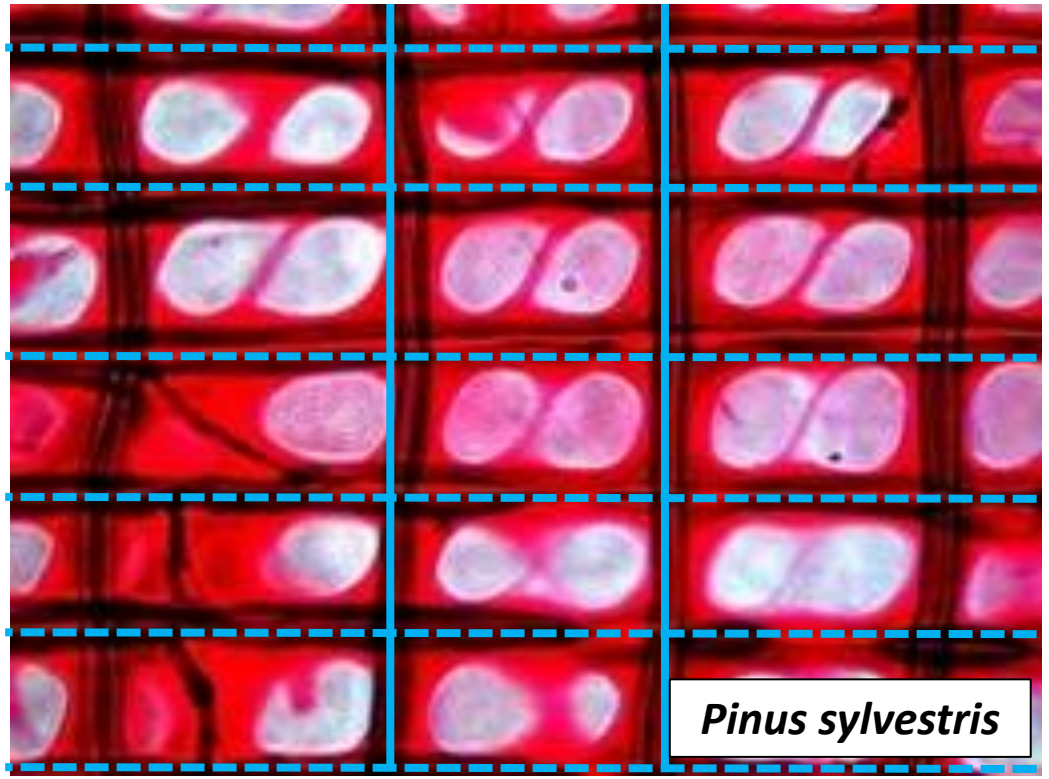


Source: Hoadley

Cross-field pits - Fenestriform

- Located at the intersection of rays (dotted line) and longitudinal tracheids (solid line)
- **Fenestriform**
  - *Pinus sylvestris*
  - *Pinus strobus*
  - *Pinus resinosa*



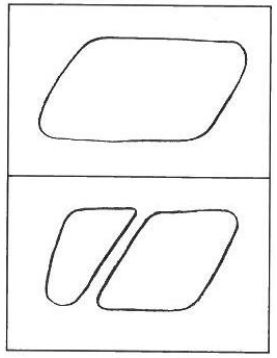


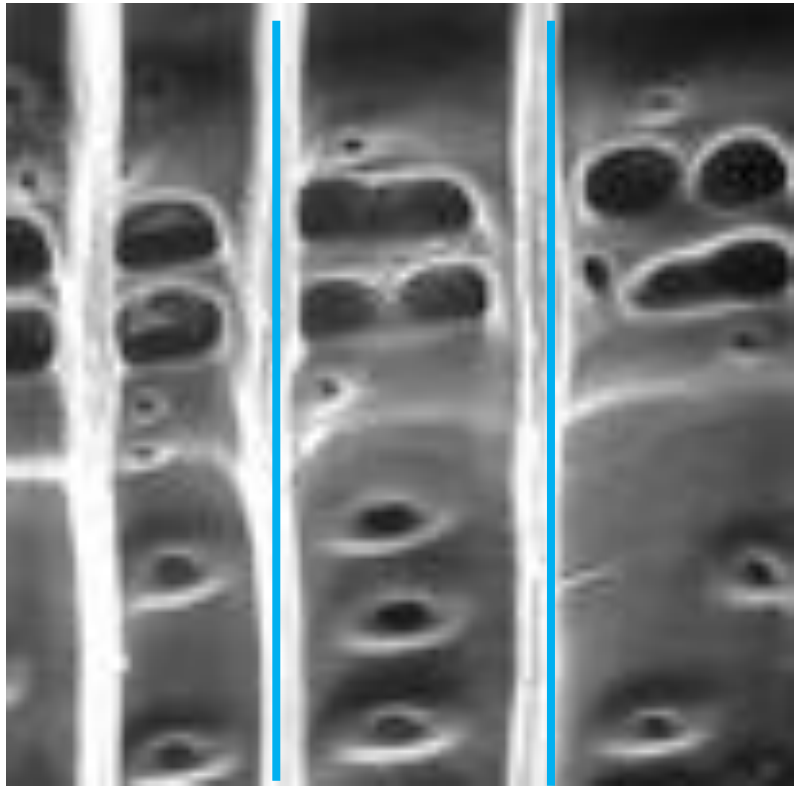
Longitudinal tracheid

Source: Schoch

Cross-field pits - Fenestriform

- Located at the intersection of rays (dotted line) and longitudinal tracheids (solid line)
- **Fenestriform**
  - *Pinus sylvestris*
  - *Pinus strobus*
  - *Pinus resinosa*



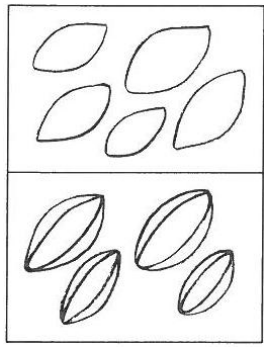


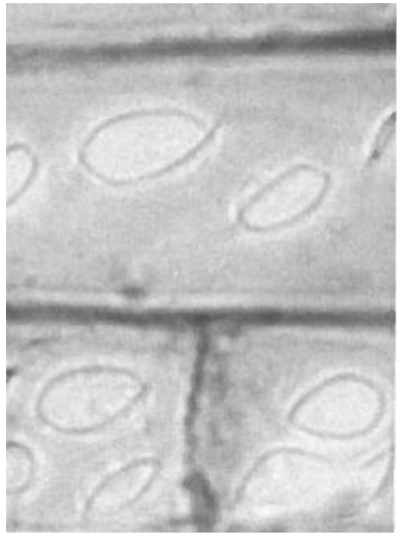
Source: Mike Milota, OSU, WSE 521

Longitudinal tracheid

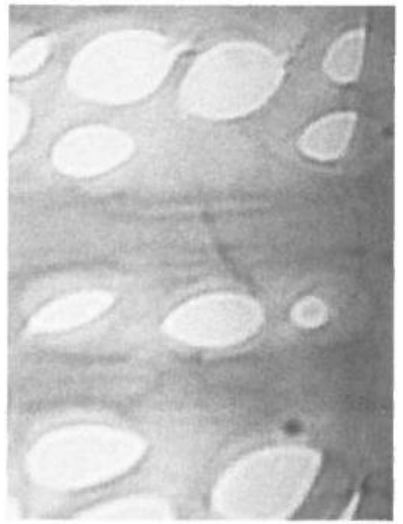
Cross-field pits - Pinoid

- Located at the intersection of rays (dotted line) and longitudinal tracheids (solid line)
- **Pinoid**
  - *Pinus echinate*
  - *Pinus taeda*





Pinus echinate



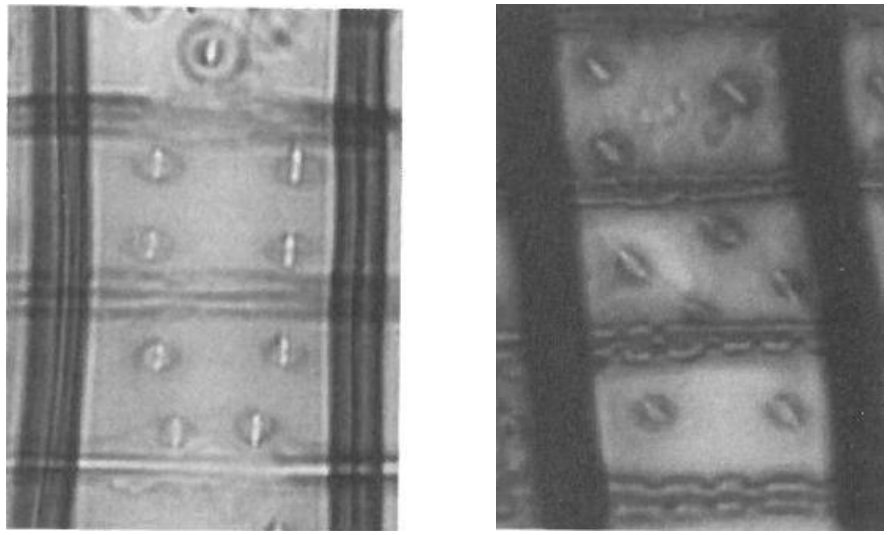
Pinus taeda

Source: Hoadley

Cross-field pits - Piceoid

- Located at the intersection of rays (dotted line) and longitudinal tracheids (solid line)
- **Piceoid**
  - *Pseudotsuga menziesii*
  - *Picea spp.*
  - *Larix spp.*



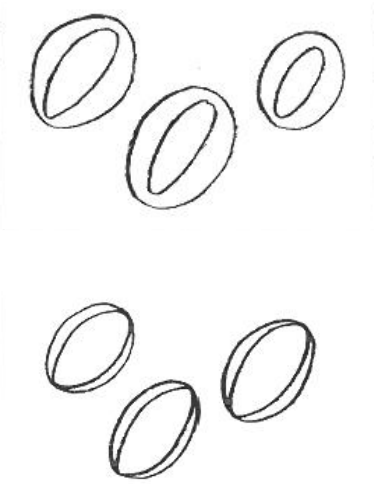


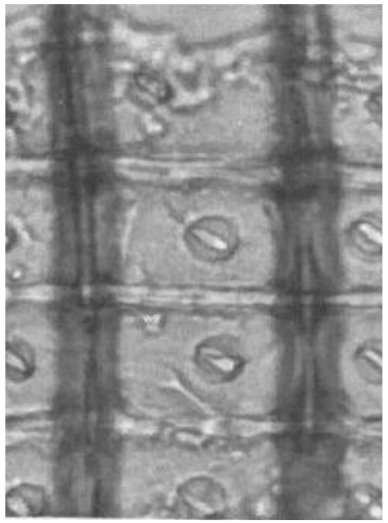
Picea spp.

Source: Hoadley

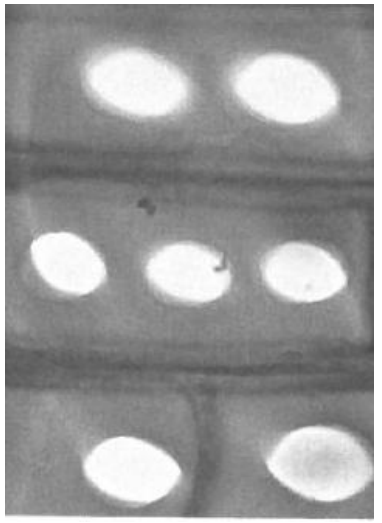
Cross-field pits – Cupressoid/Taxodioid

- Located at the intersection of rays (dotted line) and longitudinal tracheids (solid line)
- **Cupressoid-Taxodioid**
  - *Sequoia sempervirens*
  - *Abies concolor*
  - *Juniperous virginiana*





Juniperous virginiana



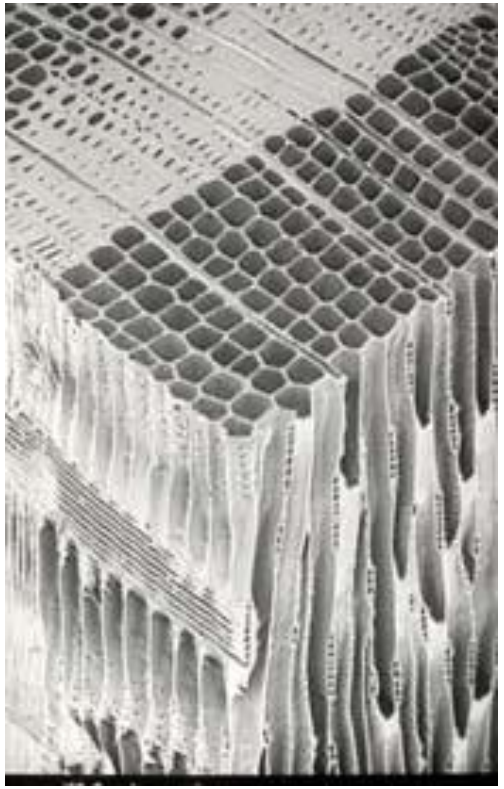
Sequoia sempervirens

Source: Hoadley

Spiral thickening

- Occurs in tracheids of two conifer species
  - *Psuedotsuga menzisii*
  - *Taxus baccata*
- The inside of tracheids is usually smooth

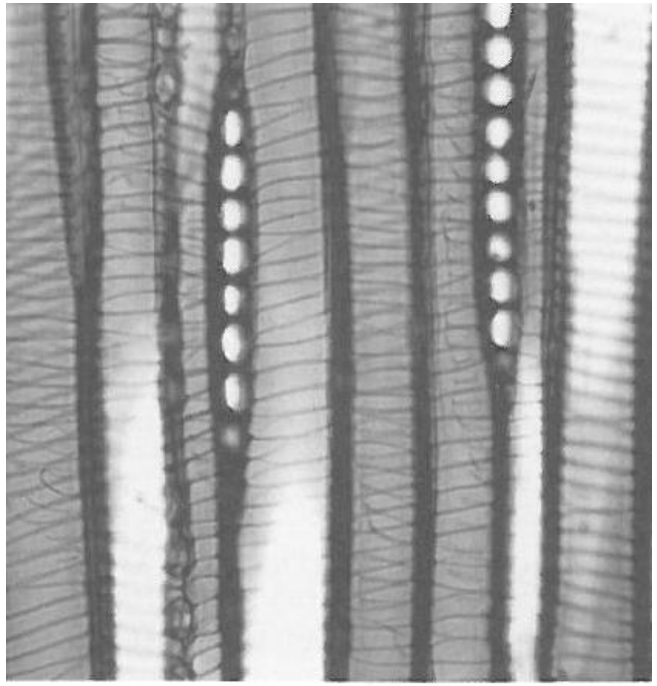


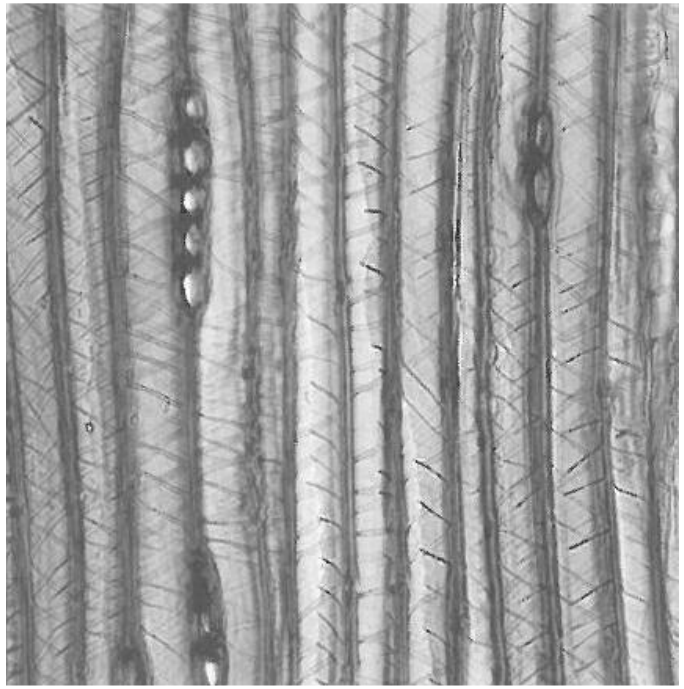


Source: Meylan and Butterfield

Spiral thickening

- Occurs in tracheids of two conifer species
  - *Psuedotsuga menziesii* – left image
  - *Taxus baccata* – right image
- The inside of tracheids is usually smooth





Source: Hoadley

References

- Core, H.A., W.A. Côté, and A.C. Day. 1979. Wood structure and identification. Syracuse Press, Syracuse, NY.192 pp.
- Hoadley, R. Bruce. 1990. *Identifying Wood: Accurate Results with Simple Tools*. Taunton Press. 240 pp.
- Milota, M. 2010. Oregon State University. Wood Science and Engineering, WSE 521, Wood Science 1, Class Lectures.
- Meylan, B.A. and B.G. Butterfield. Three-dimensional structure of wood. Syracuse Press. Syracuse, NY. 80 pp.
- Schoch, W., Heller, I., Schweingruber, F.H., Kienast, F., 2004. Wood anatomy of central European species. Online version: www.woodanatomy.ch [Oct. 20, 2017].