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# WOOD STRUCTURE & PROPERTIES

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# Aim

- Position of wood
- Relationship with living tree physiology
- Differences among timbers
- Impact on properties





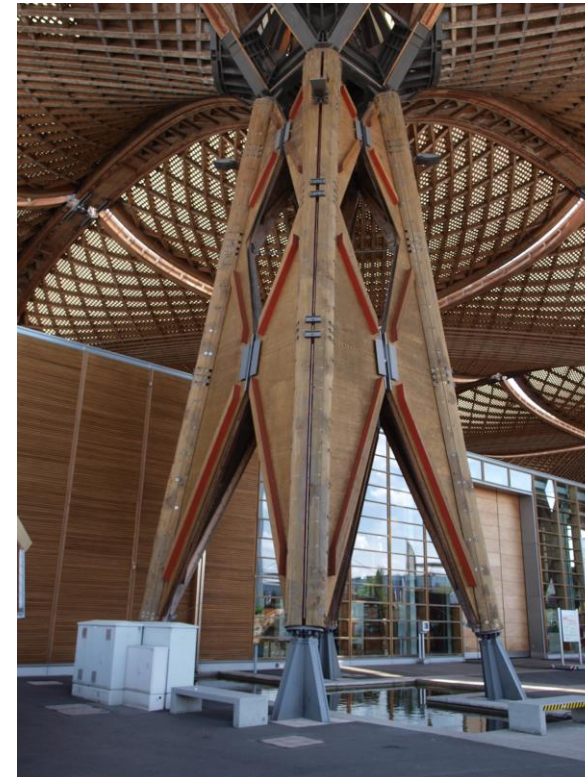


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## Position

- One of oldest materials
- One of the most favourite materials
- Has not been still replaced
- Irreplaceable in some areas
- No over-supply in the future



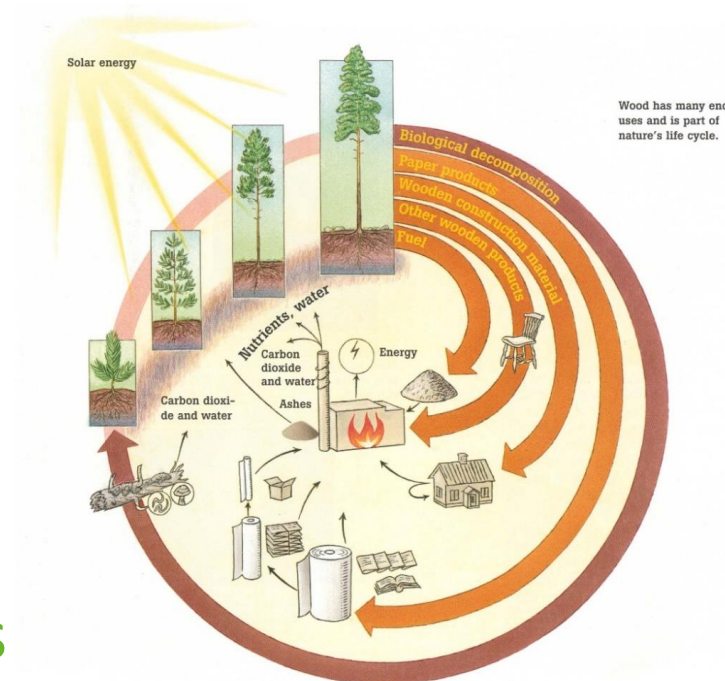






# Reasons

- Natural (no chemicals)
- „It grows by itself“
- Renewable material
- Availability
- Low weight x high strength
- Easy to handle
- Easy to work
- Good thermal insulating properties





## Problems

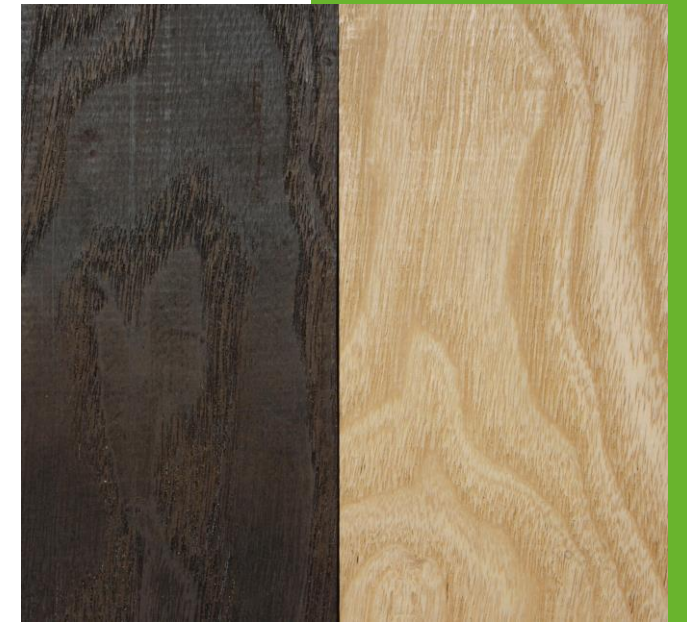
- Great **variability** in structure and properties
- **Hygroscopicity**  
(linked with changes of dimensions, shape and properties)
- Easy to set on **fire** and burn
- Low **resistance** and durability
- **Anisotropy**  
(strength / constructions)





## Prospects

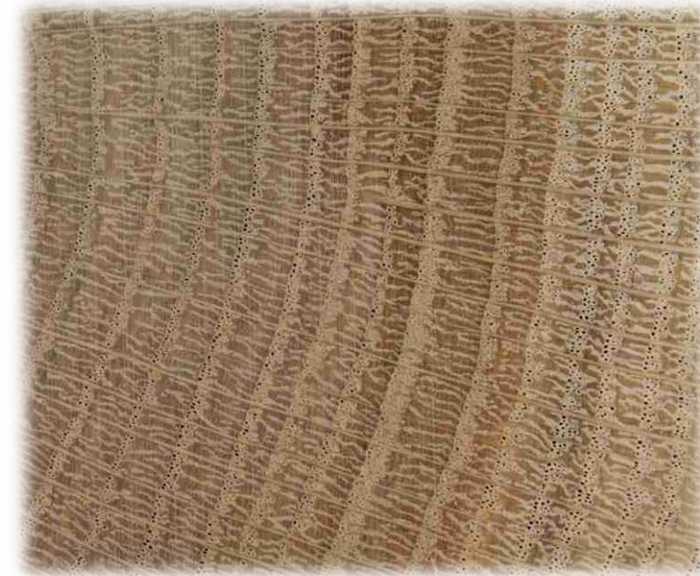
- Popular in history, popular today ....popular in future
- Irreplaceable in some areas
- Comeback of wood (new materials, modification)
- Probably shortage in the future
- Threats  
(climate change, fires, change in tree species, ...)





## Wood forming

- Wood is a „product“ of living trees
- All parts (e.g. cells) accommodated to tree physiology
- Possibility to influence wood quality
- Cambium is producing new cells (growth rings)

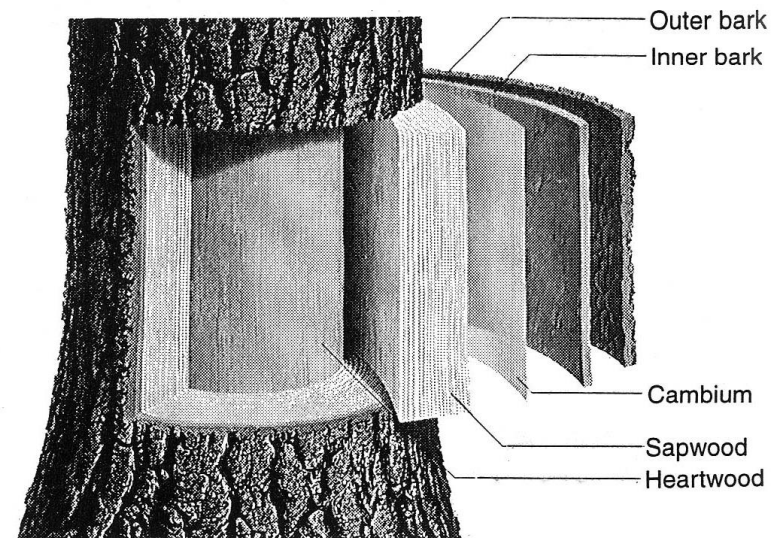






# Cambium

- Produces new cell ( xylem / phloem)
- Whole life of a tree
- Increase diameter
- Not present in palm and bamboo



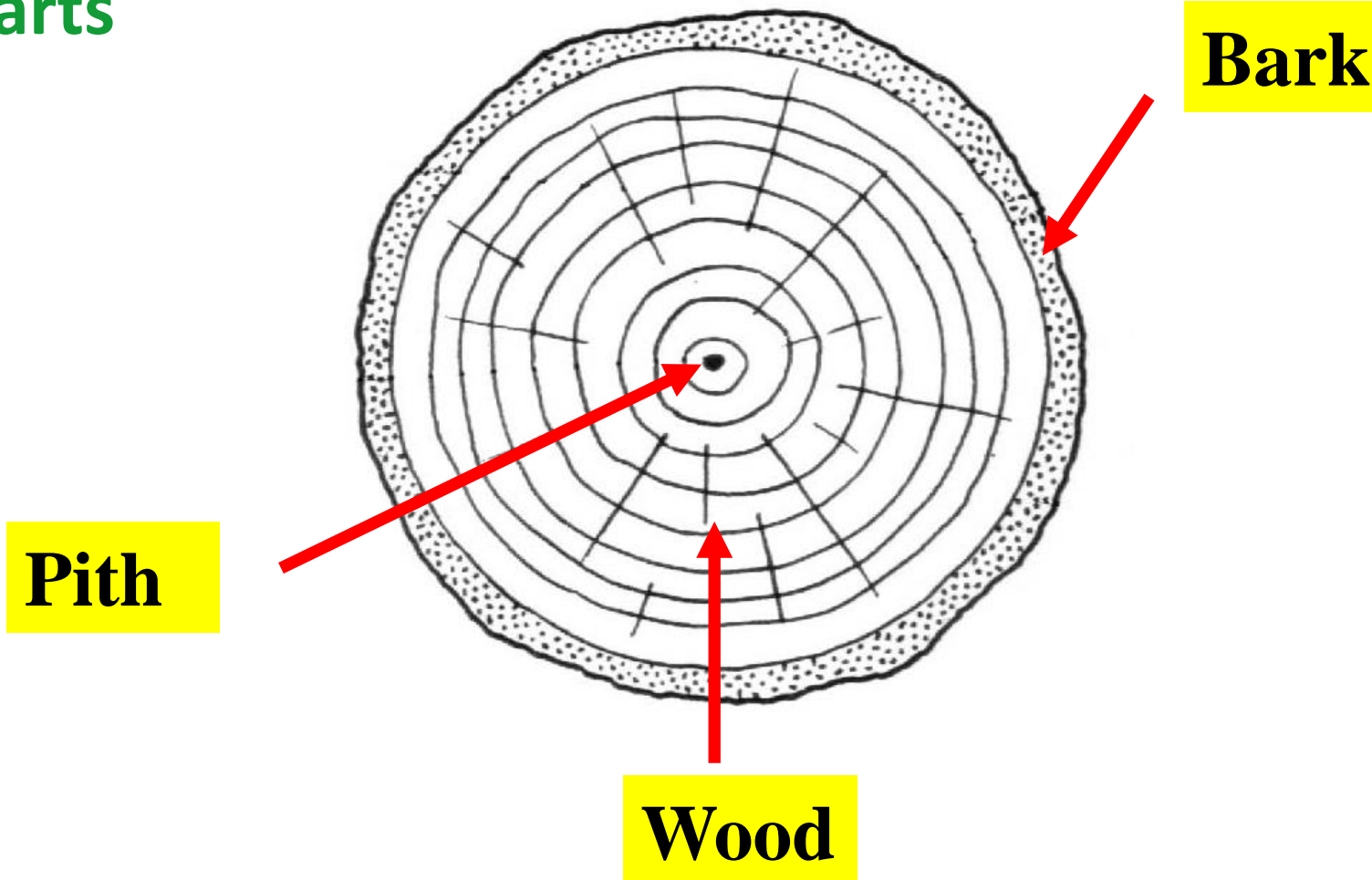


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## Stem parts

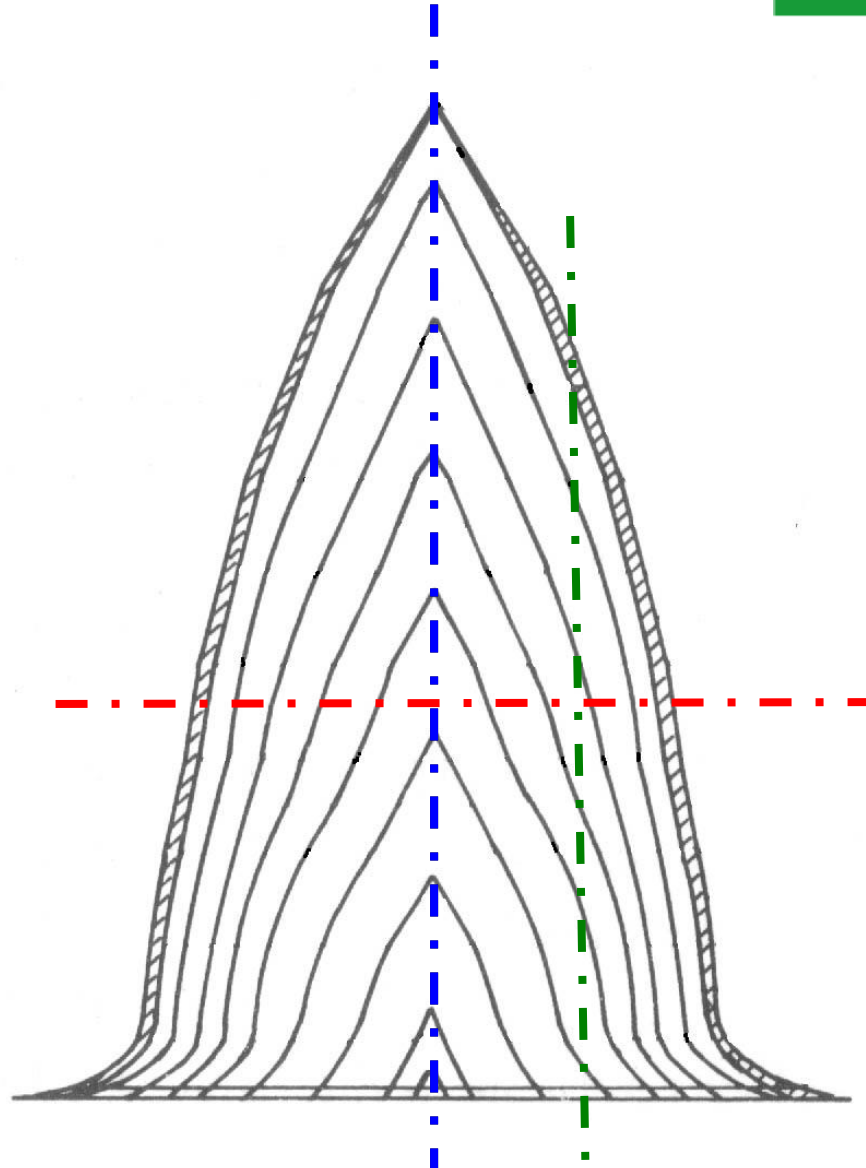
- Bark
- Wood
- Pith





## Sections

- We study structure on different sections
- Different appearance





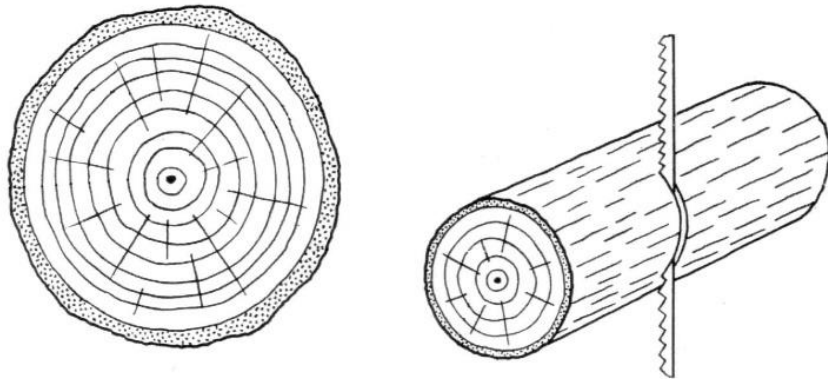


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## Cross section

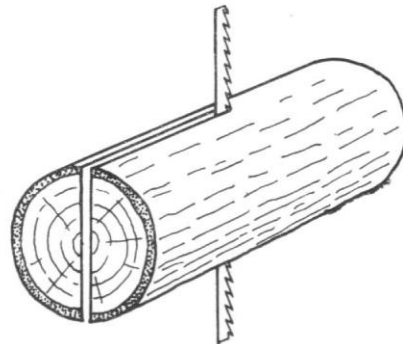
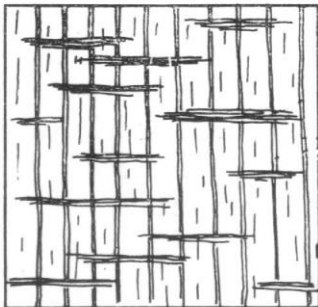
- Cut perpendicular to the stem axis
- Growth rings visible as circles





## Radial section

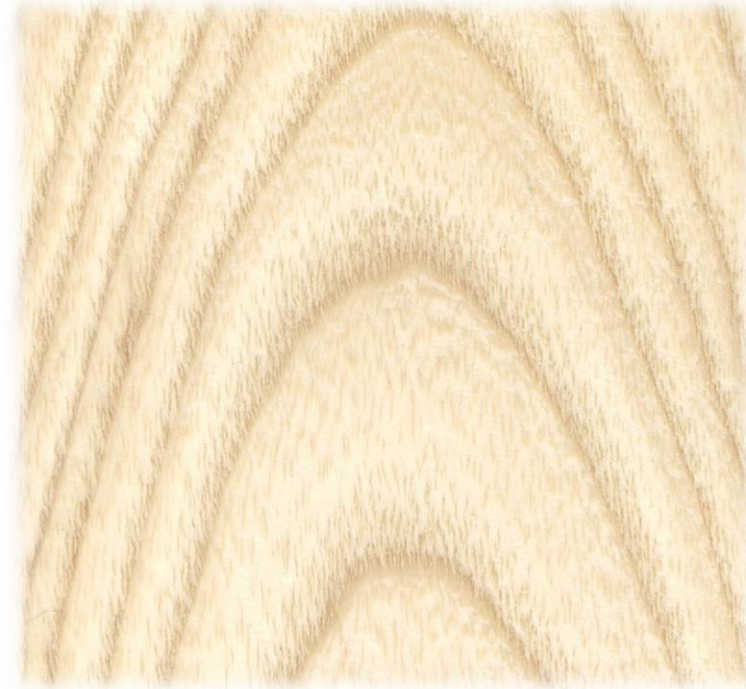
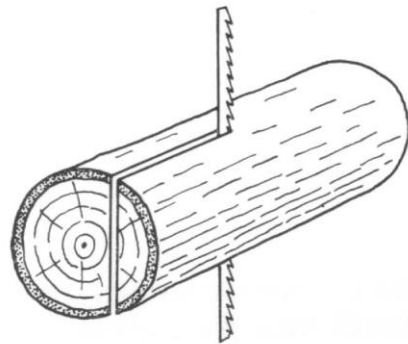
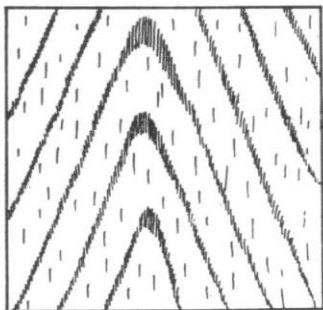
- Cut parallel to the axis
- Through the pith
- Growth rings like parallel lines





## Tangential section

- Cut parallel to the axis
- Aside from the pith
- Growth rings like parabolas







## Macroscopic features

- Visible by naked eye
- Occurrence of features (arrangement, shape, colour, ...) is typical for timbers
- Possibility of identification





## Macroscopic features

1. Growth rings
2. Vessels
3. Heartwood
4. Rays
5. Axial parenchyma
6. Colour, scent, weight, figure, ...





## Growth rings

- Cambial activity
- Visibility (temperate / tropical zone)
- In temperate zone annual rings (= age)
- No rings in palms and bamboo





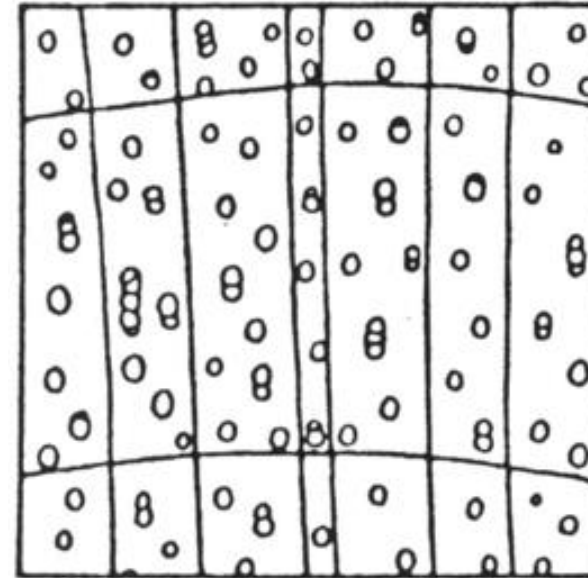
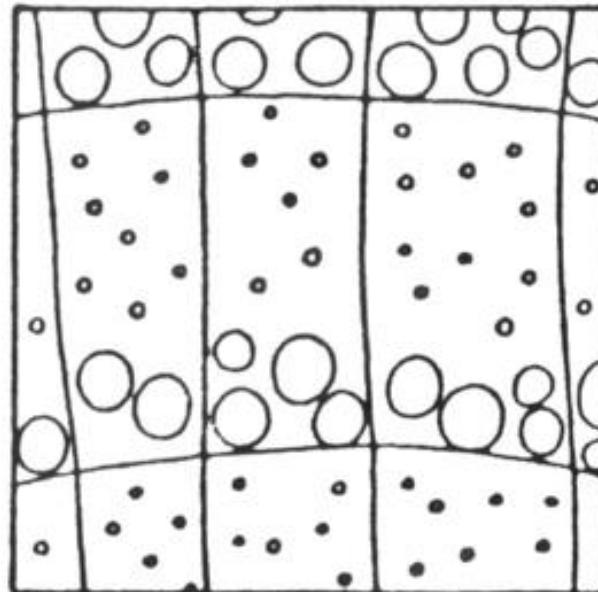


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## Vessels

- Ring porous x diffuse porouse
- Visibility (diameter)
- Arrangement





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## Vessels - Visibility





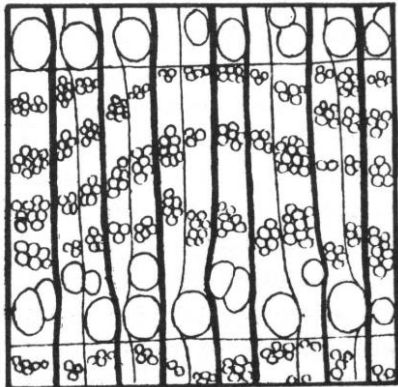


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## Vessels - Arrangement

- Radial
- Tangential
- Diagonal (Eucalyptus)







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# Heartwood

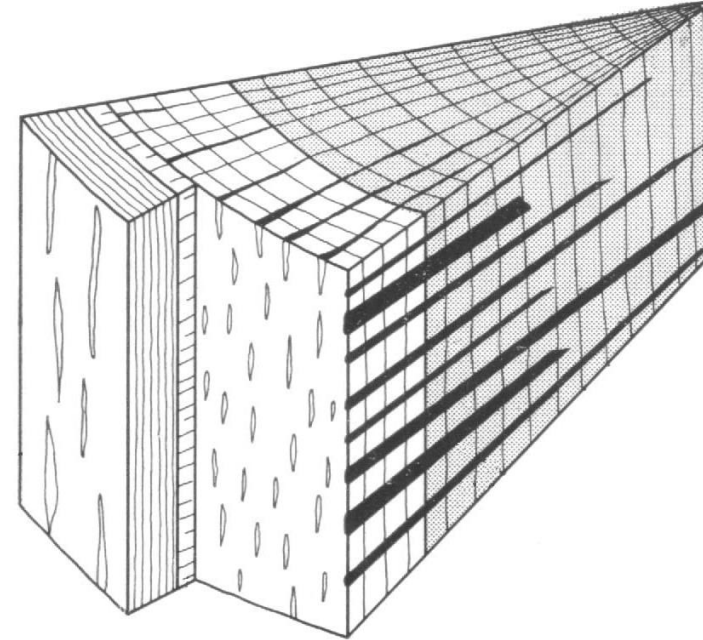
- Central darker part
- Different colour
- Extractives
- Better properties (durability) compared to sapwood





## Rays

- Parenchyma tissue
- Oriented horizontally
- Visibility (sections)
- Transportation, storage function
- Impacting properties  
(difference radial x tangential direction)





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## Rays - visibility

1. All sections
2. Radial
3. Not by eye





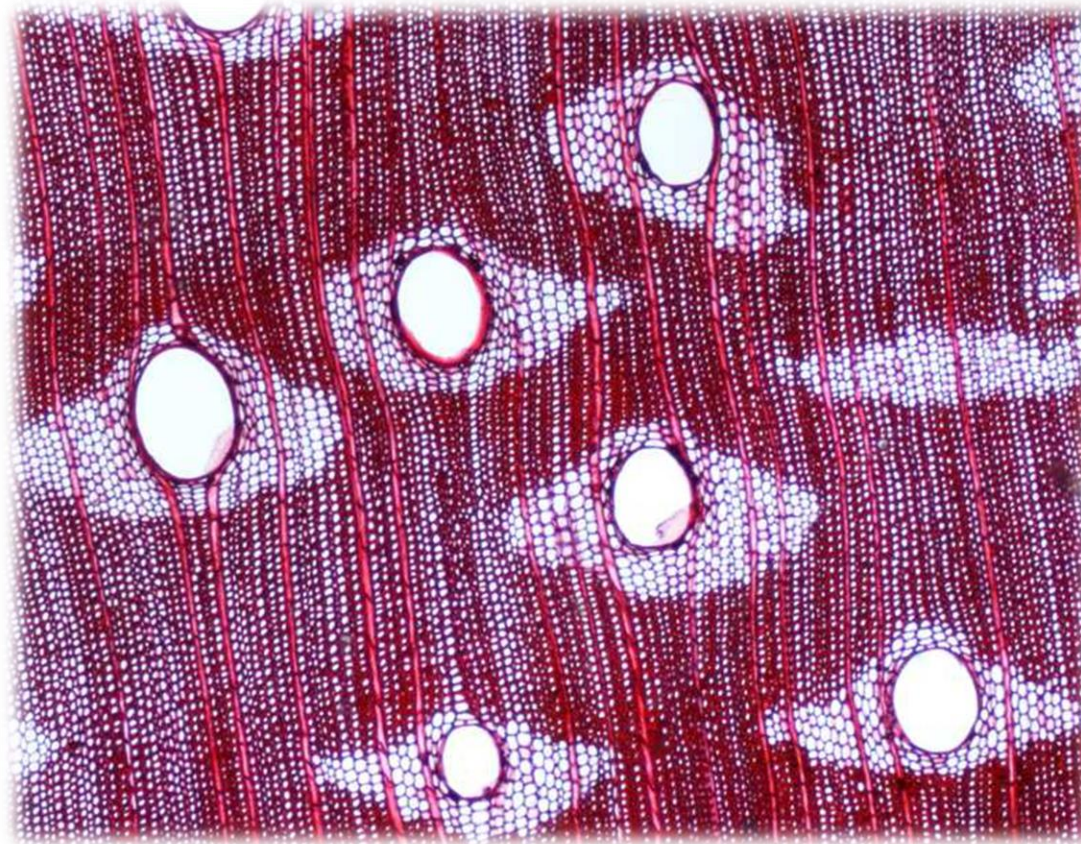
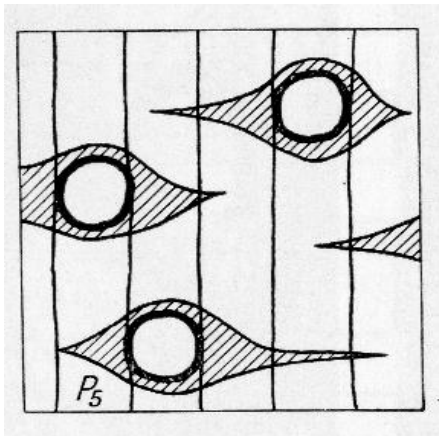


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## Axial parenchyma

- Cross section
- Typical arrangements





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# Colour

- Typical for timbers
- Especially the heartwood
- Possibilities to alter  
(UV radiation, moisture, decay, steaming, staining, modification)





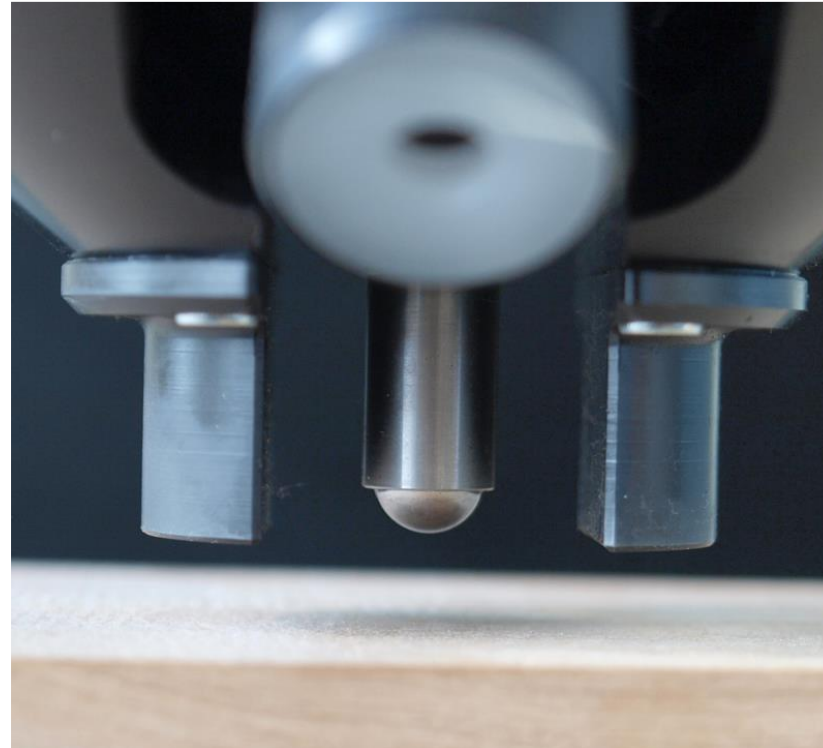


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## Weigth / hardness

- Property related to structure
- Just estimation
- Be aware of MC
- Iron woods ( $> 1\,000\text{ kg.m}^{-3}$ )







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## Scent

- Typical for timbers
- Only fresh timber
- Easy to alter  
(decay)





## Figure

- „appearance“ = arrangement of the features on sections
- Typical for timbers
- Grain orientation  
(straight, spiral, wavy, ...)
- Abnormalities provide attractive figure  
(bird's eye, burls, curl, ....)





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## Grain



interlocked



wavy





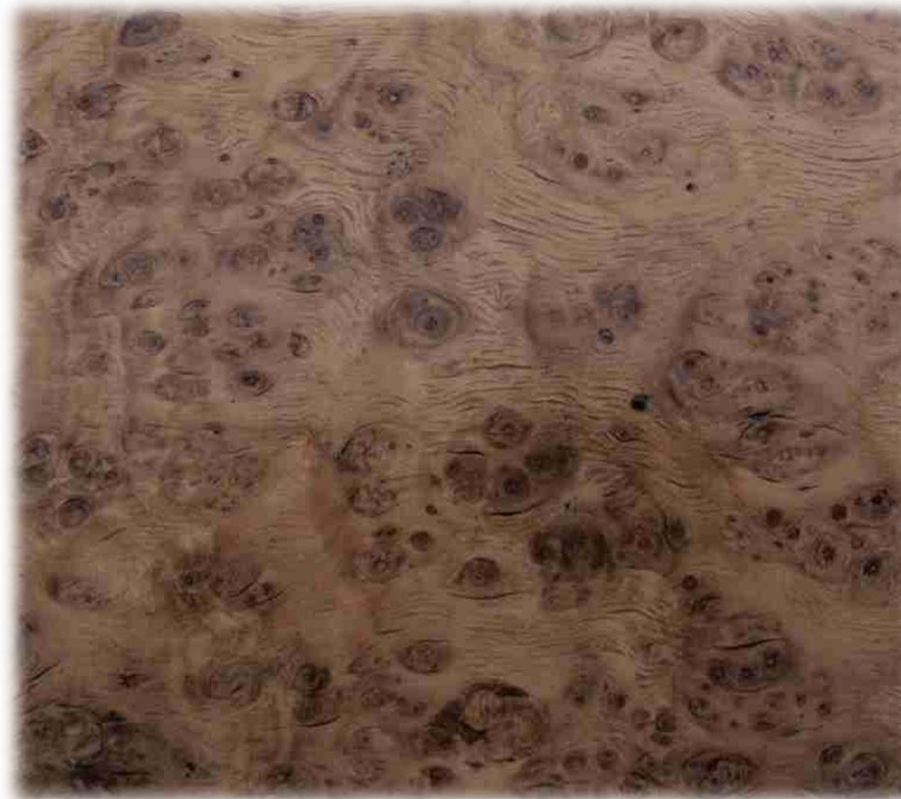
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## Figure



bird's eye



burl

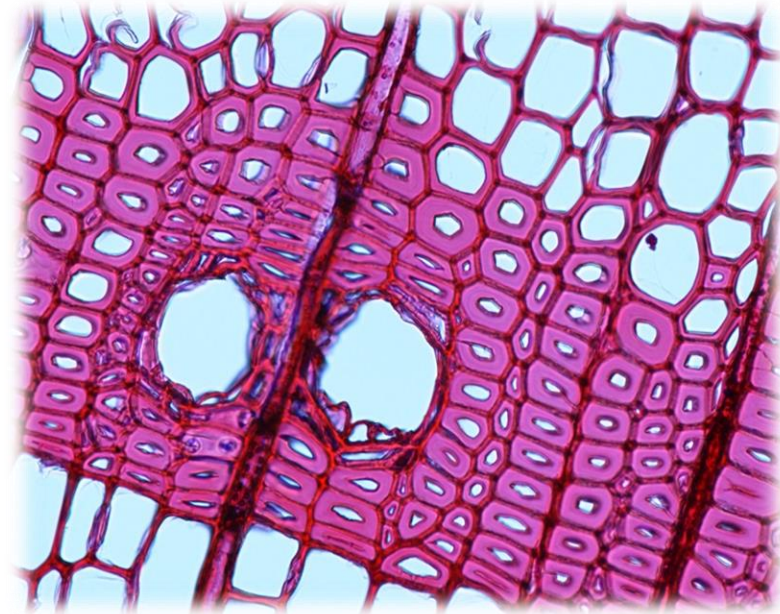


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## Microscopic structure

- Cellular structure (cells)
- Different function = shape = properties
- Softwoods x Hardwoods



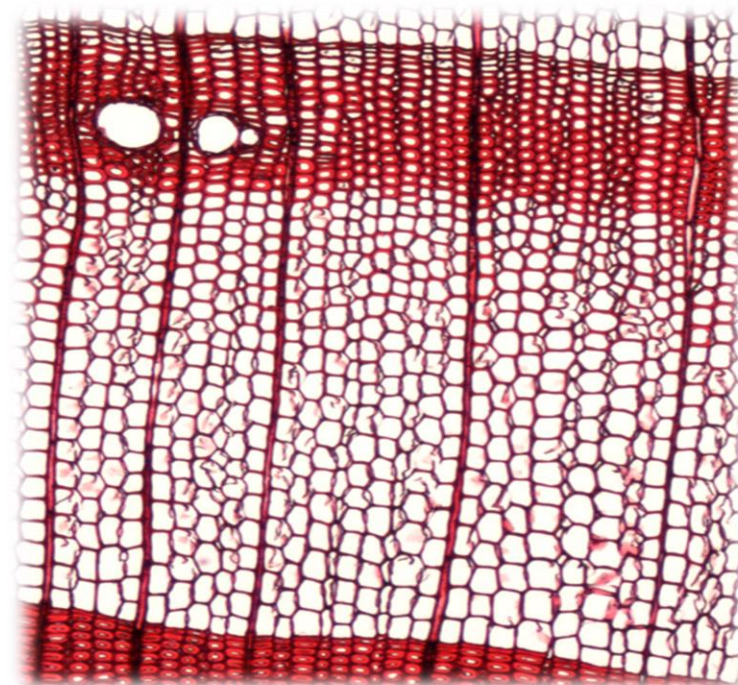


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## Softwoods

- Simple and uniform structure
- Tracheids and parenchyma cells
- Variability of properties related to annual ring width

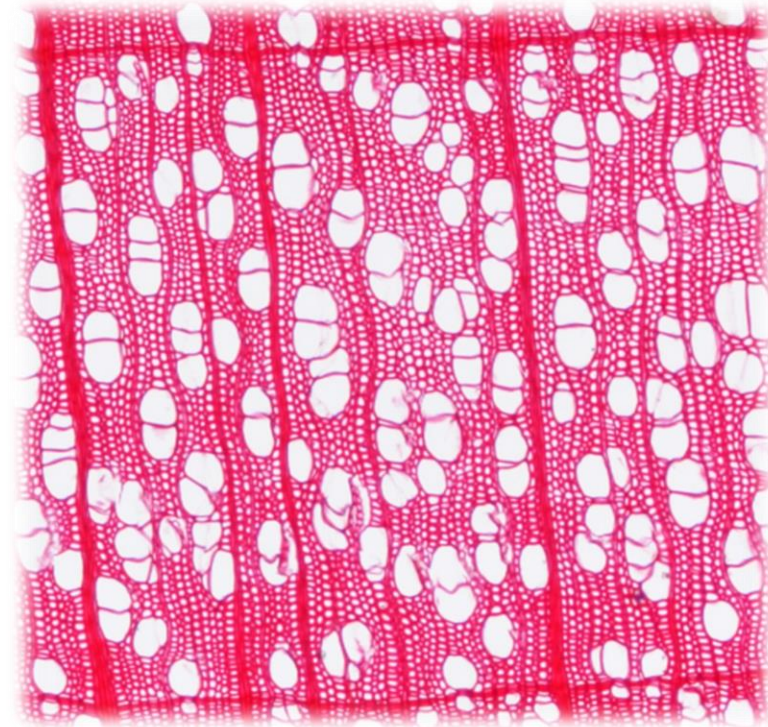






# Hardwoods

- More complex
- 4 kinds of cells
- Vessels  
(liquid transport, big diameter)
- Impact on permeability, density
- Properties related to amount  
of vessels and thick-walled fibres



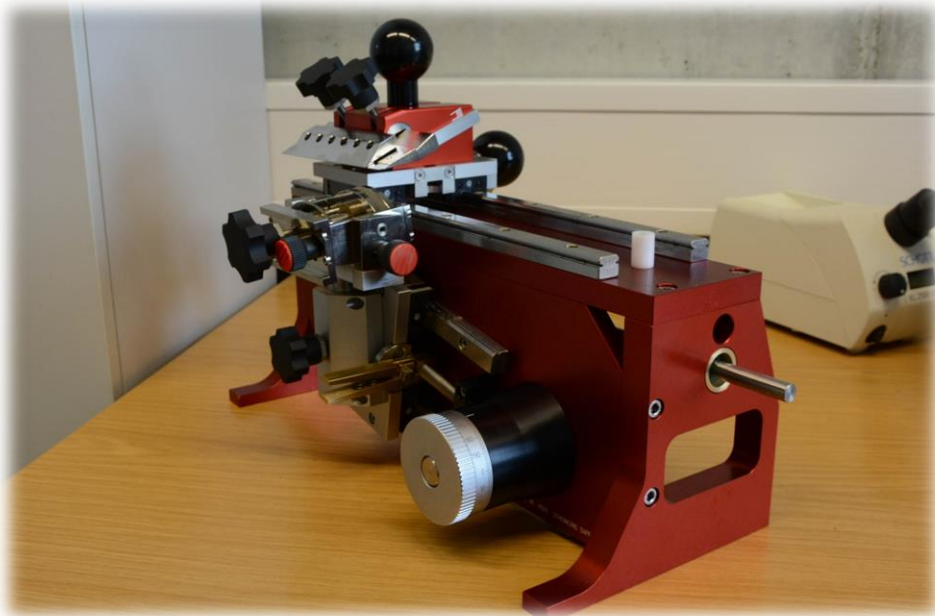


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# How to study microscopic structure

- Learn more in Prague





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# Take-home message

- Wood description (terminology)
- Differences among species (identification)
- Impact on properties

