Wood Anatomy

Macroscopic structure of wood

presentation

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Course content

- **wood structure**
  - *macroscopic structure*
  - *microscopic structure*
  - *submicroscopic structure*
- **wood defects**
- **wood formation**
- **chemical composition of wood**

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Course completion

1) Practical test of wood identification (both macro and micro)

2) Written exam

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Wood – definition

What is wood like?

biological point of view

- Wood (xylem) is a complex of plant tissues whose cells have lignified walls.

chemical point of view

- Natural substance consists mainly of cellulose, hemicelluloses and lignin.

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Wood

Where is wood in nature?

Answer: mostly in woody species

Woody species *(plantae lignosae)*

= plants that retain some living woody material at or above ground level through the non-growing season

- tree *(arbor)*
- liana *(liana)*
- shrub *(frutex)*
- subshrub *(hemixyla, suffrutex)*

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The classification and naming of woods

Classification of the spermatophytes

Kingdom: Plant *(Plantae)*

class: *Gymnospermae*

class: *Angiospermae*

subclass: *Monocotyledonae*

subclass: *Dicotyledonae*

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The classification and naming of woods

Conifers 

spruces, pines, ...

Characteristics

- seeds produced in cones
- needle-like leaves
- many are evergreen

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The classification and naming of woods

Broadleaved trees

maples, oaks, elms, ...

Characteristics

- seeds produced in fruits
- broad leaves with net-like veins
- many are deciduous

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The classification and naming of woods

Trees and their wood

Conifers ▸ *softwoods*

Broad leaved trees ▸ *hardwoods*

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The classification and naming of woods

Softwoods vs. hardwoods

Softwoods

- only ~400 species of softwood trees

Hardwoods

- tens of thousands species of hardwood trees

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The classification and naming of woods

Example: **Norway spruce *(Picea abies)***

Kingdom: Plant *(Plantae)*

class: *Gymnospermae*

order: *Coniferales*

family: *Pinaceae*

genus: *Picea*

species: *abies*

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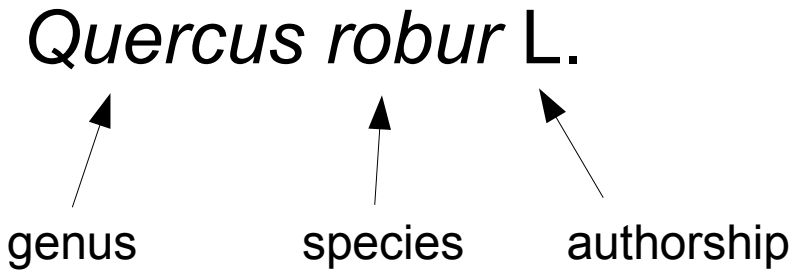
The classification and naming of woods

Scientific names



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The classification and naming of woods

Common name × scientific name

Norway spruce *(Picea abies)*

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The classification and naming of woods

Trade name (= commercial names)

- used to designate lumber
- place of origin occasionally creeps into the trade name
- one name for more than one species

example

trade names: mahagon sapelli, sapelli, sapeli, aboudikro, sapele, penkwa, assié, lifaki, dilolo, undianuno

scientific name: *Entandrophragma cylindricum*

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The classification and naming of woods

Trade name problems

! one species with more trade names

! one trade name for more species

example

trade names: mahagon sapelli, sapelli, sapeli, aboudikro, sapele, penkwa, assié, lifaki, dilolo, undianuno

scientific name: *Entandrophragma cylindricum*

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The classification and naming of woods

Tree species vs. kind of wood

Species defined on external characteristics

i.e. *fruits, leaves, bark*

NOT on wood anatomy!

Usually it is not possible to identify isolated pieces of wood to species level!

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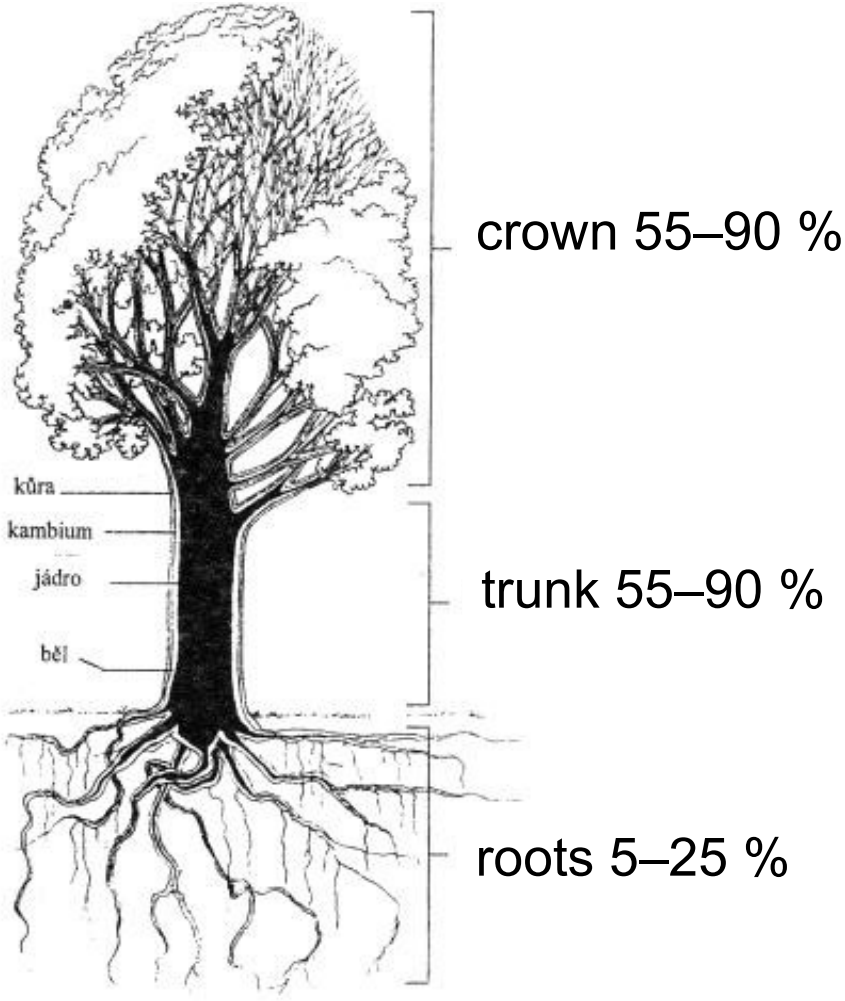
Main parts of a tree



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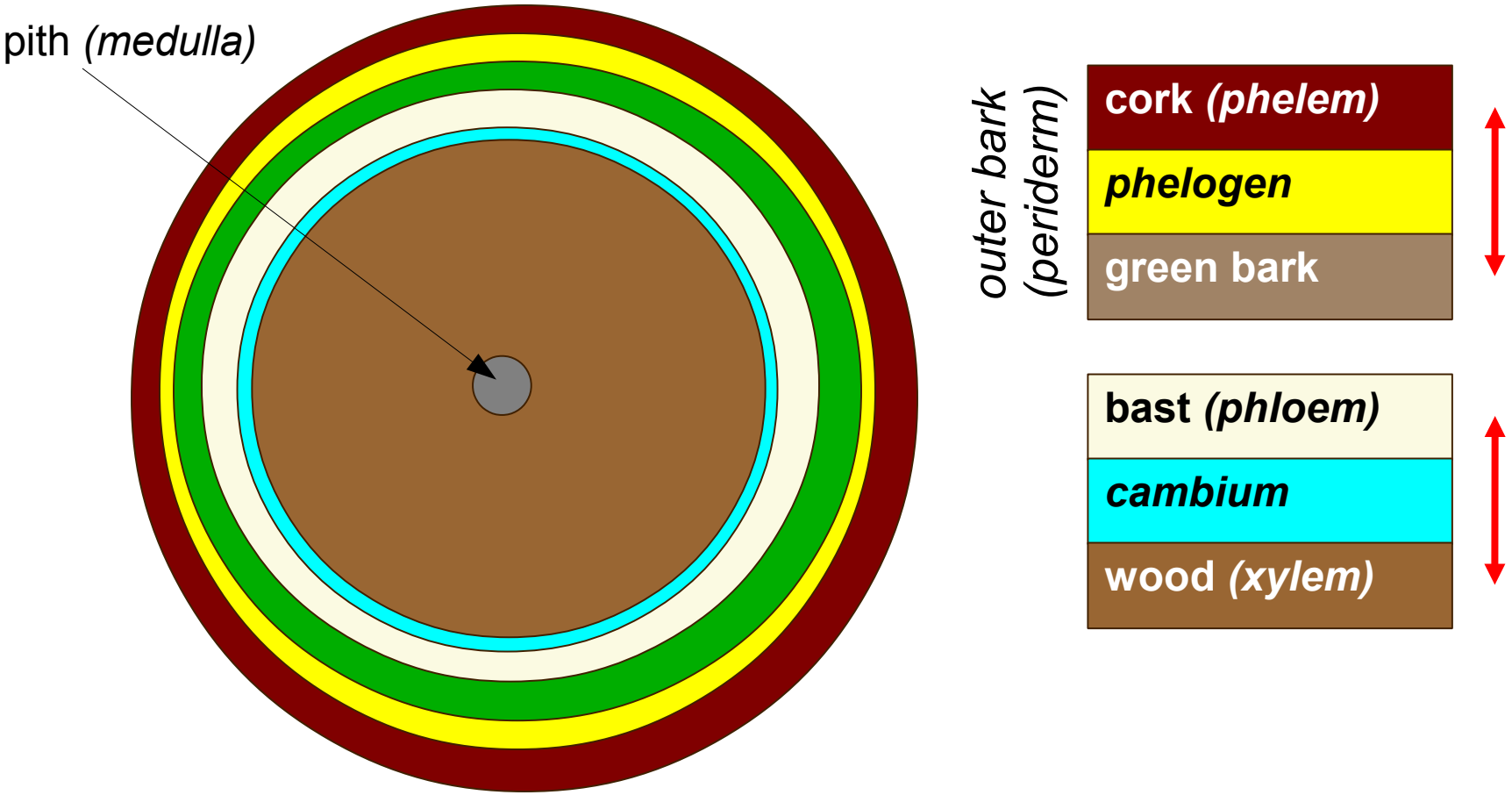
Transverse section of a stem



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Transverse section of a stem

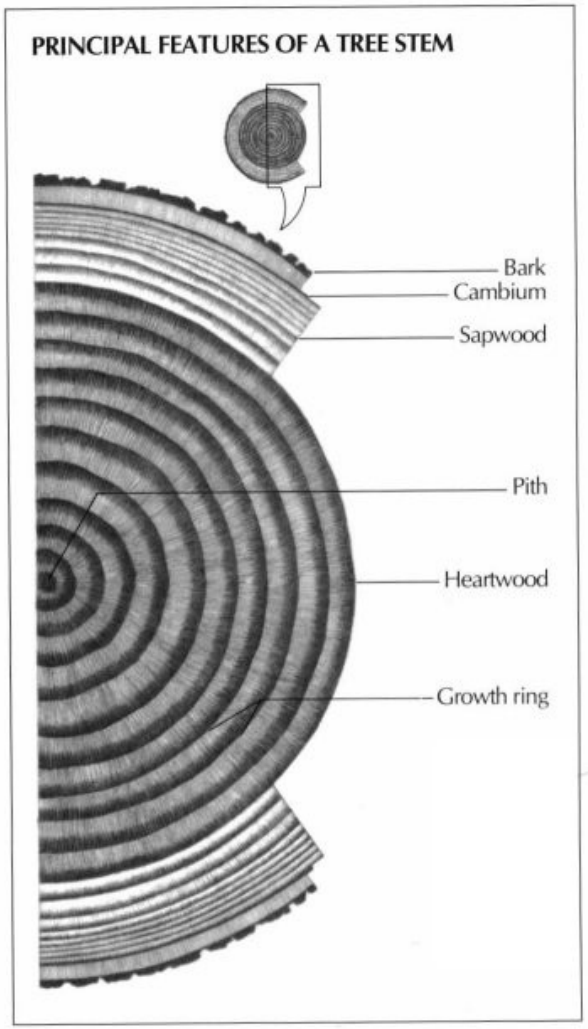
bark *(periderm)*
outer
- cork *(suberoderm, felem)*
- green bark *(feloderm)*

inner = lýko *(phloem)*

cambium
= meristematic tissue

wood *(xylem)*
= meristematic tissue

pith
= central rare tissue



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Pith

pith shapes

elliptic – lime, maple, elm

triangular – alder, beech, birch

tetragonal – ash

lobate – oak

asterisk-like – pine

Common diameter

2–5 mm

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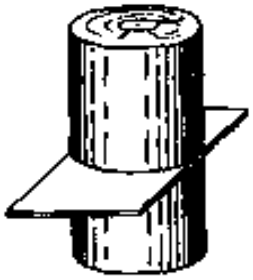
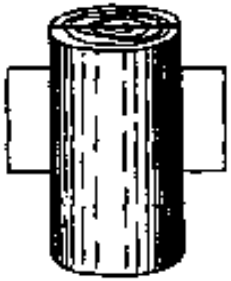
Main sections in a stem

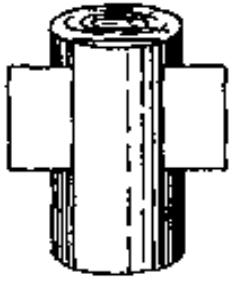
transverse (X)



radial (R)



tangential (T)



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Main sections in a stem

transverse

X

radial

R

tangential

T

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Gross features of wood

- Structural features
  - growth rings
  - rays
  - vessels
  - resin canals
  - pith flecks
  - knots

- Additional features
  - colour (heartwood & sapwood)
  - lustre
  - odour
  - density & hardness

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Growth rings

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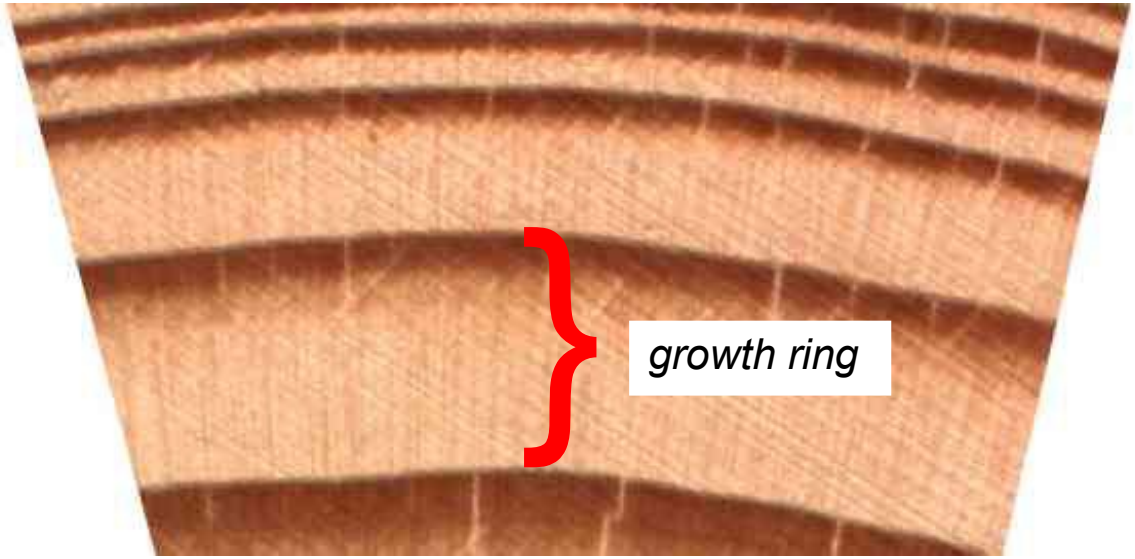
Growth rings

Growth ring is an radial increment of wood per growing period



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Growth rings

earlywood
– lighter, lower density
latewood
– darker, higher density

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Growth rings

Groups of woods according to the structure of growth rings:

softwoods

ring-porous hardwoods

diffuse-porous hardwoods

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Rays

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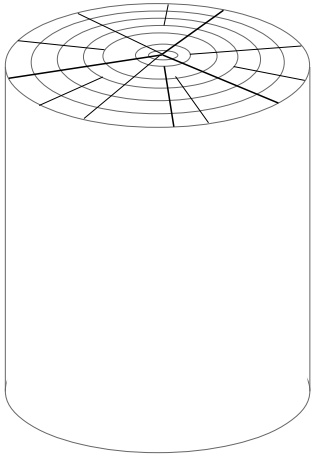
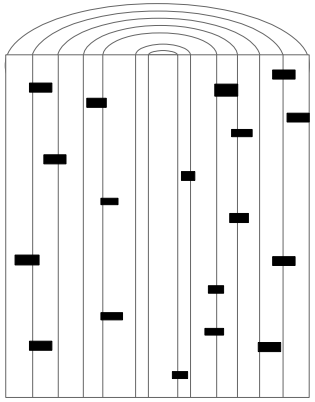
Rays

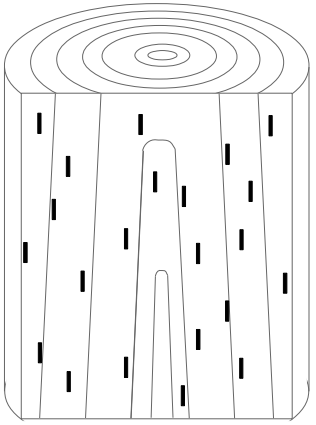
Appearance of rays



P



R



T

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Rays

a) *wide rays*

X

R

T

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Rays

b) *narrow rays*

X R T

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Rays

c) *very narrow rays*

X

R

T

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Vessels

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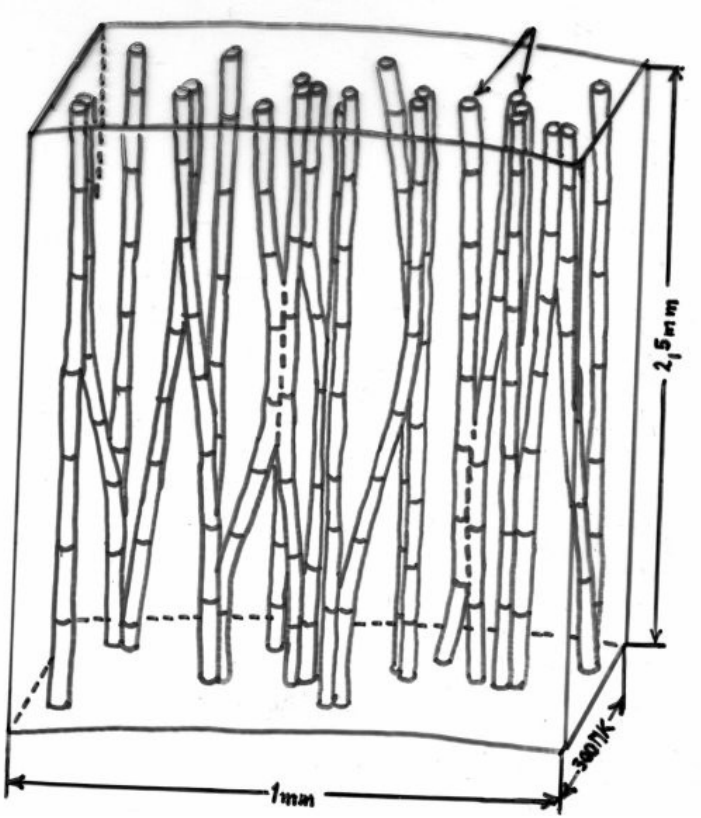
Vessels

Vessels are long tubes-like cells oriented parallel to the stem axis.
Function: transport of water



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Vessels

ring-porous hardwoods – macrovessels & microvessels

X

R

T

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Vessels

diffuse-porous hardwoods – microvessels only

X

R

T

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Vessels

semiring-porous hardwoods
– only macrovessels (Walnut) or only microvessels (cherry, plum)

X

R

T

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Resin canals

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Resin canals

Resin canals (or resin ducts) are small intercellular spaces where special parenchyma cells produce resin.

Constant feature only in:

- spruce (*Picea* spp.)
- pine (*Pinus* spp.)
- larch (*Larix* spp.)
- Douglas-fir (*Pseudotsuga* spp.)

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Resin canals

Appearance

X

R

T

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Additional features

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Colour (heartwood & sapwood)

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Colour (heartwood & sapwood)

Colour (heartwood & sapwood)

sapwood trees
hornbeam, alder, birch, maple, pear tree

heartwood trees
larch, pine, oak, black locust, elm, cherry, plum

ripewood trees
fir, spruce, beech, lime

sapwood & light heartwood & heartwood trees
ash, willow

light heartwood

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Lustre

Lustre = ability to reflect light

- lustrous woods
  - plane tree, maple, beech, elm
- dull woods
  - hornbeam, apple tree

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Odour

Odour in wood is due to the volatility of extraneous substances

- disagreeable odour
  - lime
- pleasant odour
  - juniper

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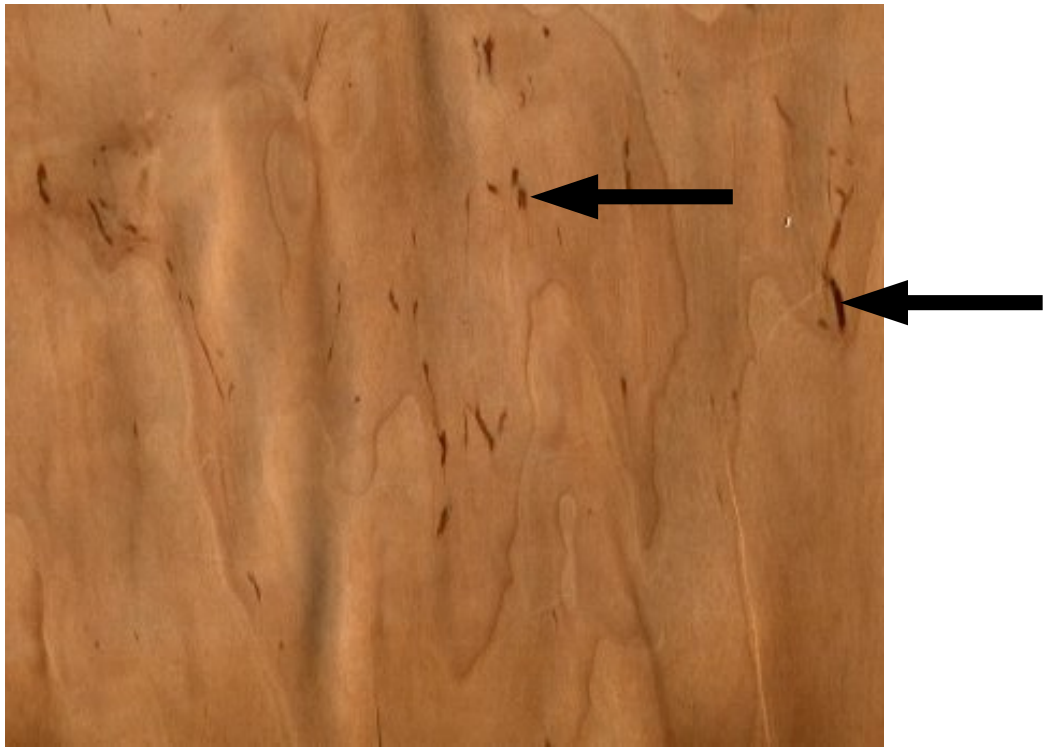
Pith flecks

Pith flecks – parenchyma tissue produced by cambium when attacked by insects

Frequent occurrence in: birch, alder, pear, horse chestnut



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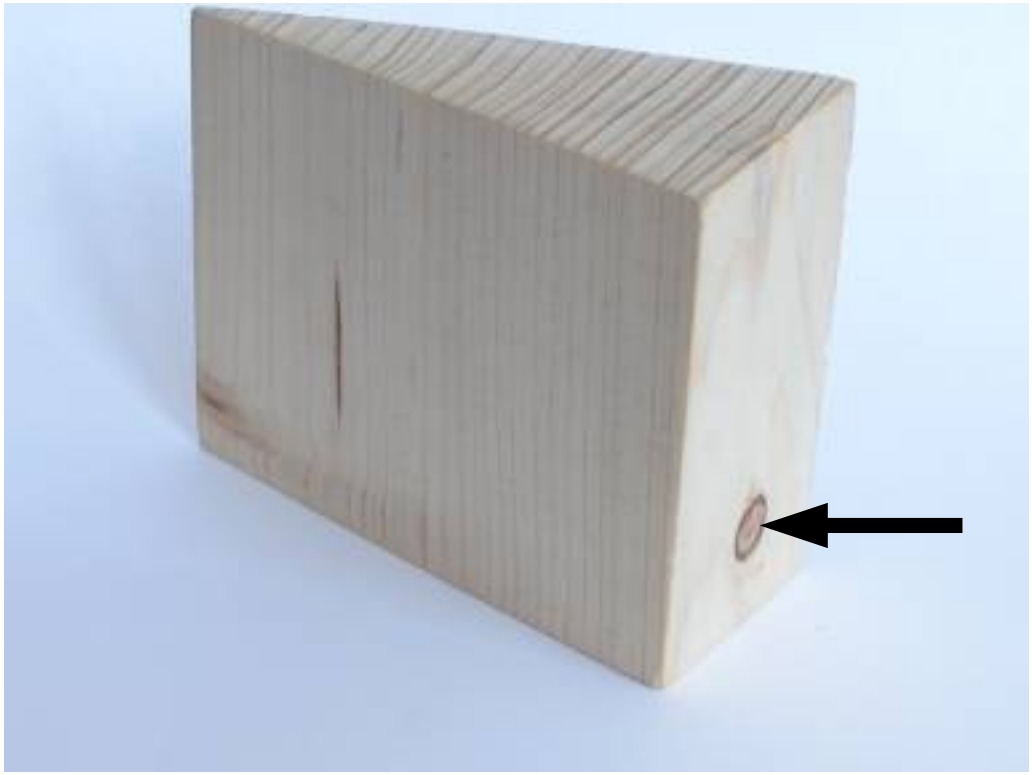
Knots



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Wood density

a) low density woods (ρ_{12} < 540 kg.m^{-3})

spruce, fir, pine, poplar, alder, lime, ...

b) middle density woods (ρ_{12} = 540–750 kg.m^{-3})

larch, beech, oak, elm, ash, plane wood, walnut

c) high density woods (ρ_{12} > 750 kg.m^{-3})

black locust, hornbeam

The lowest density wood: balsa (ρ_0 = 130 kg.m^{-3})

The highest density wood: guajak (ρ_0 = 1300 kg.m^{-3})

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Hardness

a) soft woods (H_J < 40 MPa)
spruce, fir, pine, poplar, alder, linden, ...

b) middle hard woods (H_J = 40–80 MPa)
larch, beech, oak, elm, ash, plane wood, walnut

c) hard woods (H_J = 81–100 MPa)
black locust, hornbeam

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