TreProX: Innovations in Training and Exchange of Standards for Wood Processing

INTRODUCTION TO WOOD ANATOMY AND WOOD QUALITY

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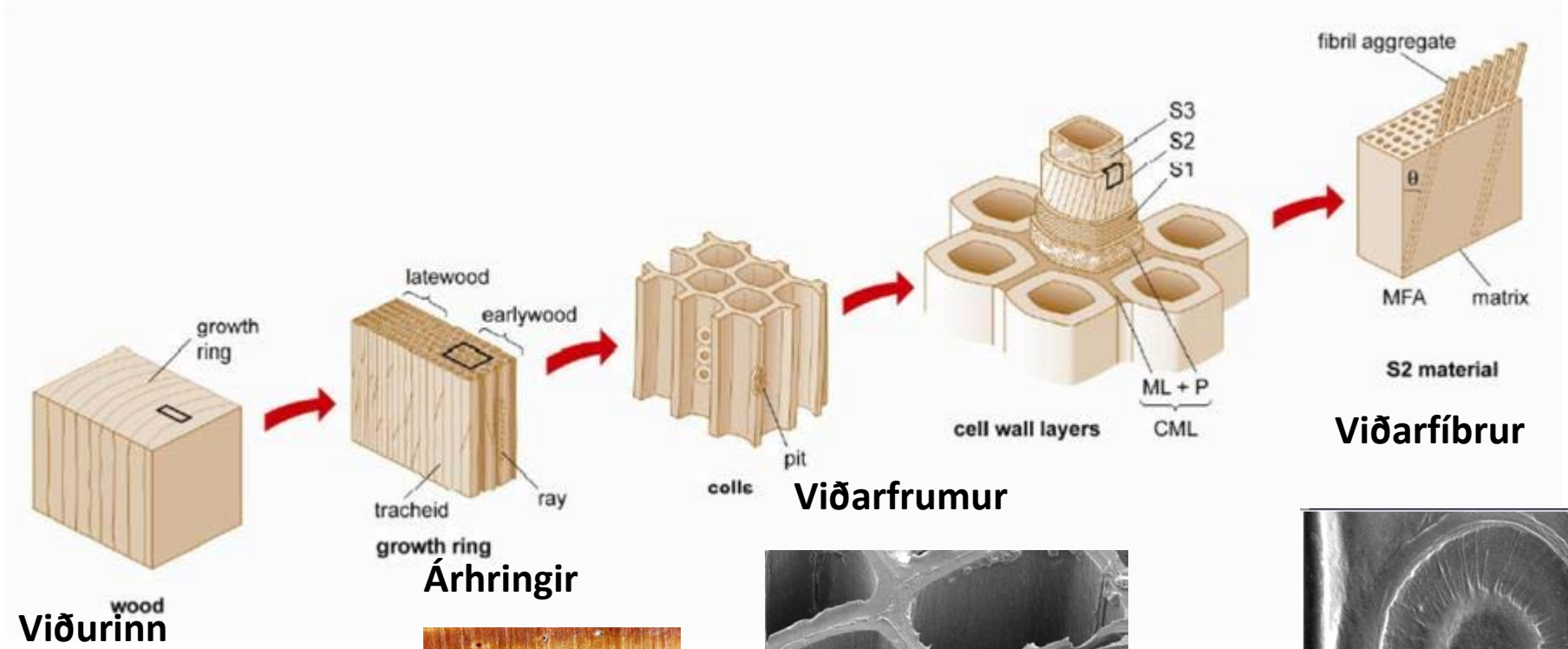
Trétæknirádgjöf slf. Wood Technology
UNIVERSITY OF COPENHAGEN
Linnæus University
Erasmus+

Wood Properties and Structure

(Viðargæði og bygging)

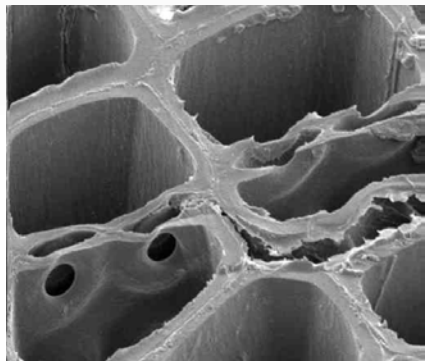


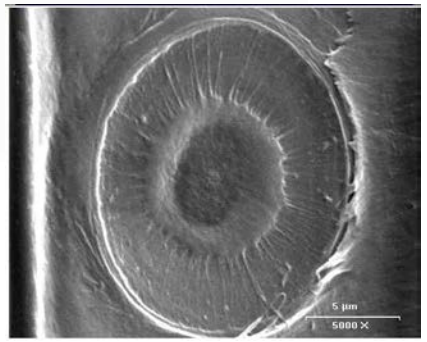
Viðurinn

Árhringir

Viðarfrumur

Viðarfíbrur





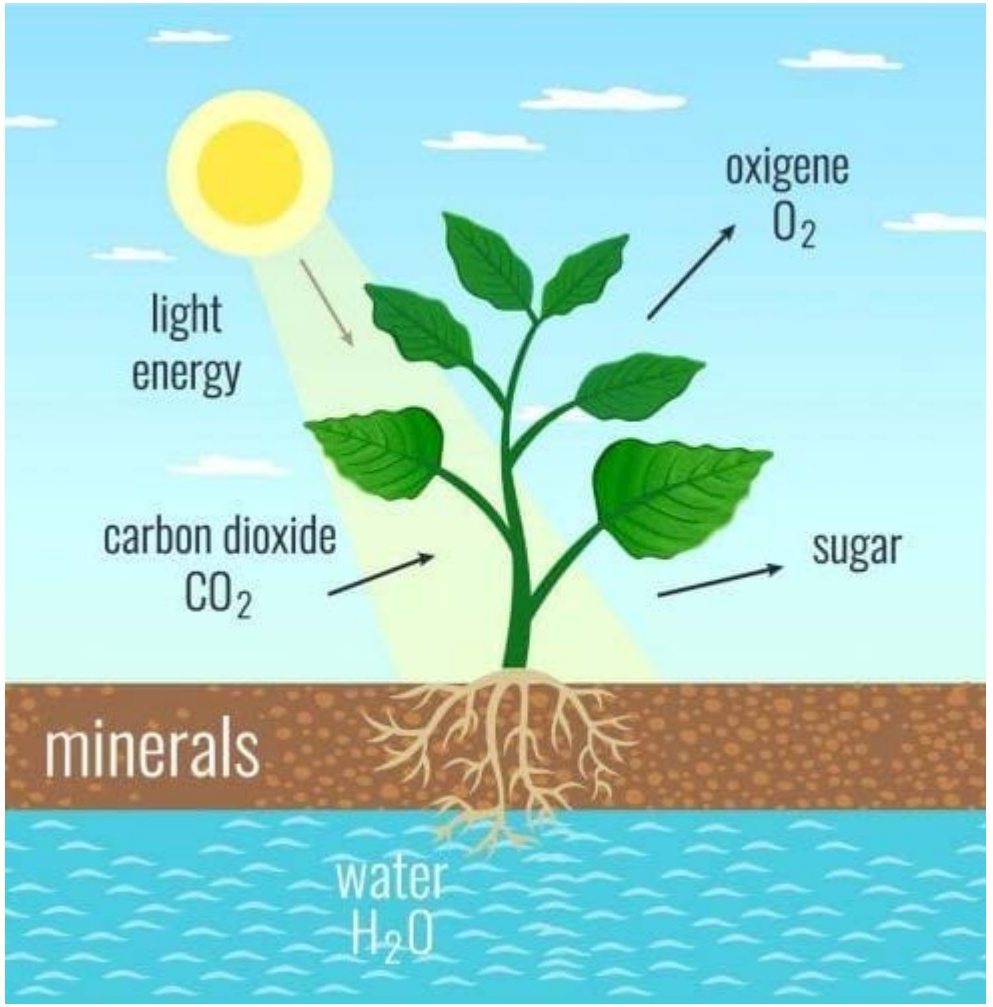
Where do wood products come from?

- Wood is from trees!
- Where do trees come from?
- Formed from CO2 and water using sunlight as an energy source.

This process is known as **photosynthesis** (ljóstillífun)

Carbon dioxide (CO_2) + water + light energy (sólarljós) → carbohydrate (sykrur) + oxygen (súrefni)

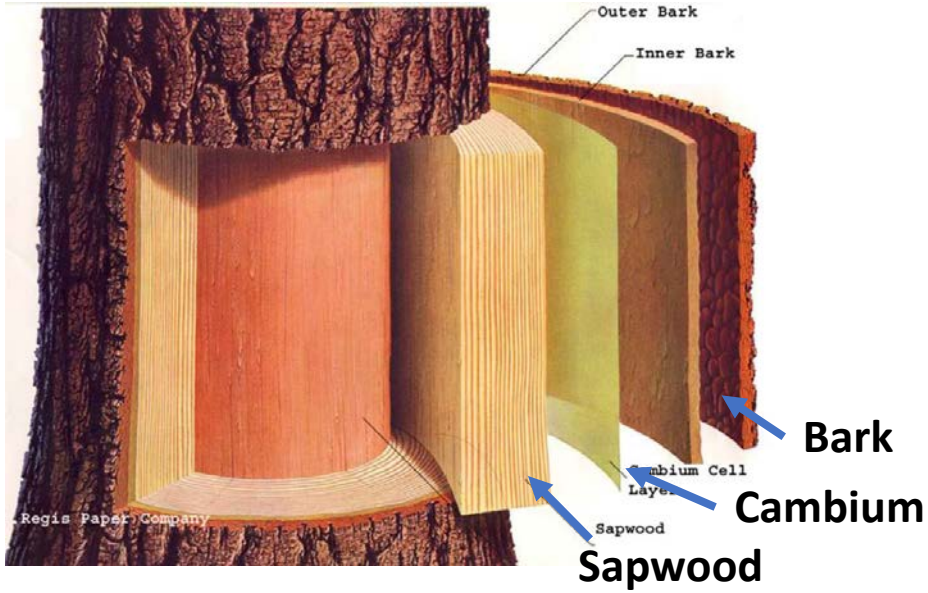
Photosynthesis is the process whereby light energy is converted into chemical energy that can then be used by the plant to fuel its metabolism

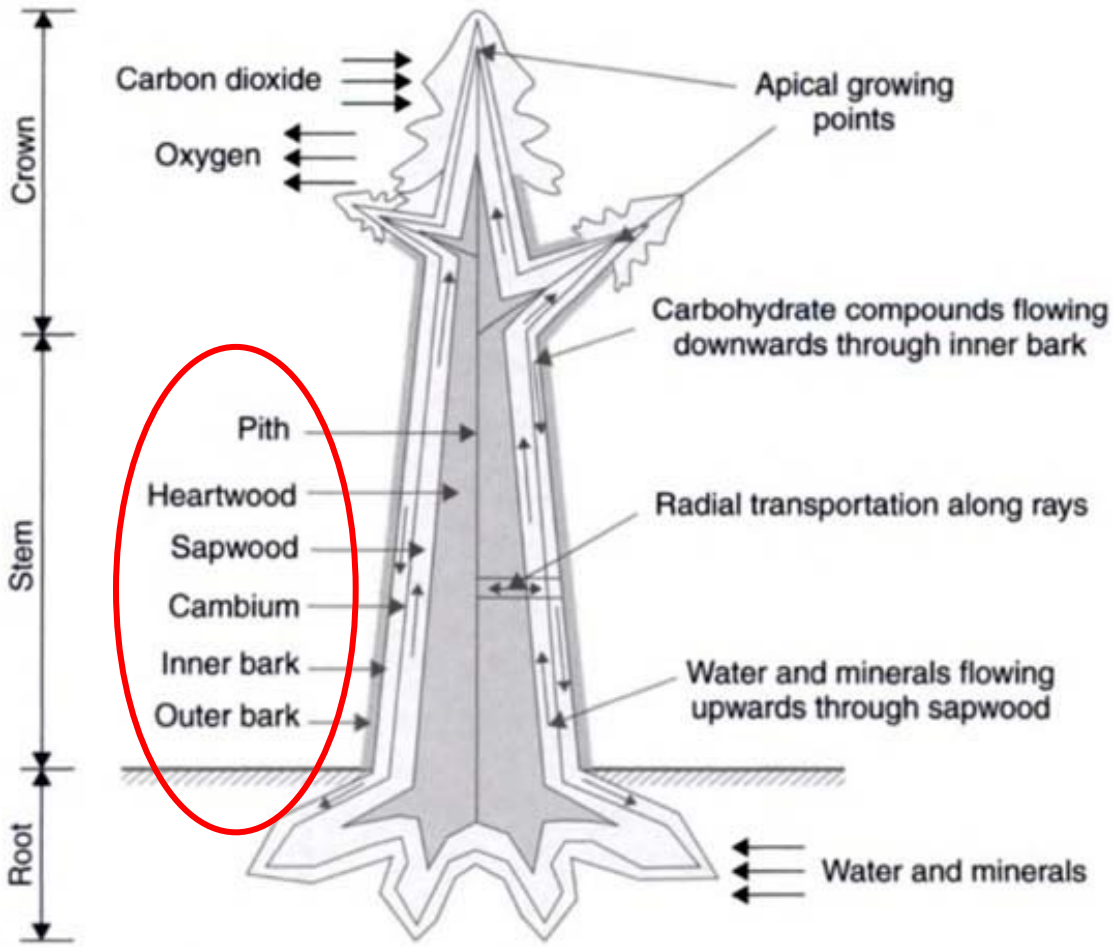


Tree growth

- Growth occurs in the vascular **cambium (vaxtarvef)** were living cells divide and differentiate outwards to form the **bark** and inwards to form the **wood**.

- The **meristem (toppvaxtarvefur)** is responsible for increasing the height





Basic characteristics of the tree

- ***Gymnosperms*** (softwoods; conifers; barrtré)
  - Gymnosperms have ***"naked seeds",*** attached to the surface of cones.
  - Needles, which are **usually** evergreen

- ***Angiosperms*** (hardwoods; broadleaves; lauftré)
  - Angiosperms have ***seeds enclosed in fruit*** (apple, pear…. acorn, etc.)
  - Leaves (which are lost in the autumn in temperate climates)

Pine (fura)

Birch (birki)

Tree structure

- The growth of a tree is a combination of genetics (erfðir) and environmental factors (umhvefi)
- Genes decide species and growth forms etc.
- Environmental factors influence tree growth, for example:
    - Climatic factors (temperature, rain, snow)
    - Soil
    - Location (stand / clearing)
    - External stresses (wind, frost)

Genetics

Environmental factors

The wood

(viðurinn)

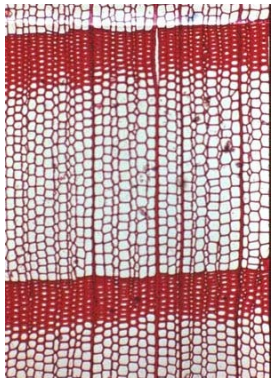
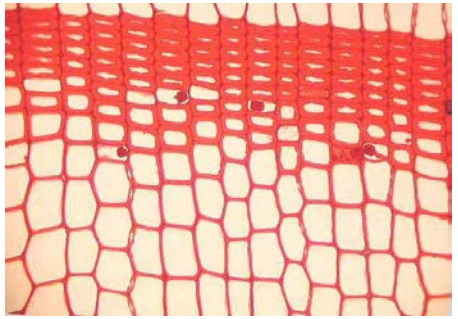
Macrostructure of wood:

- Visible to the naked eye
- Heartwood/sapwood, growth rings, grain, knots



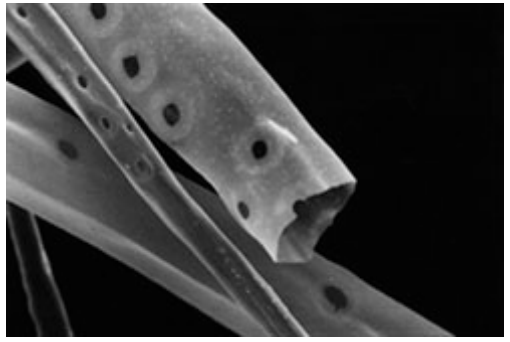
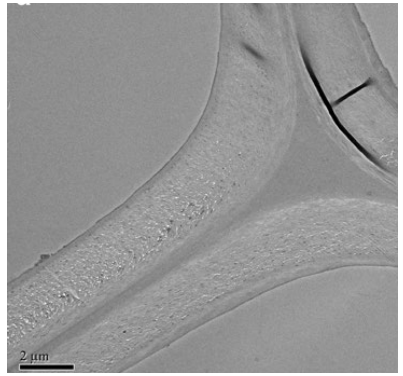
Microstructure of wood

- Visible under a light microscope
- Different cell types, morphology of cells

The cell wall

- Visible by electron microscopy

The Knots

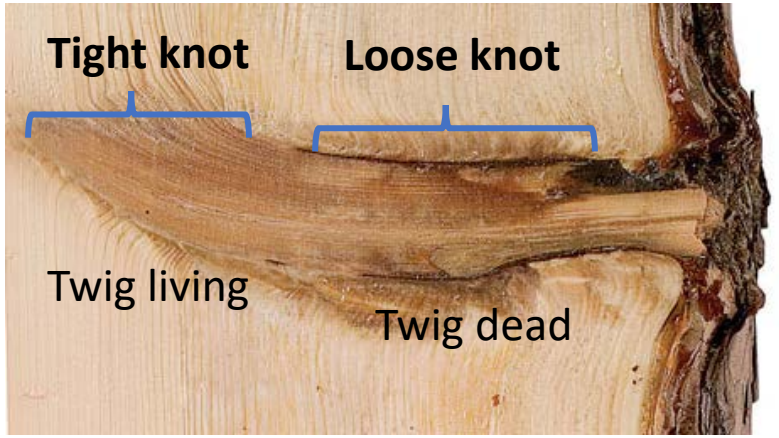
(kvistir)

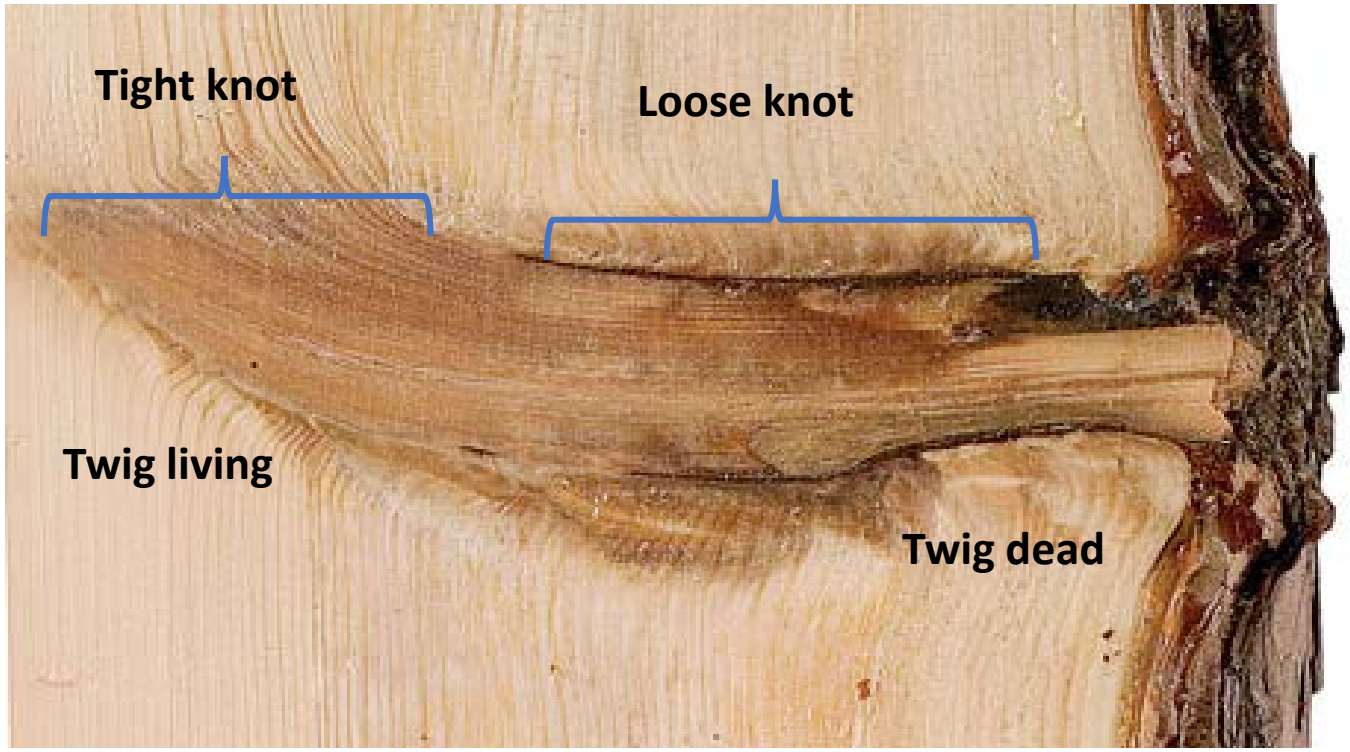
Live knot (or tight knot)

(ferskur kvistur)

Dead knot (or loose knot)

(þurrkvistur)




Tight knot
Loose knot
Twig living
Twig dead

Growth rings – Tree rings

Conifer

(Árhringur, barrtré)

Earlywood
(Vorviður)

Latewood
(Sumarviður)

Annual growth ring
(árhringur)

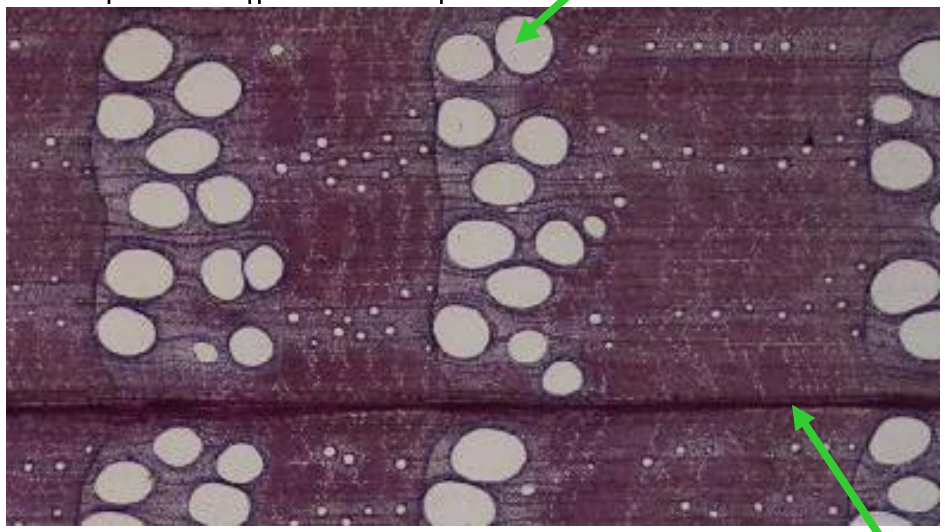
Broad-leaved tree

(Árhringur, lauftré; eik)

Earlywood
(Vorviður)

Latewood
(Sumarviður)

Vessels
(viðaræðar)



Annual growth ring
(árhringur)

Ray
(merggeisli)

- The portion of latewood depends on ecological factors and species.
- As growth decelerates latewood percentage grows
- A warm autumn increases the latewood percentage
- A drought in the autumn results in a lower proportion of latewood

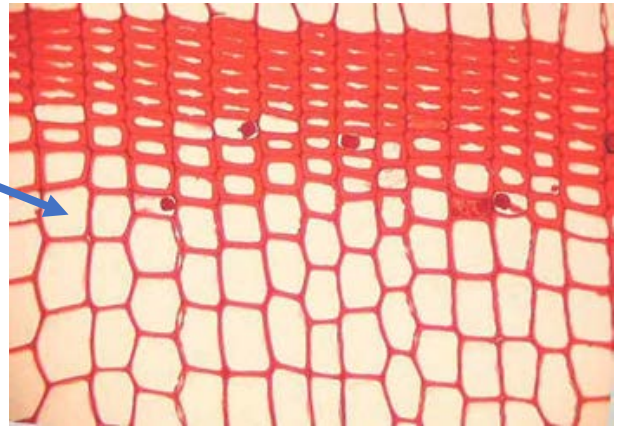
Density (pine):
Earlywood 300-370 kg/m3
Latewood 810-920 kg/m3

Density (oak):
Earlywood 542-585 kg/m3
Latewood 807-887 kg/m3

The cell (tracheid)

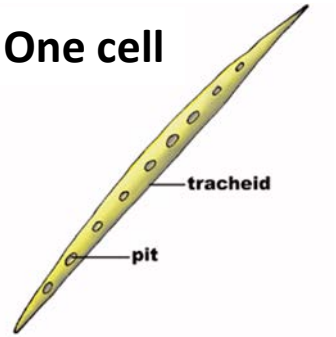
(viðarfumur eða trefjaæðar)

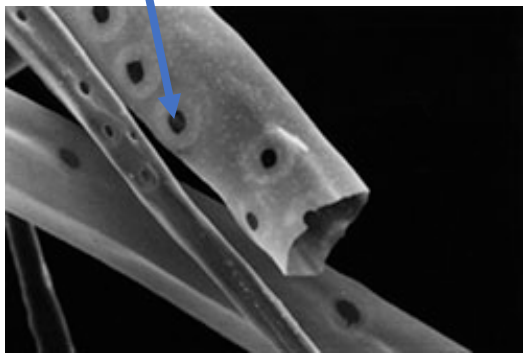
- Tube like structure
- Wall thickness depends on function
- The “opening” in the center is called the **lumen**
- **Pits** connect cells were flow of fluids happens between the cells
- Formed by cell division



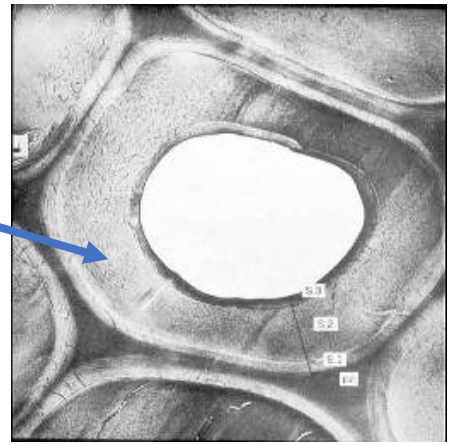
Pits

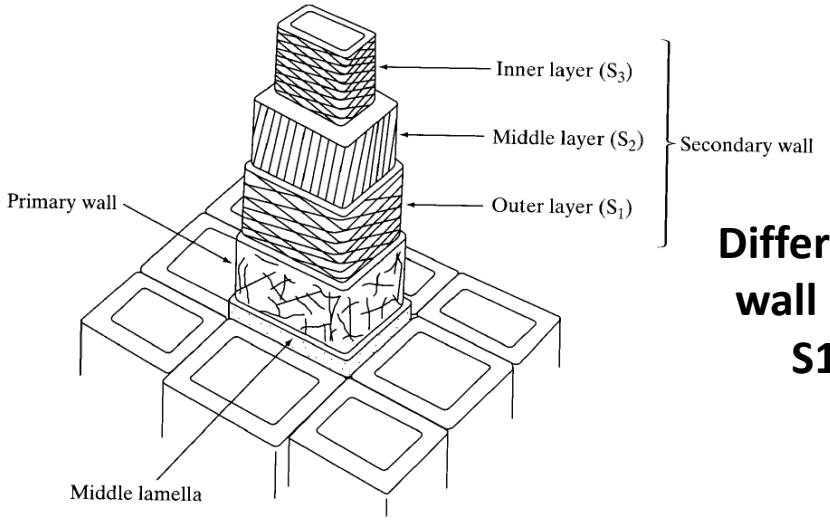
One cell





The cell walls





Different cell wall layers, S1-S3

The wood density (Specific Gravity) and strength

(rúmþyngd (eðlisþyngd) og styrkur viðar)

- The material of which wood is made of is heavier than water; its density is about 1,5 regardless of wood species.
- Part of the volume of a wood is occupied by hollows and pores. The size of these openings and in the thickness of the cell walls explains the wood density.
- Density is a good index of mechanical properties of wood, high density = more strength.

Name	Density (dry) g/cm^3
Balsa wood	0.11 - 0.14
Coniferous	0.30 - 0.70
Larch	0.45 - 0.60
Pine	0.39 - 0.65
Jatoba	0.52 - 0.62
Sitka spruce	0.33 – 0.48
Ebony	0.96 - 1.12
Acer	0.62 - 0.75
Oak	0.60 - 0.90
Tekk, (Afríka)	0.98
Tekk, (Indland)	0.66 - 0.88

Name (Icelandic wood)	Density (dry) g/cm3
Siberian larch	0.40 – 0.63 (0.54)
Contorta pine	0.35 – 0.53 (0.41)
Sitka spruce	0.33 – 0.48 (0.38)
Black cotton wood (alaskaösp)	0.27 – 0.49 (0.35)

Ebony

Icelandic larch

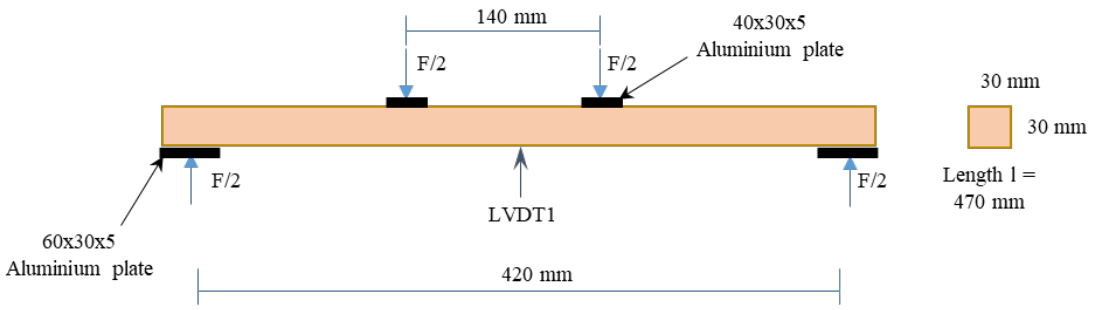
Wood strengt main parameters

MOE = Modulus of elasticity = Stífni

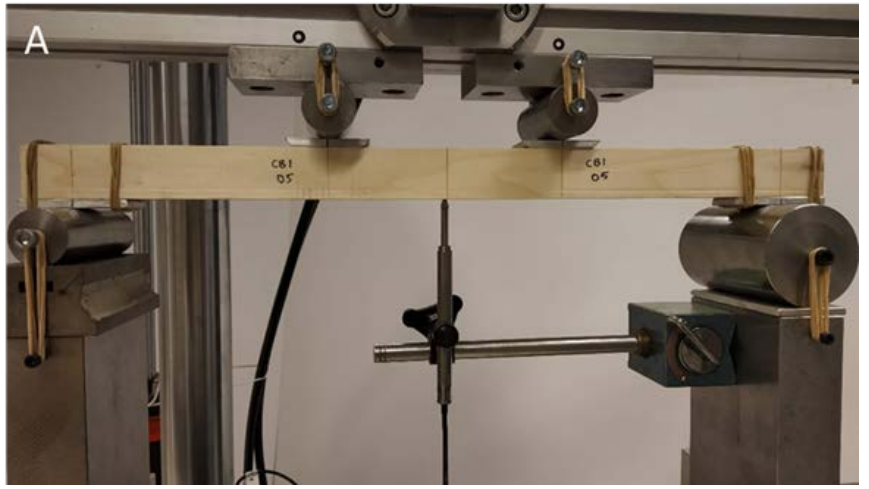
MOR = Modulus of Rupture = Beygjutogþol (bending strength)

Modulus of elasticity (MOE) is the measures a **woods stiffness** and is a good overall indicator of its strength.

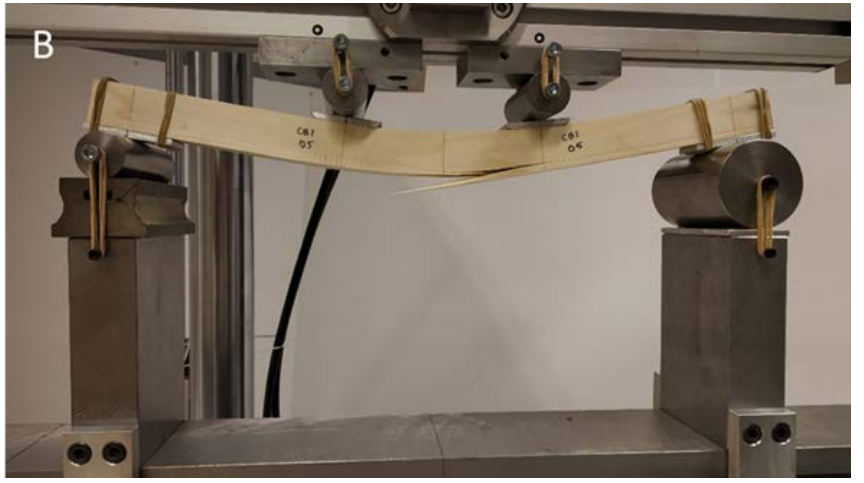
Modulus of rupture (MOR)
This reflects the **maximum load-carrying capacity of a wood**



Experiment setup



Before



After

Grading and Strength Classes

(styrkleikaflokkun)

Strength classes	C14	C16	C18	C20	C22	C24	C27	C30	C35
Visual Grading (útlitsflokkun)	T0		T1			T2		T3	
Graded by machine (vélflokkun)		C16	C18	C20	C22	C24	C27	C30	C35
Basic density	0,290	0,310	0,320	0,330	0,340	0,350	0,370	0,380	0,400
Modulus of rupture (MOR)	14	16	18	20	22	24	27	30	35
Modulus of elasticity (MOE)	7,000	8,000	9,000	9,500	10,000	11,000	11,500	12,000	13,000

Icelandic wood →

	MOR $\sigma_{b,12}$ [Mpa] Beygjustyrkur	MOE E_{12} [Mpa] Stífni
Siberian larch	92	11,697
Sitka spruce	74	10,444
Contorta pine	71	8,278
Alaskan poplar (Alaskaösp)	63	7,044

Wood and water

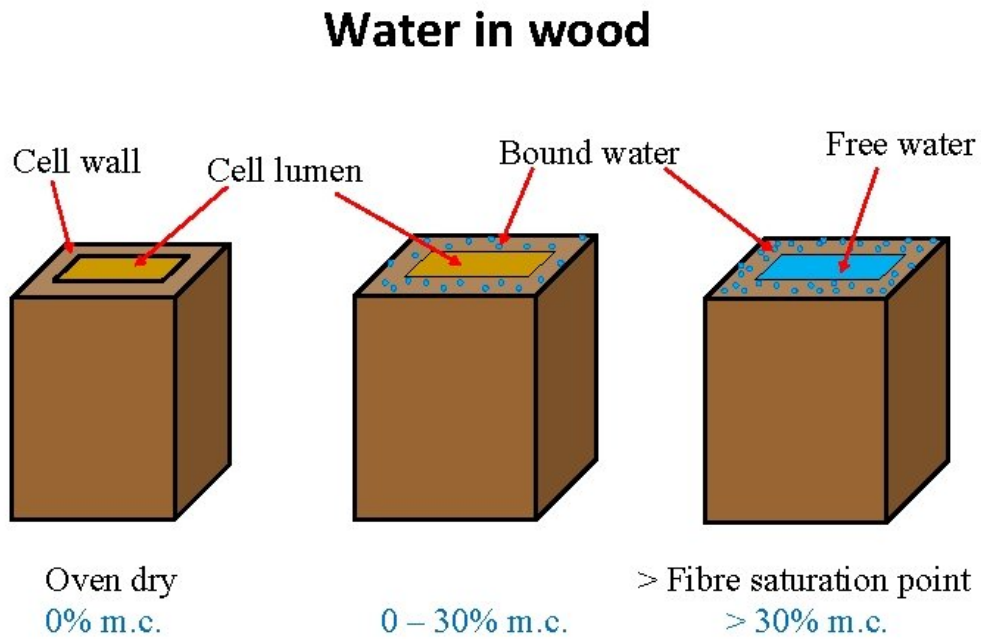
(viður og vatn)

Water can be present in two states in wood:

Free water (laust vatn). Water exist in liquid pockets located in the cell lumen and other open spaces in the wood.

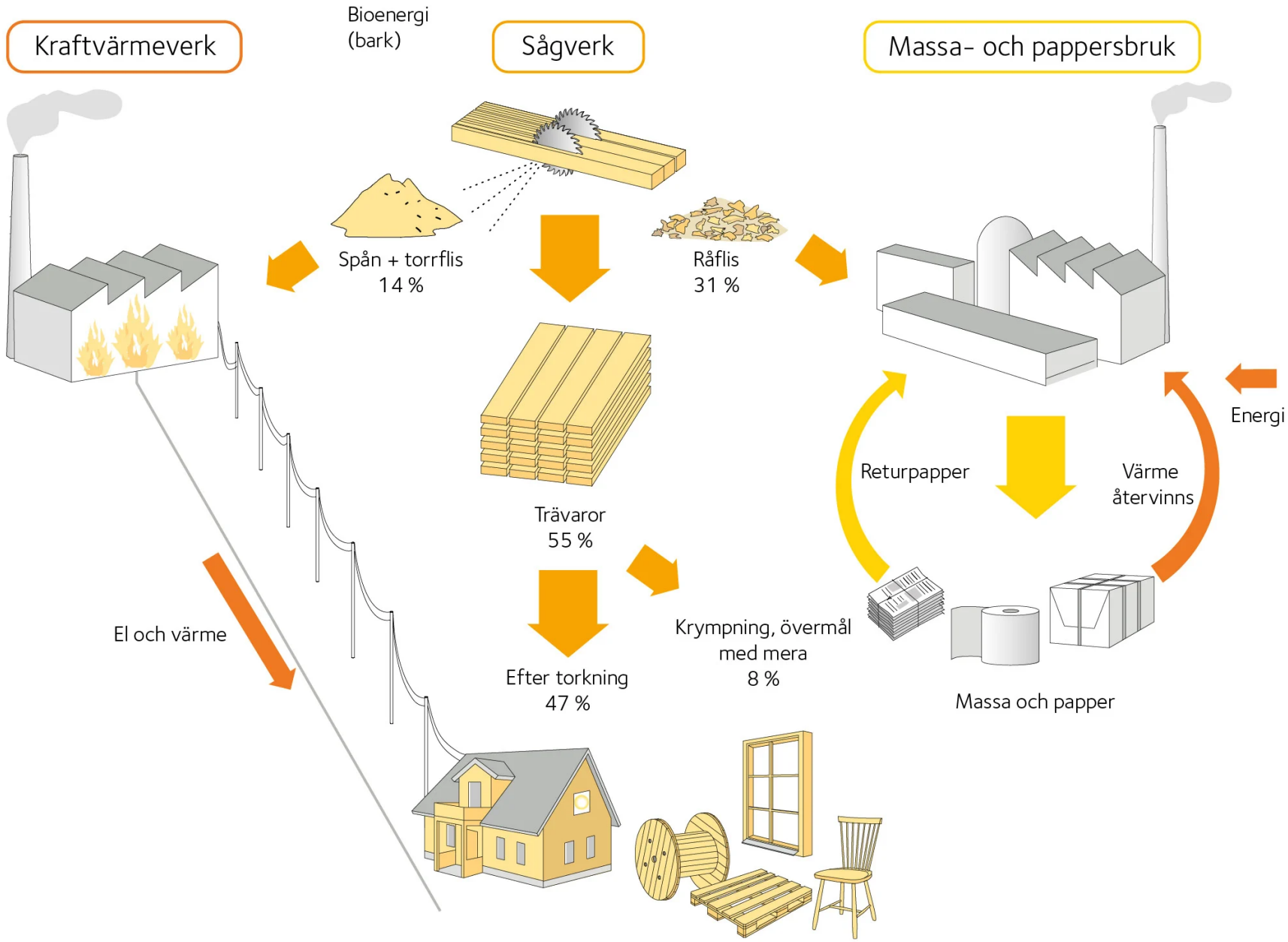
Bound water (bundið vatn). The water is in the cell walls of the wood.

The point (about 30% moisture) where the transition occurs between free water and bound water is called the **Fiber Saturation Point (FSP) (trefjamettunarmörk).** At or above the fiber saturation point, both free water and bound water are present.



The forest value chain (Sweden)

(SLU)


Kraftvärmeverk
Bioenergi
(bark)
Sågverk
Massa- och pappersbruk
Spån + torrflis
14 %
Råflis
31 %
Trävaror
55 %
Energi
Returpapper
Värme
återvinns
El och värme
Efter torkning
47 %
Krympning, övermål
med mera
8 %
Massa och papper

TAKK

Erasmus+

Landbúnaðarháskóli Íslands
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