

CHEMICAL COMPOSITION OF WOOD

Prof. dr hab. Magdalena Zborowska

Wood Chemistry

Start Course

Prof. dr hab. Magdalena Zborowska

For over 20 years, I have been a lecturer at Poznań University of Life Sciences. I mostly deal with lignocellulose biomass chemistry, wooden cultural heritage as well as instrumental methods while investigating lignocellulose biomass.

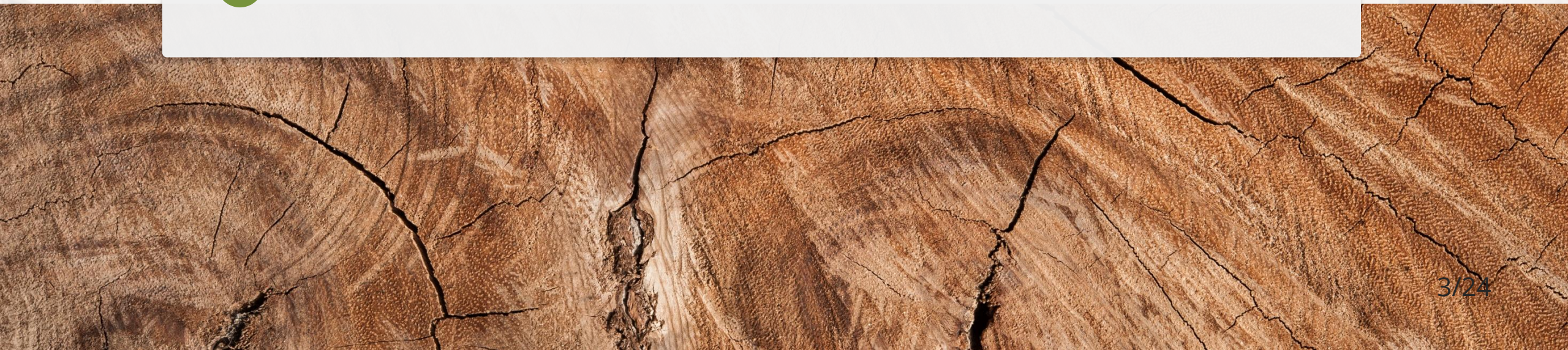
I’m the author of more than 100 scientific publications and a participant of numerous international conferences.

I’m also a keen cyclist and keeper of mixed breed dogs.



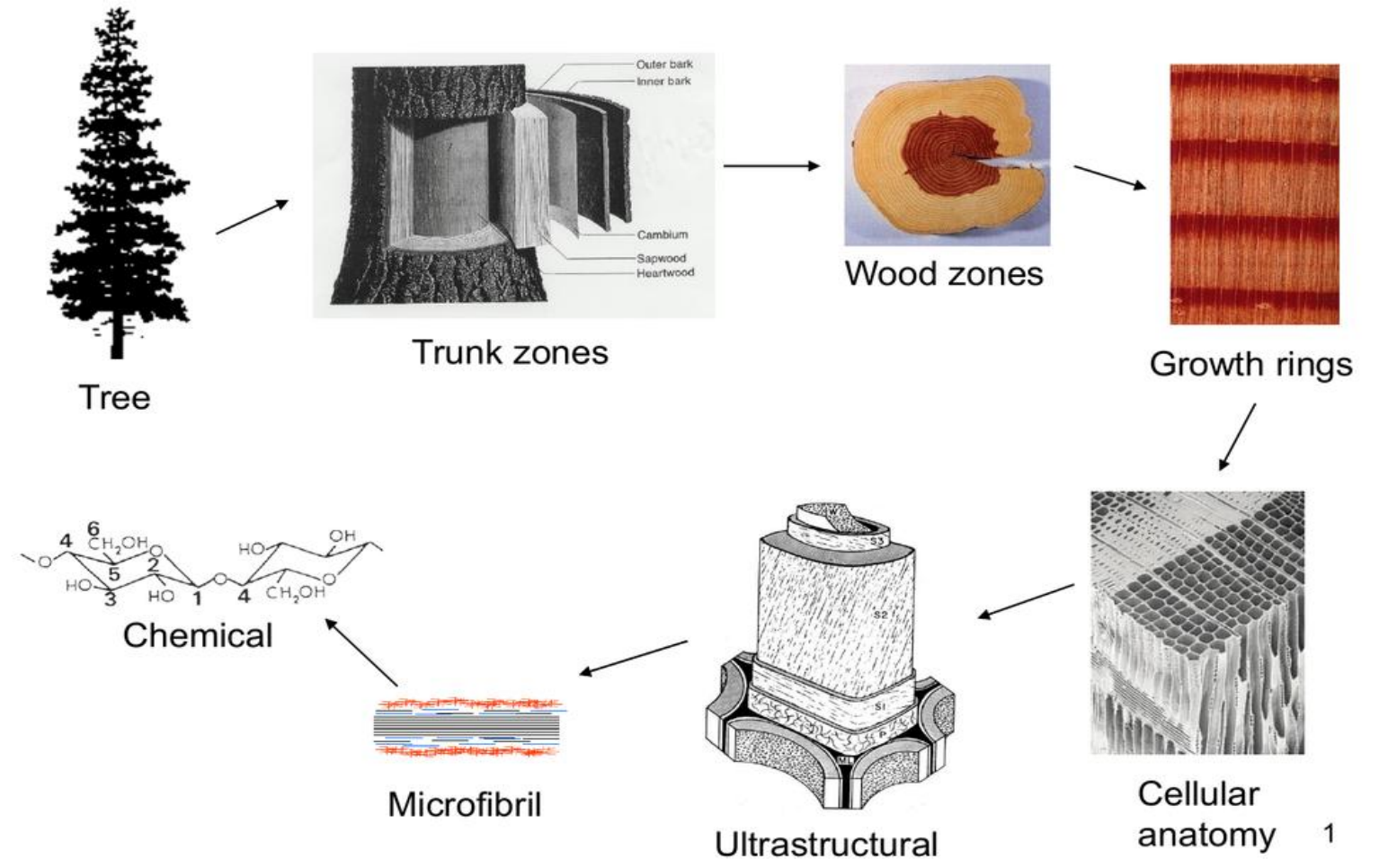
Introduction to wood chemistry

1. Chemical elements of wood
2. Chemical components of wood
3. Percentage of chemical components of wood
4. Functions of chemical components of wood

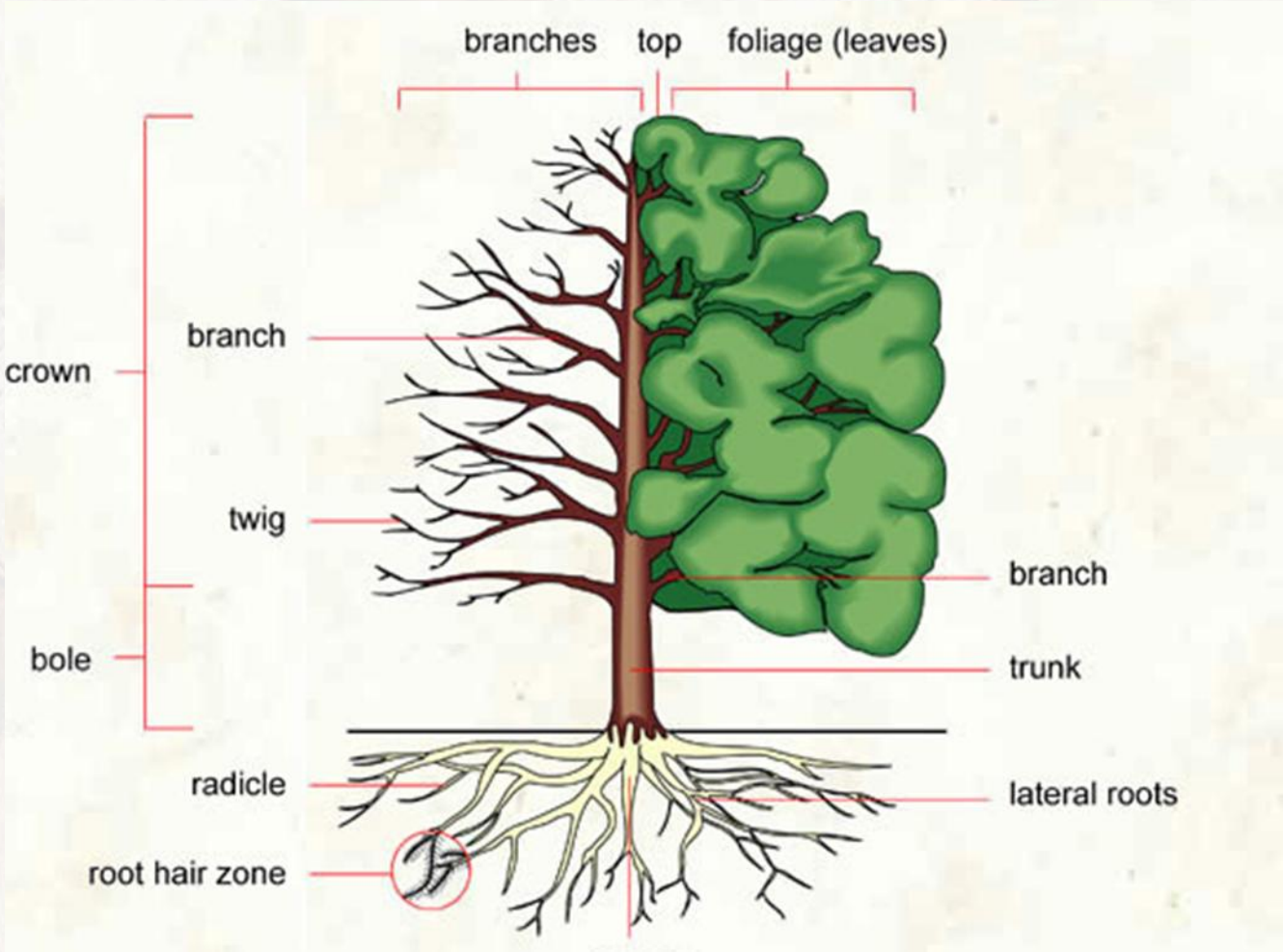


Structure and micro-structure of wood at various scale levels

The chemical composition of wood is discussed at different levels of its structure.



Parts of a tree



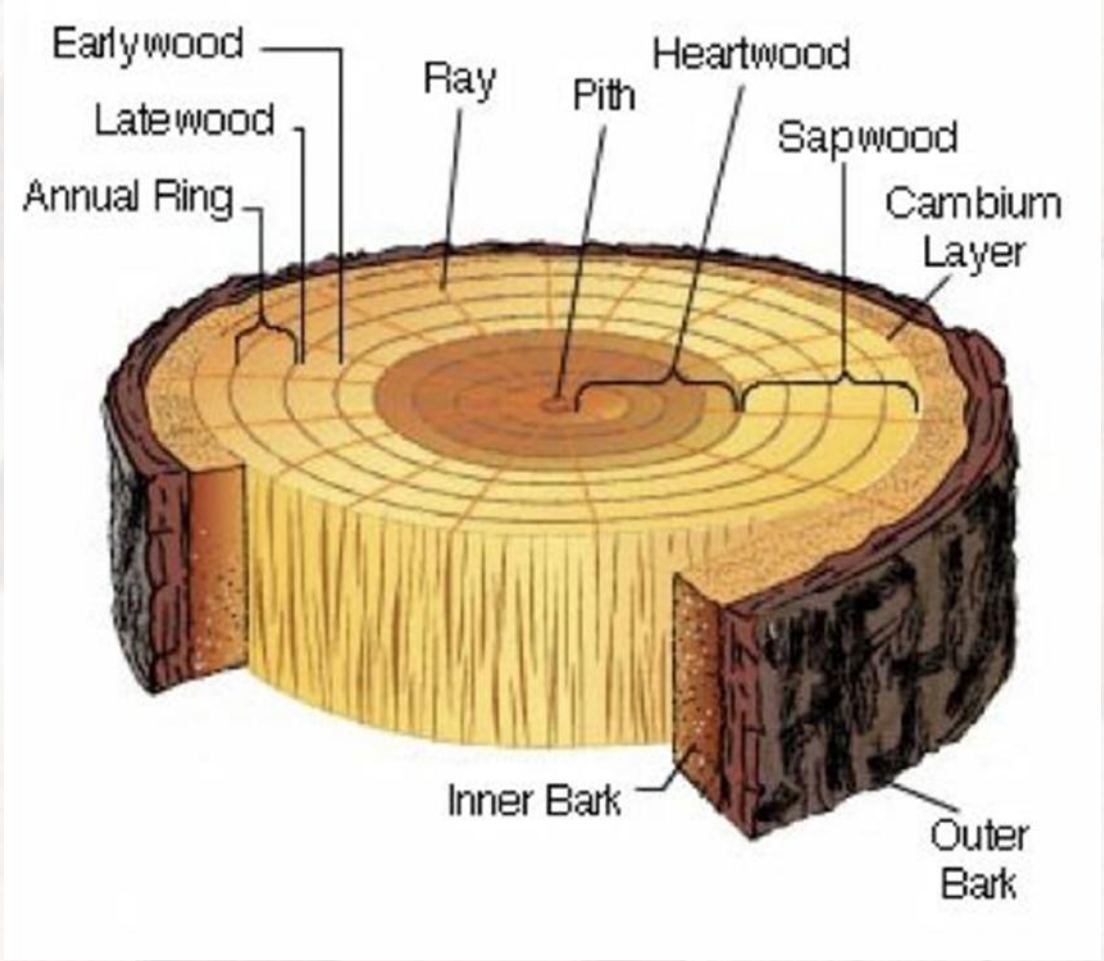
Structure and micro-structure of wood at various scale levels

There are visible differences between the share of individual parts for sapwood and heartwood species.

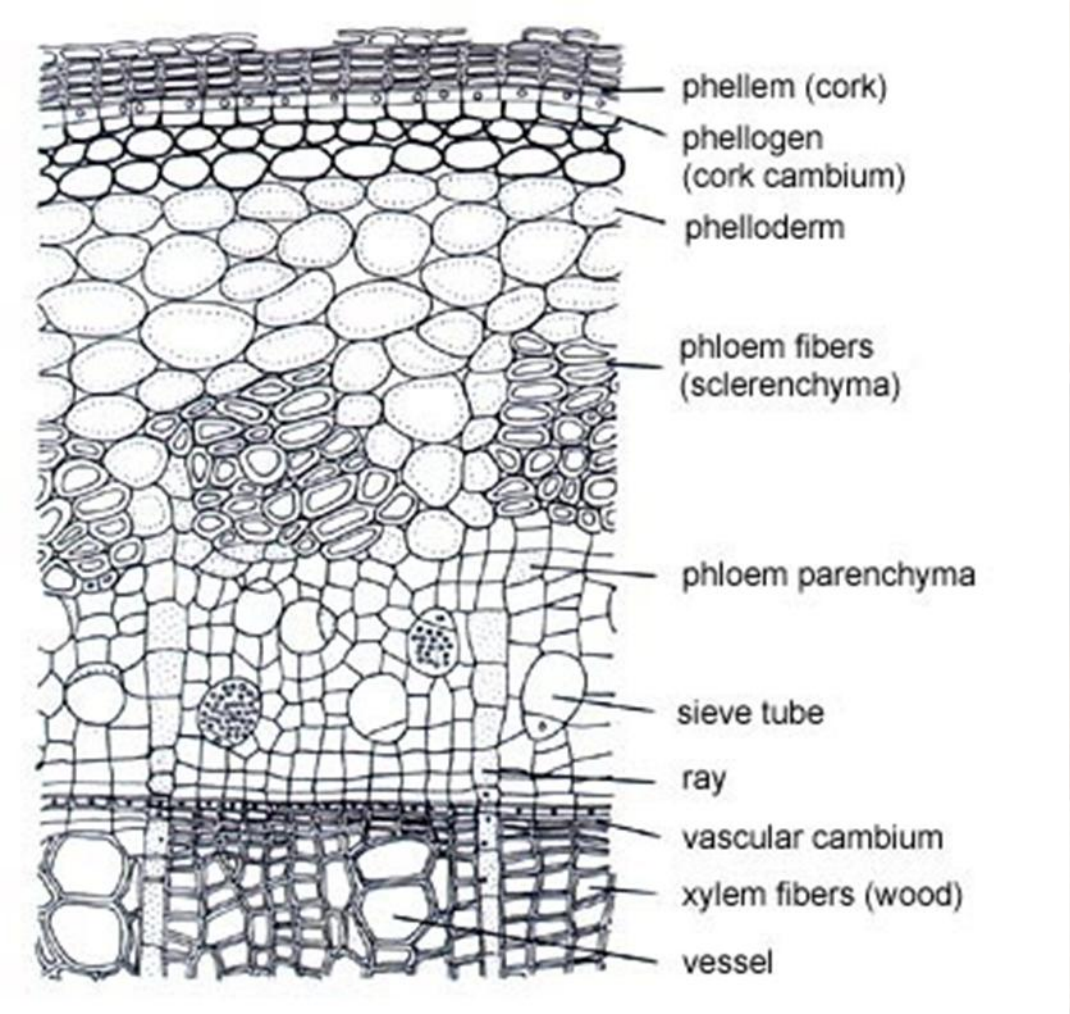
	roots	trunk	crown
		[%]	
Pinus sylvestris L.	15-25	65-77	8-10
Abies alba L.	12-15	77-82	6-8
Quercus L.	15-20	50-75	10-20
Fraxinus L	15-25	55-70	15-20

Trunk and wood zones (cross section of the trunk of a tree)

When we look deeper we distinguish zones on the trunk cross-section.

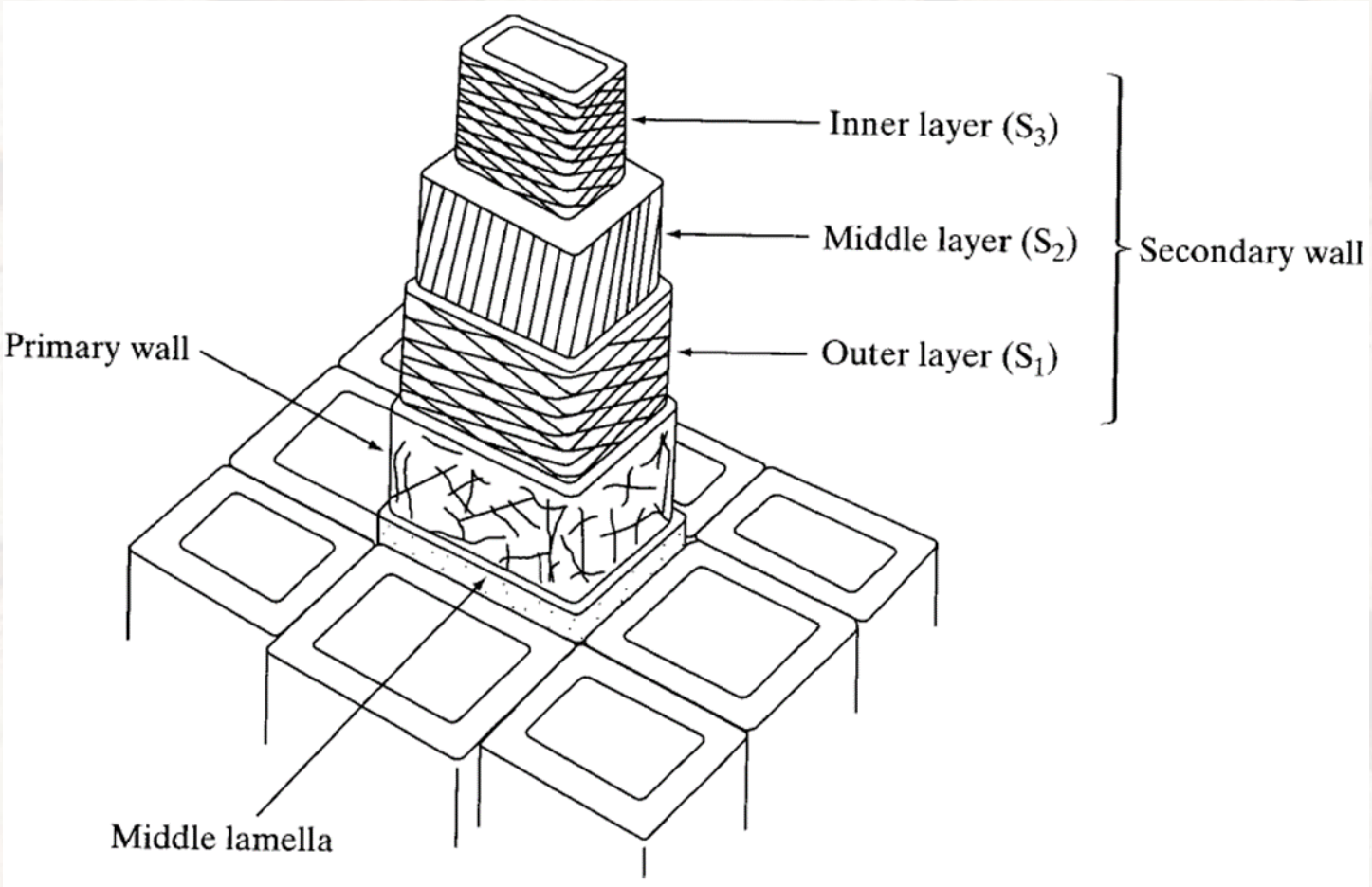


Trunk and wood zones
(cross section of the bark of a tree)



Model of the cell wall structure of softwood tracheids and hardwood libriform fibres

The following layers are separated at the cellular level.



Average percentage of the wall layers in *Picea abies L.*

The thickness of the individual layers varies greatly.

	earlywood	latewood
Primary wall	4,3	2,1
Secondary wall: outer layer (S_1)	12,4	8,8
Secondary wall: middle layer (S_2)	79,0	85,9
Secondary wall: inner layer (S_3)	4,0	3,3

Chemical composition of wood

Chemical composition varies e.g. with:

- tree part (root, stem, or branch),
- type of wood (i. e., normal, tension, or compression),
- age of wood,
- geographic location,
- climate,
- soil conditions.



Elemental composition of wood (1

The wood elemental composition was determined by quantifying the levels of carbon, hydrogen, nitrogen, sulfur and oxygen.

How do you think, why it is worth knowing elementary composition?

Click to learn more



Elemental composition of wood (2/2)

Wood has an elemental composition of about 50% carbon, 6% hydrogen, 44% oxygen, and trace amounts of several metal ions.

However, there are some differences depending on the species and part of the tree:

	Pinus sylvestis L.		*Fagus L.*	
	trunk	branch	trunk	branch
	[%]			
carbon	51,39	52,04	50,64	50,64
hydrogen	6,11	6,07	6,23	6,0
nitrogen	0,94	1,12	1,28	1,01

Chemical composition of wood - general

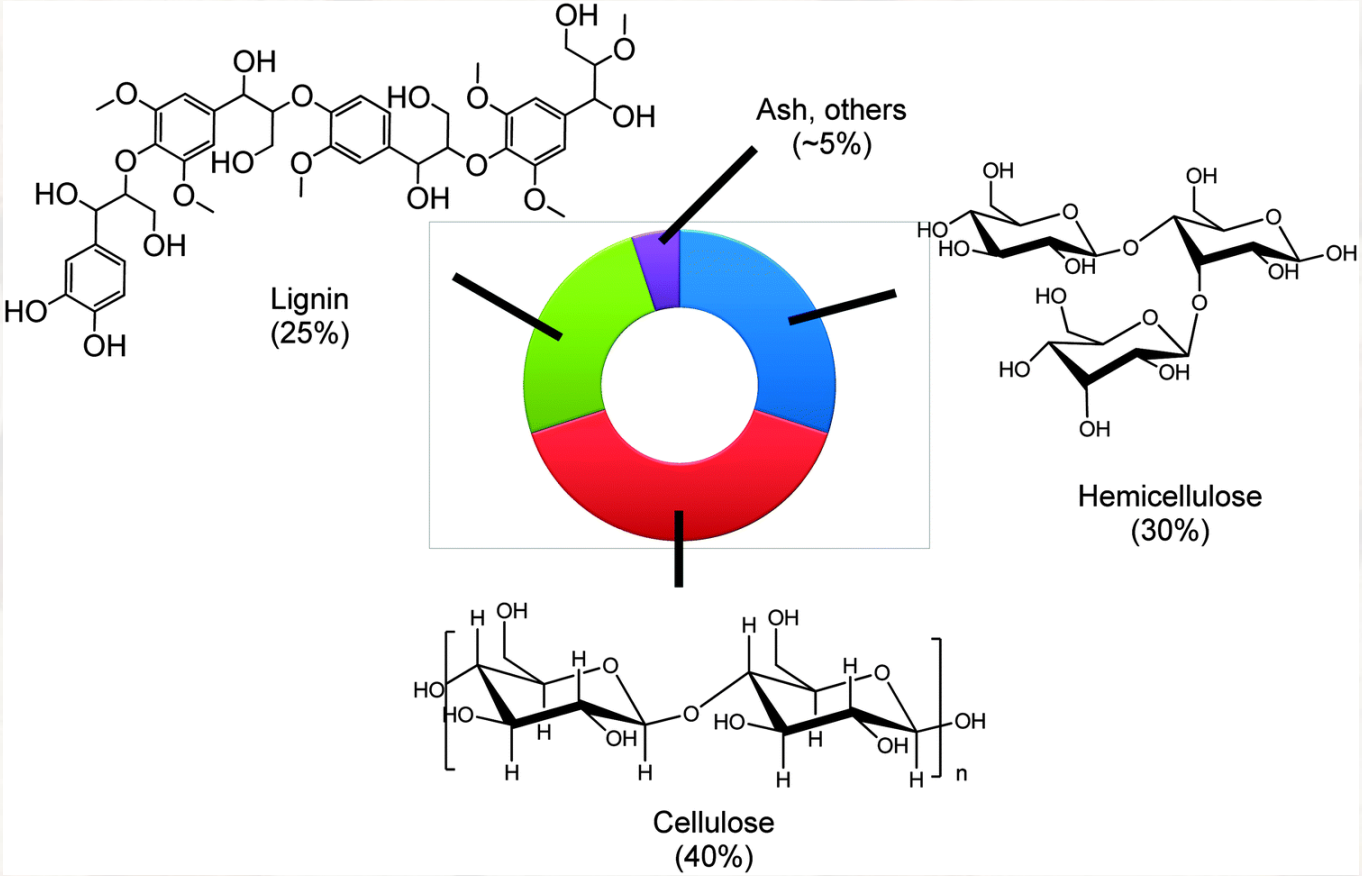
There are two major chemical components in wood:

- lignin (20-30%)

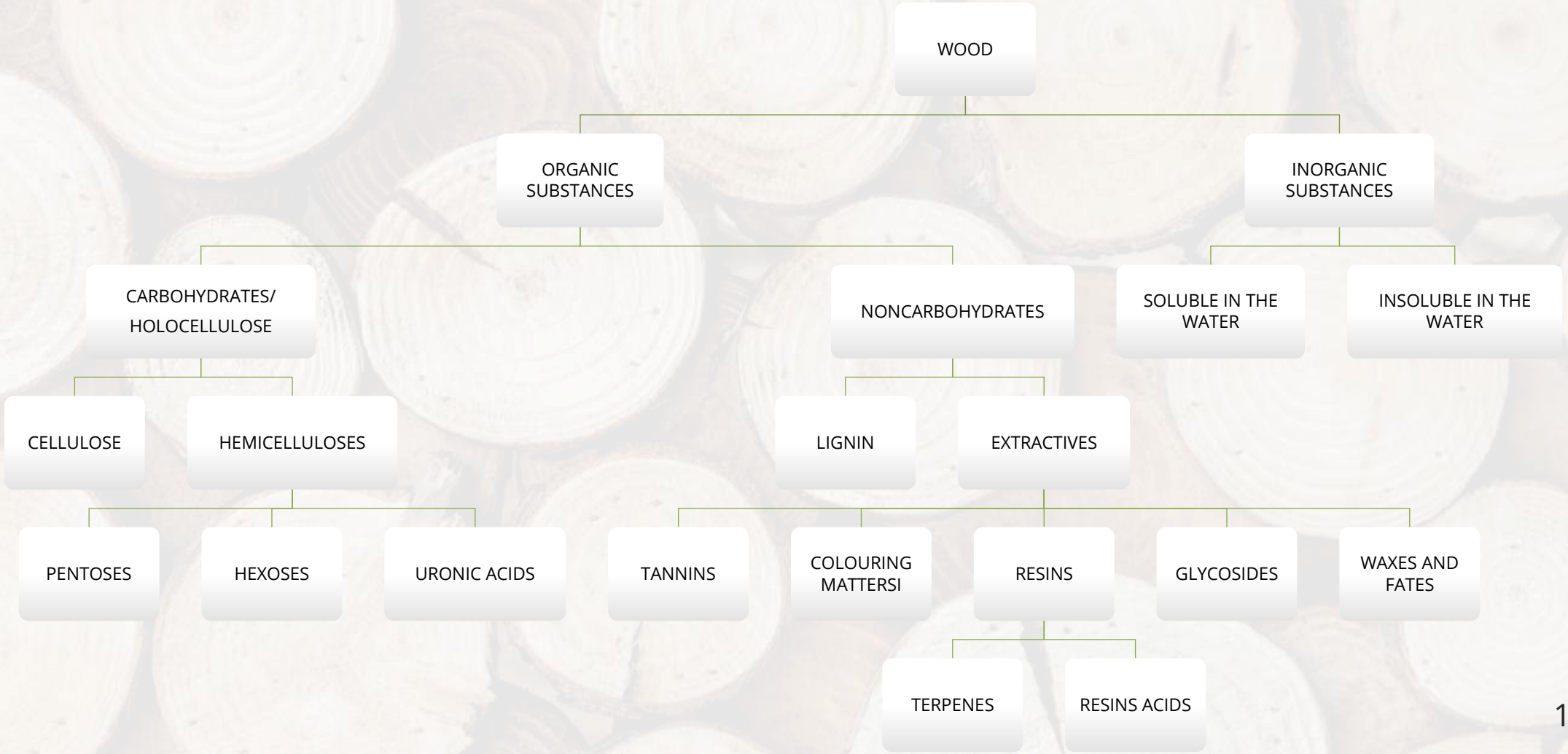
-carbohydrate (cellulose and hemicellulose) (65-75%).

Both are complex, polymeric materials.

Minor amounts of extraneous materials, mostly in the form of organic extractives and inorganic minerals (ash), are also present in wood (usually 5%).



Chemical composition of wood – in details



Chemical composition of wood – average percentages

- cellulose – 40-50%
- lignin – 20-30%
- hemicelluloses – 10-30%
- pentoses– 8,5-25,5%
- hexoses – 0,5-13,5%
- uronic acids – 2,0-5,5%
- extractives – 3-10%
- ash– 0,3-1,0%



Chemical composition of wood – the influence of the age tree

Age (years)	cellulose	lignin	hemicelluloses
		[%]	
7	39,63	22,97	25,15
14	42,19	23,93	23,98
70	44,48	25,75	23,10

Check your knowledge

Does the lignin content in wood decrease or increase over the years?



You should already know the answer.

However if you don’t, please repeat the course.

Chemical composition of wood – the influence of the tree species

	Pinus sylvesries L.	*Fagus L.*
	[%]	
cellulose	54,25	53,46
lignin	26,35	22,46
hemicelluloses	13,23	25,88
extractives	3,45	1,78
ash	0,39	1,17

Check your knowledge

Which species, sapwood or heartwood, have more hemicelluloses?



You should already know the answer.

However if you don’t, please repeat the course.

Chemical composition of wood - their functions and tasks

- cellulose - structural basis of the plants cells
- pentoses – skeletal functions
- hexoses – nutritional function
- uronic acids- binder function
- lignin – mechanical properties
- tannins – antiseptic function resins – protective function against infection (plaster function),
- terpenes - protective function against infection,
- waxes – protective function from excessive transpiration
- fates – protective function against sudden changes in temperatures

Click to learn more

Check your knowledge

Which wood components have a protective function?



You should already know the answer.

However if you don’t, please repeat the course.

Summary

In this course you've learnt about:

- Chemical elements of wood
- Chemical components of wood
- Percentage of chemical components of wood
- Functions of chemical components of wood



Congratulations!

You've finished Chemical Composition of Wood course.

