State Education Development Agency
Republic of Latvia

EUROPEAN UNION

Login: **Well Network**
Password: **Wellwifi**

Erasmus+ TCA thematic seminar
Green Practices for Increasing Environmental Sustainability

Bioeconomic Explorations

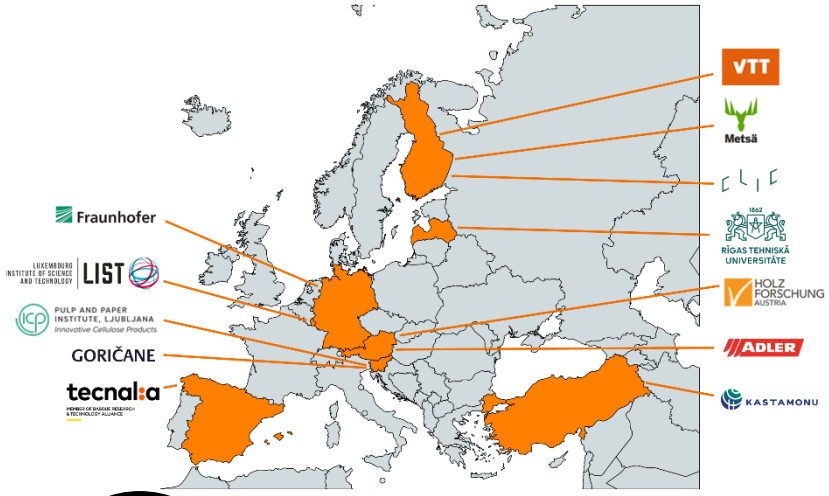
Leading researcher Ilze Vamža

Ilze Vamža

- Researcher at the Institute of Energy Systems and Environment
- 2023 - Defended PhD thesis "Bioeconomy innovations in the conifer value chain"
- 2019. Completed the MSc in Environmental Science in 2019
- 2016. Year of the Bachelor of Biology

RTU VASSI

Super Bark



ADDED VALUE OF BARK

Mixture of polyphenols and microcellulose derived from coniferous bark for the manufacture of binders and coatings

Circular Bio-based Europe Joint Undertaking
Co-funded by the European Union
Bio-based Industries Consortium
The project is supported by the Circular Bio-based Europe Joint Undertaking and its members.
Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or CBE JU. Neither the European Union nor the CBE JU can be held responsible for them.

Value-added

Different value added and CO_2 storage period

Fuel pellets

440 € / TONNE

Coating

1200 € / TONNE

What kind of company would our youth to like to work for?

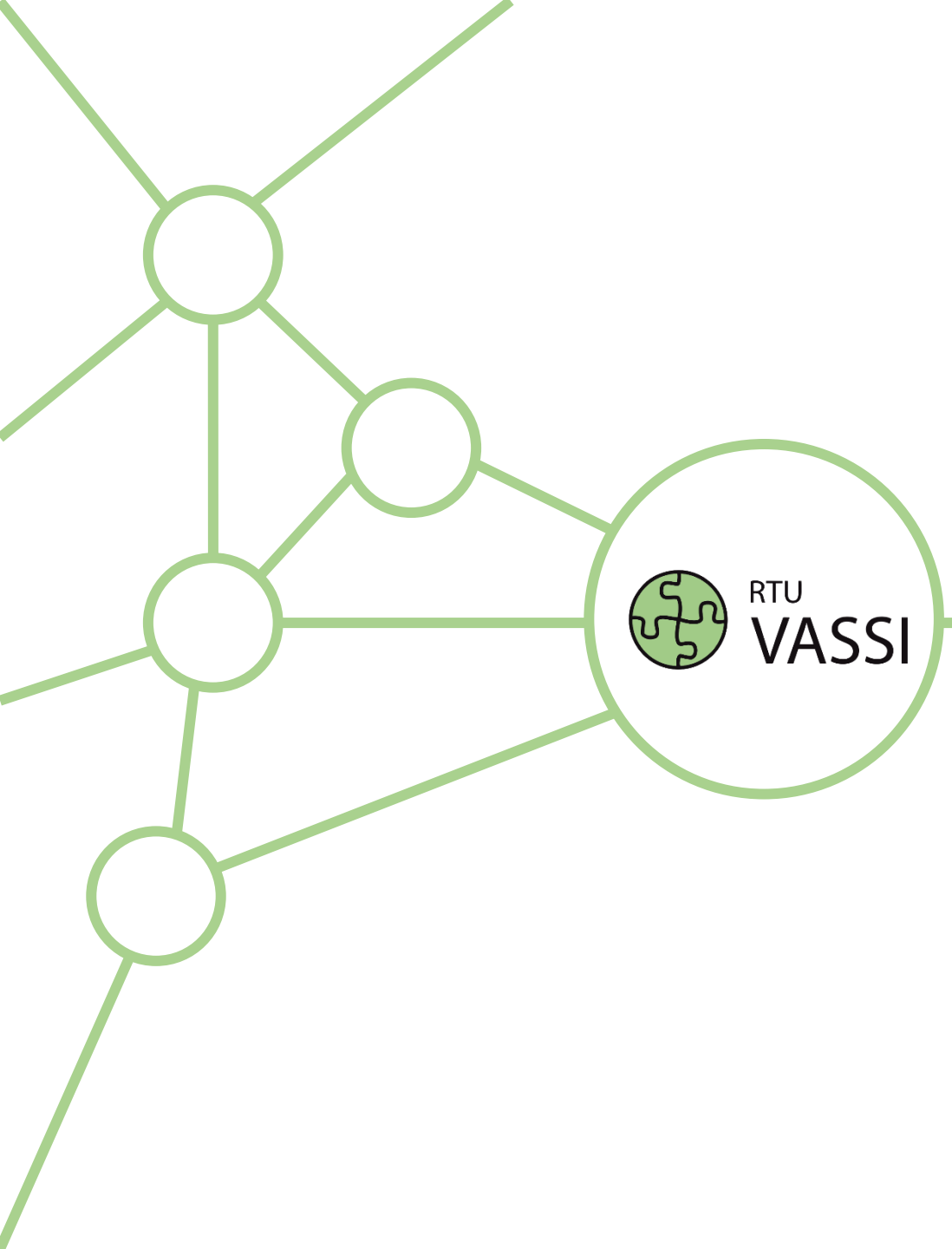
Sawmill

In the coating plant

Photo: "ADLER"

Bioeconomic Explorations

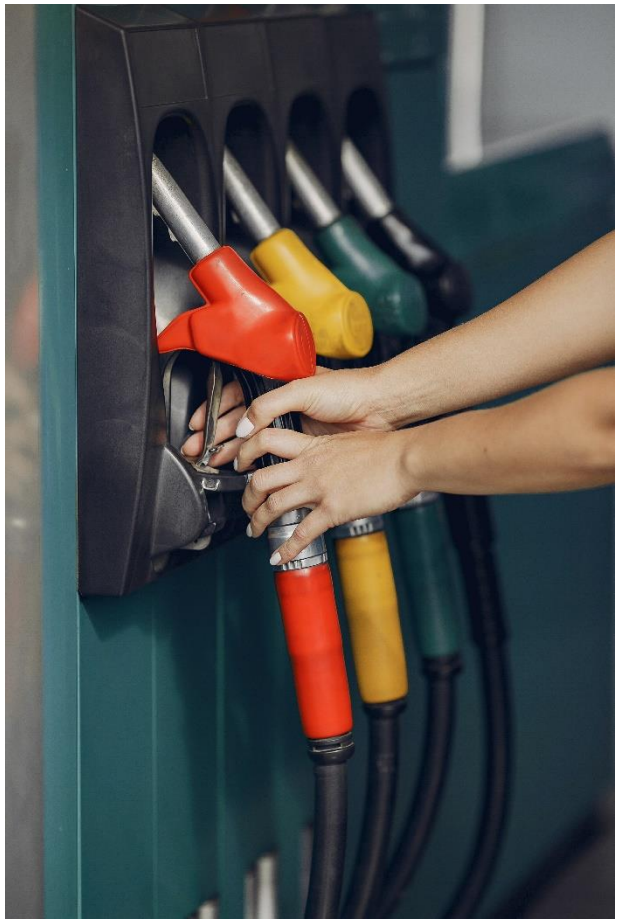
Ph.D. Ilze Vamža

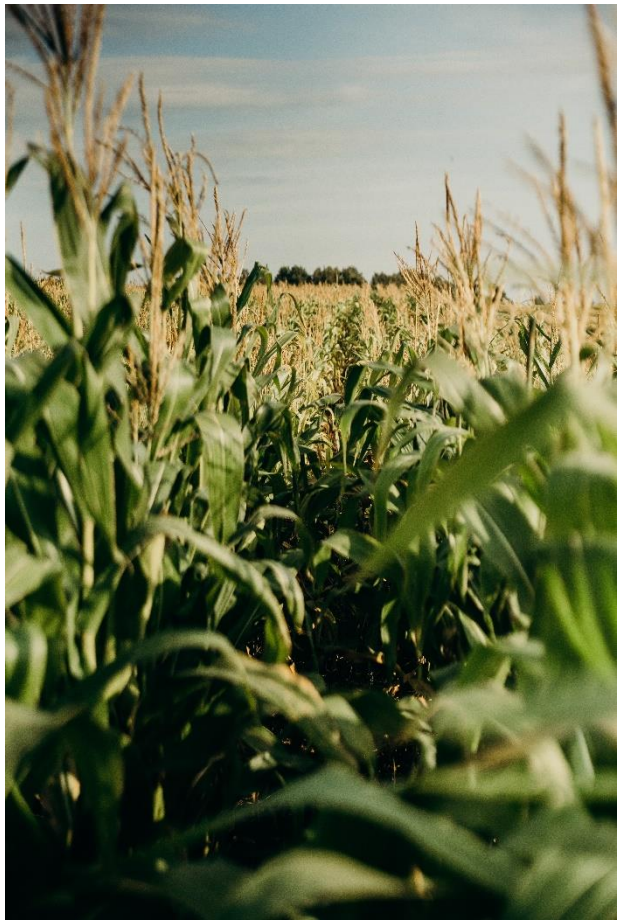


Informative part

Introduction to the Bioeconomy concept, examples and innovations

What is bioeconomy?





PRIMARY RESOURCES IN SECTORS

AGRICULTURE

Raw
Grain
Legumes
Potatoes
Fruit trees
Eggs
Livestock
After primary treatment
Grains of wheat
Meat
Peas
Apples
After Industrial Processing
Bread
Juice
Canned food

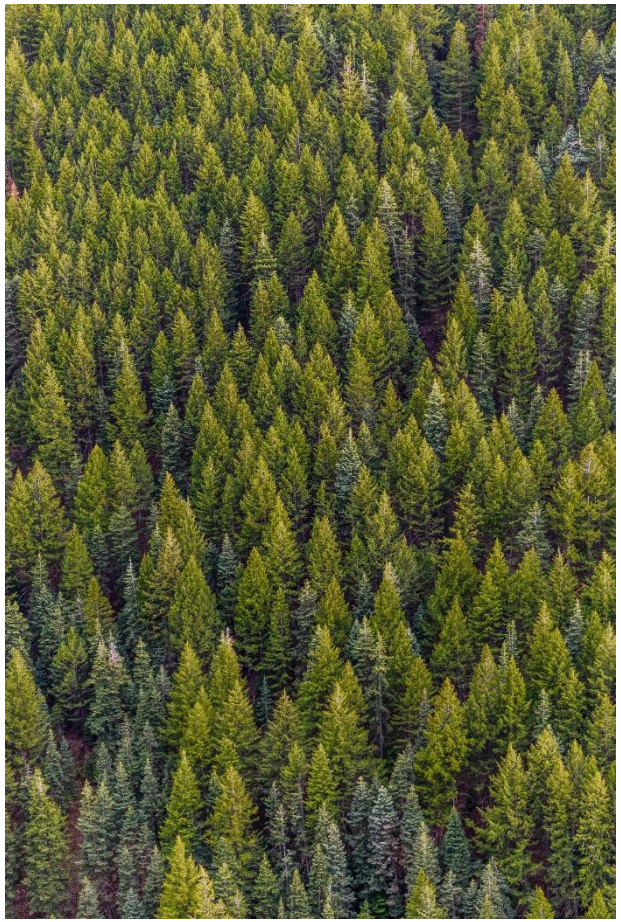
FORESTRY

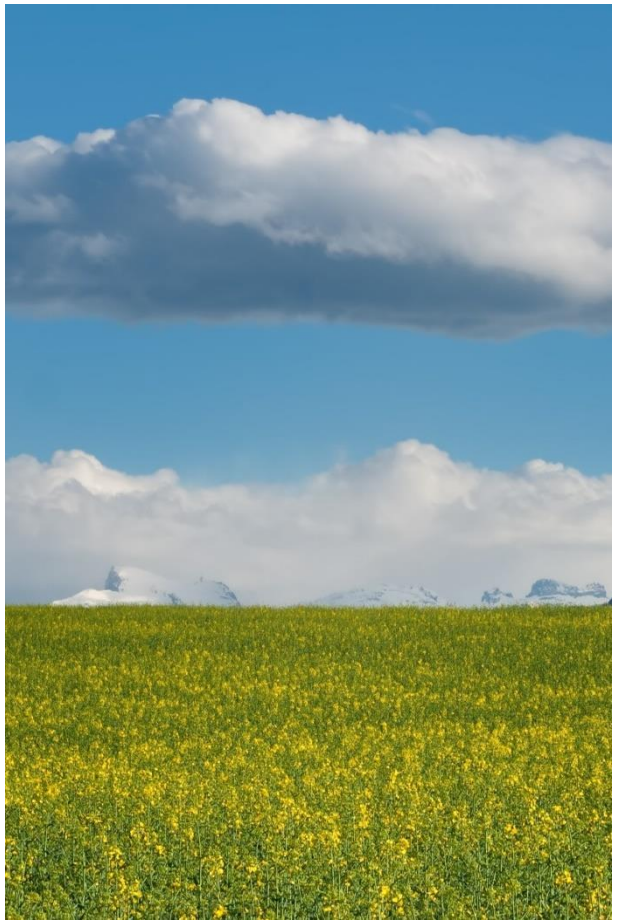
Raw
Wood
After primary treatment
Logs
After industrial
Paper
Fibre
Furniture

FISHERIES

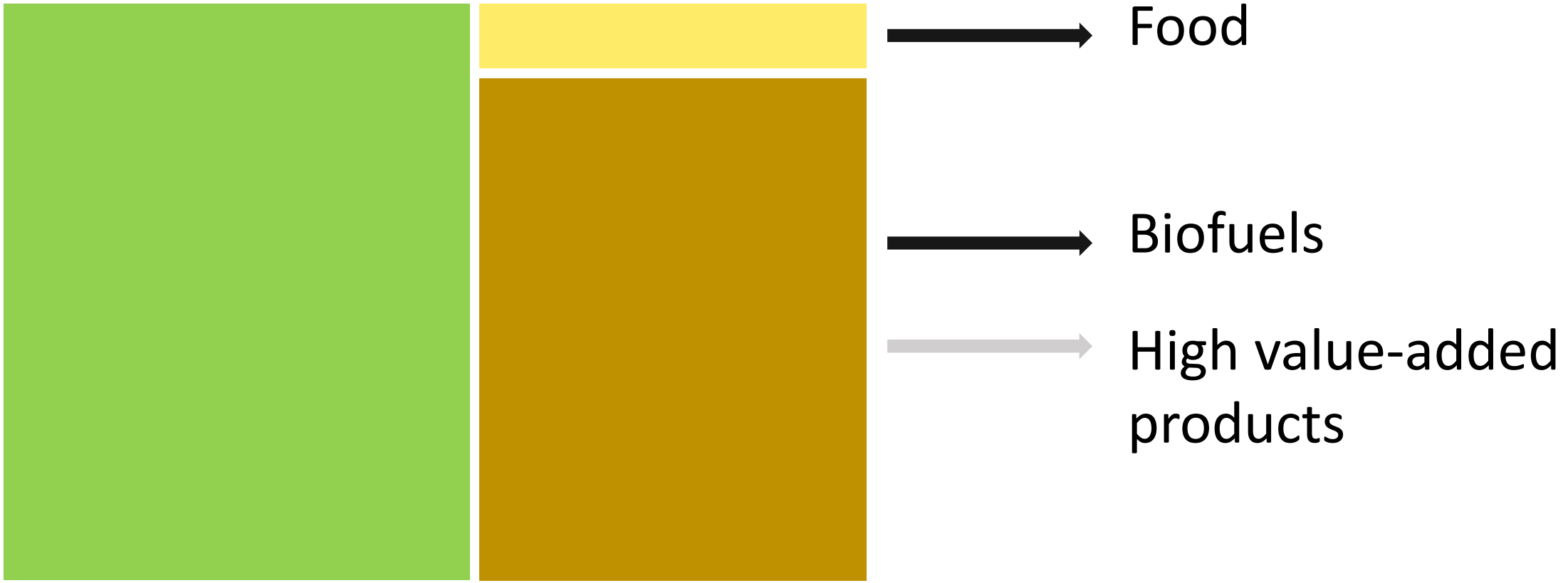
Raw
Fish
Crustaceans
Microalgae
After primary treatment
Fish body
Caviar
After industrial
Fish fillet

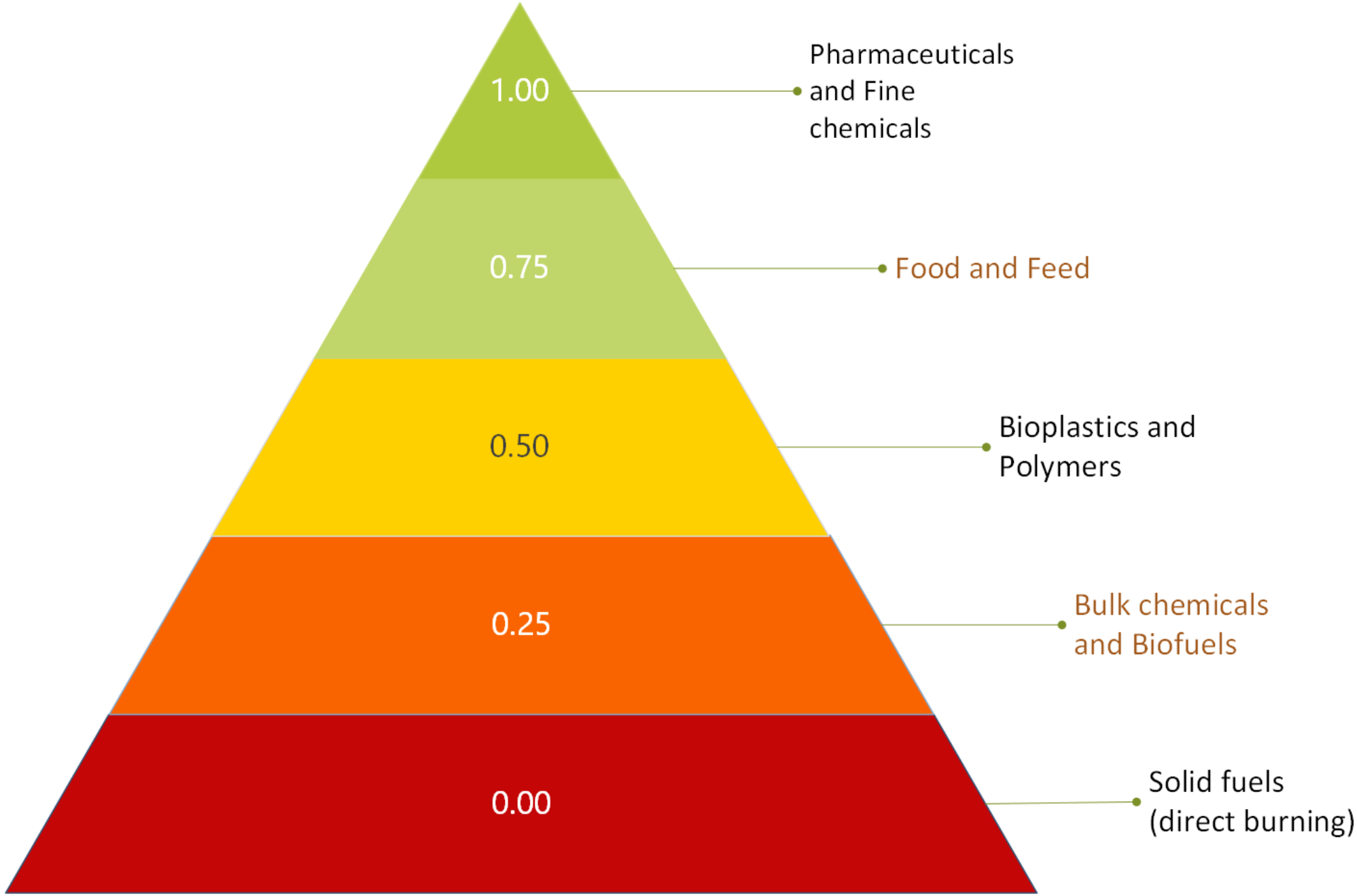
Limits



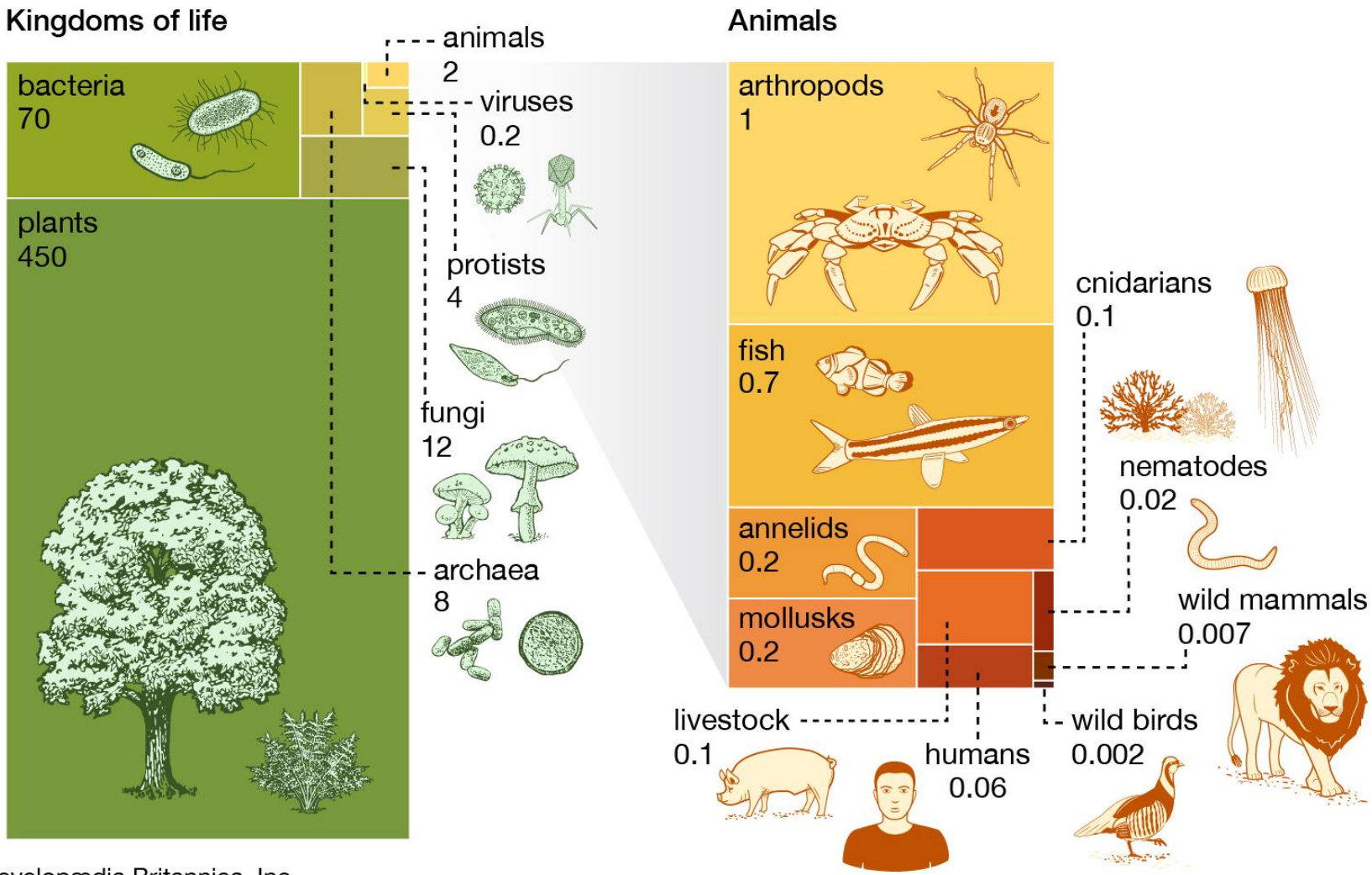


Productivity




1.00
Pharmaceuticals and Fine chemicals
0.75
Food and Feed
0.50
Bioplastics and Polymers
0.25
Bulk chemicals and Biofuels
0.00
Solid fuels (direct burning)

Biomass

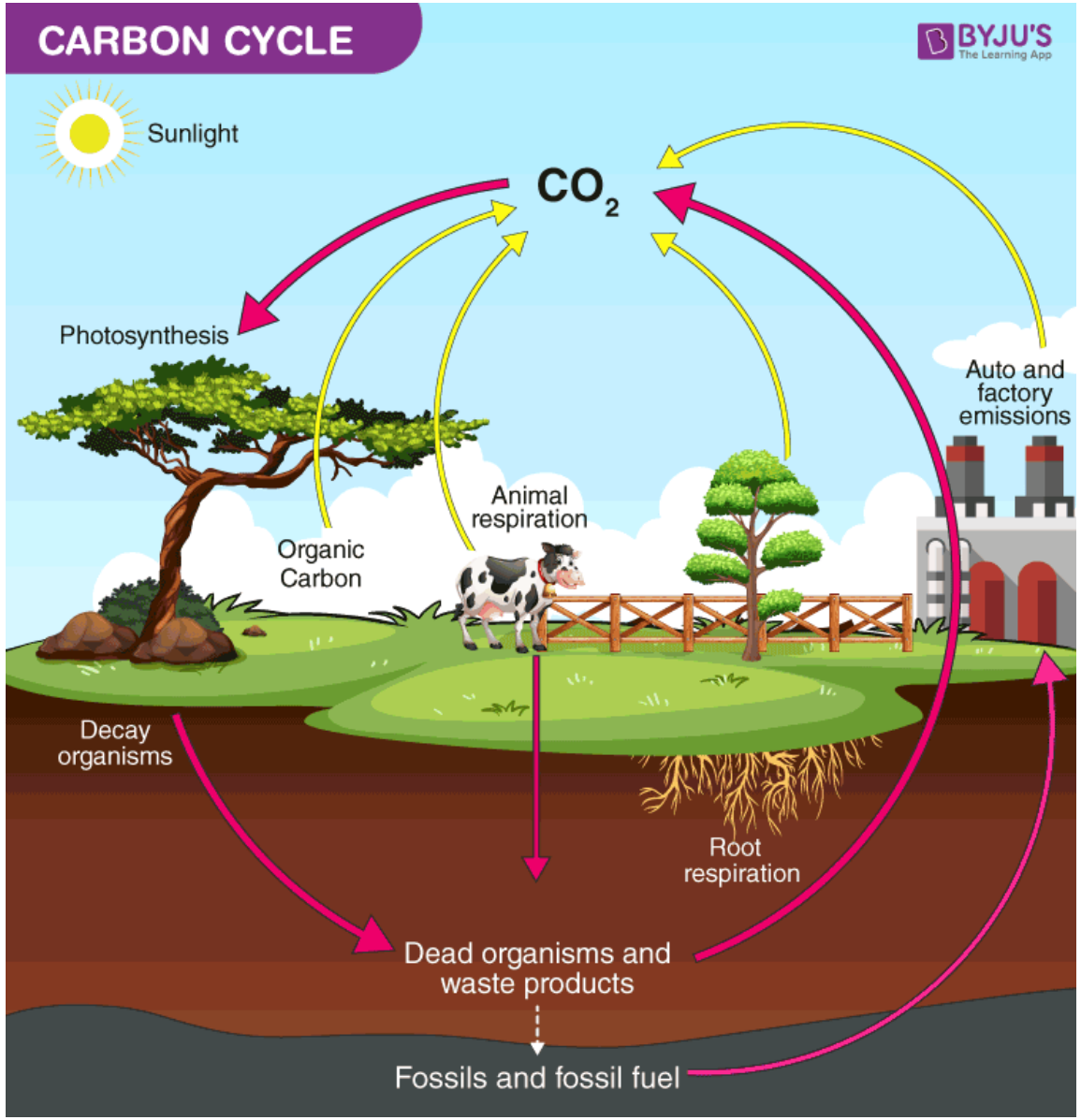


What makes up most biomass?

Relative amount of biomass
GT carbon

Plants 82%
Bacteria 13%
Fungi 2%
People 0.00011%

Carbon cycle

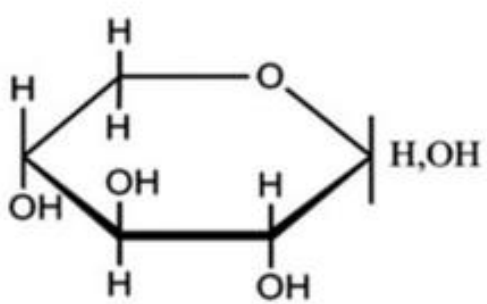


$$6CO_2 + 6H_2O \xrightarrow{hv} C_6H_{12}O_6 + 6O_2$$

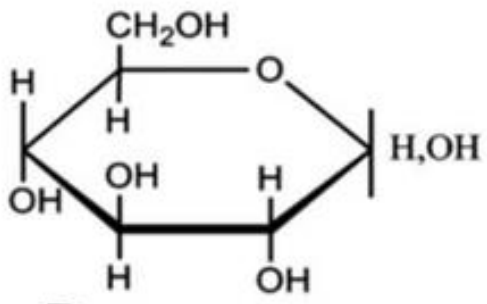
E

Carbohydrates in hemicellulose

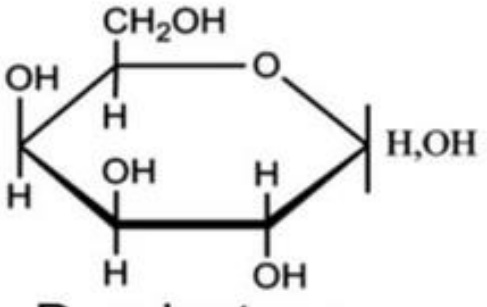
base chain



D-xylose

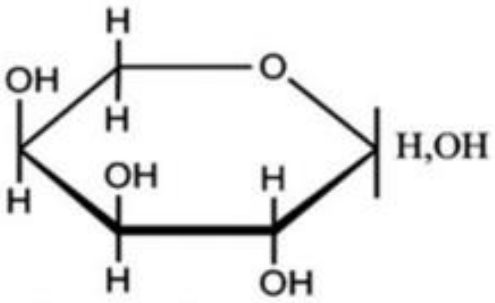


D-mannose

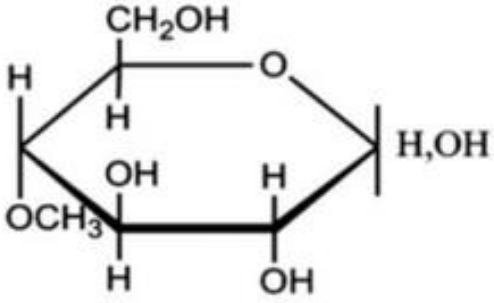


D-galactose

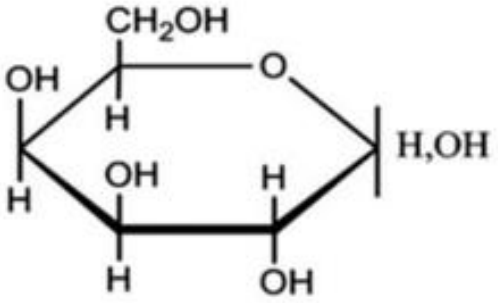
side chain



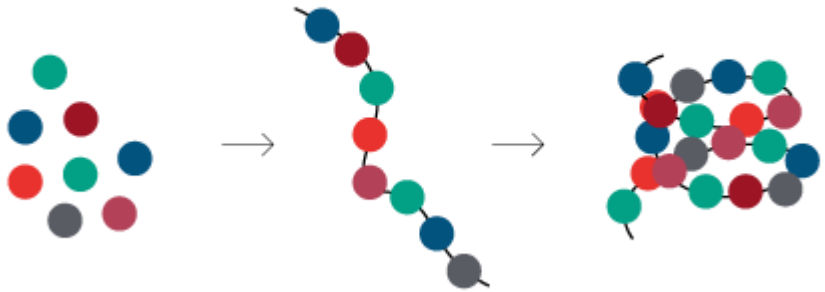
L-arabinose

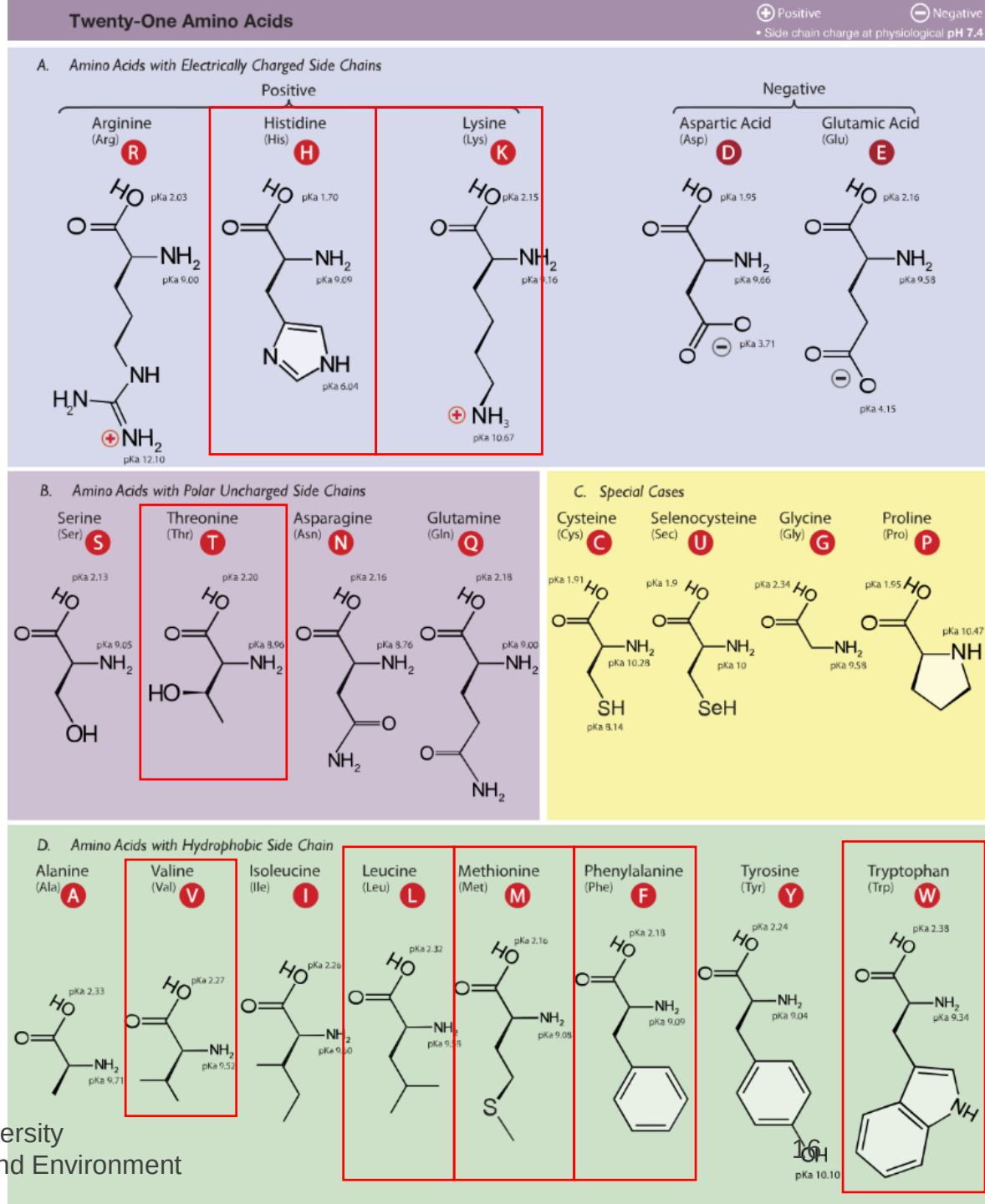


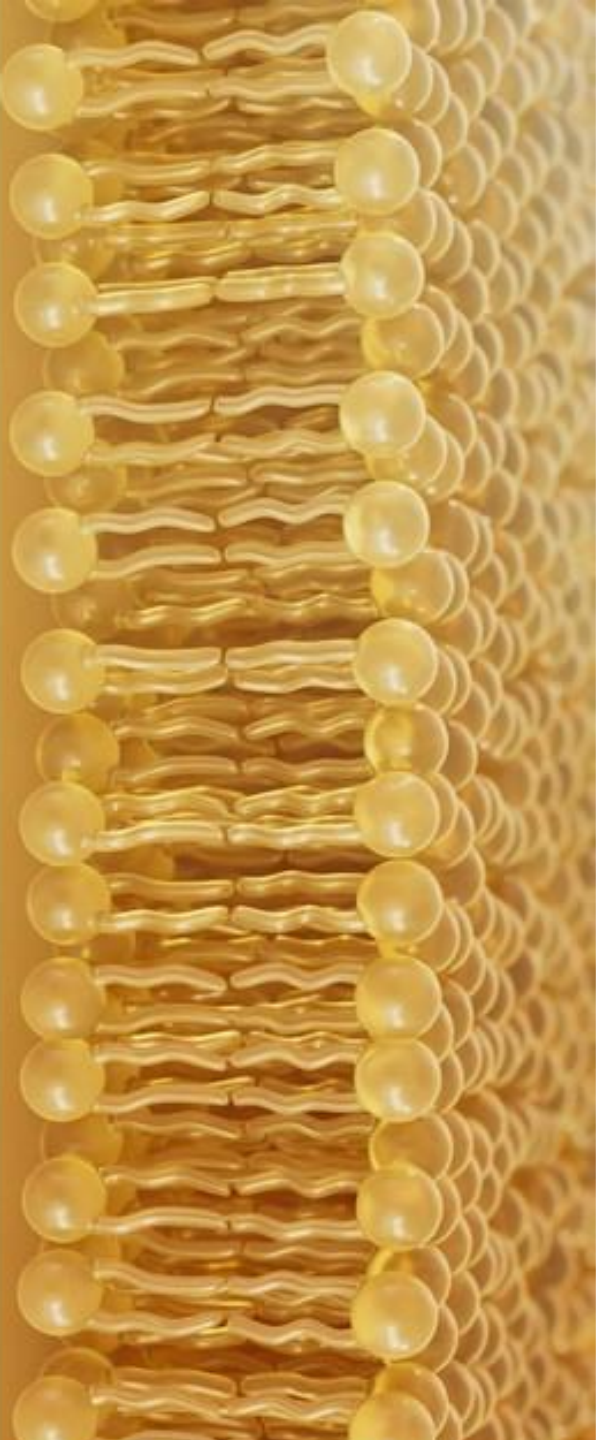
4-O-methyl-D-gulcuronic acid



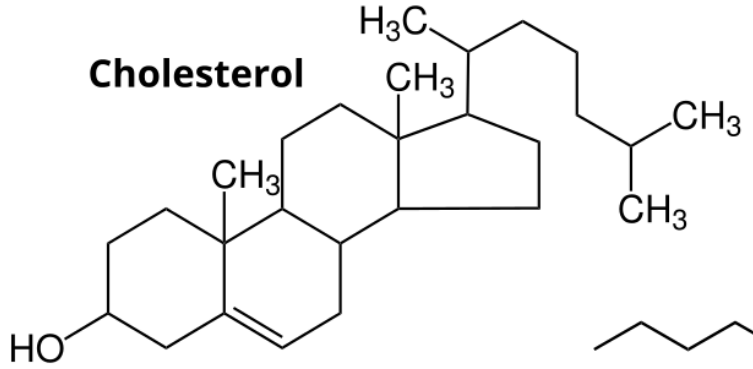
D-galactose



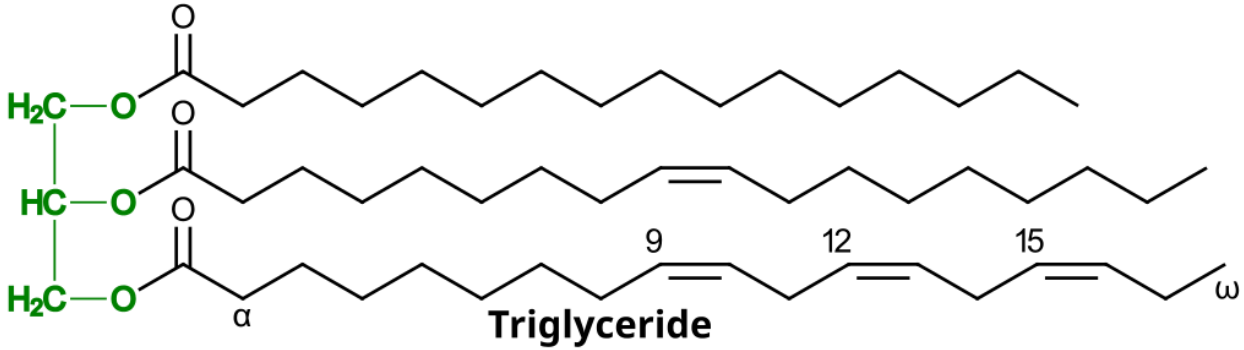

Twenty-One Amino Acids
Positive
Negative
• Side chain charge at physiological pH 7.4
A. Amino Acids with Electrically Charged Side Chains
Positive
Arginine (Arg) R
Histidine (His) H
Lysine (Lys) K
Negative
Aspartic Acid (Asp) D
Glutamic Acid (Glu) E
B. Amino Acids with Polar Uncharged Side Chains
Serine (Ser) S
Threonine (Thr) T
Asparagine (Asn) N
Glutamine (Gln) Q
C. Special Cases
Cysteine (Cys) C
Selenocysteine (Sec) U
Glycine (Gly) G
Proline (Pro) P
D. Amino Acids with Hydrophobic Side Chain
Alanine (Ala) A
Valine (Val) V
Isoleucine (Ile) I
Leucine (Leu) L
Methionine (Met) M
Phenylalanine (Phe) F
Tyrosine (Tyr) Y
Tryptophan (Trp) W



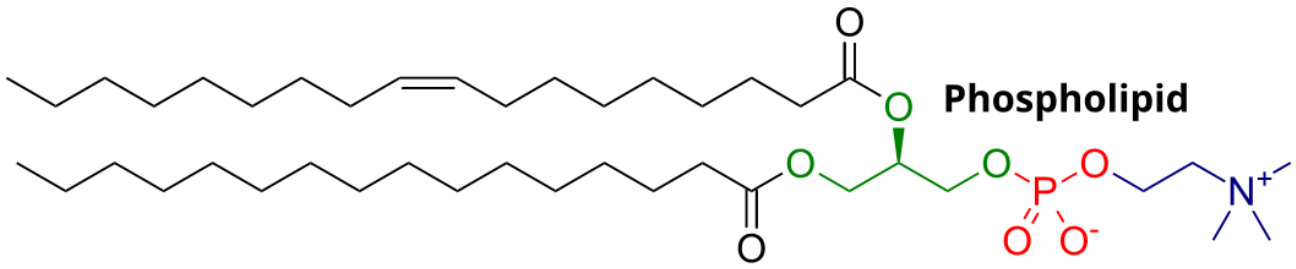
Cholesterol



Free Fatty Acid



Triglyceride



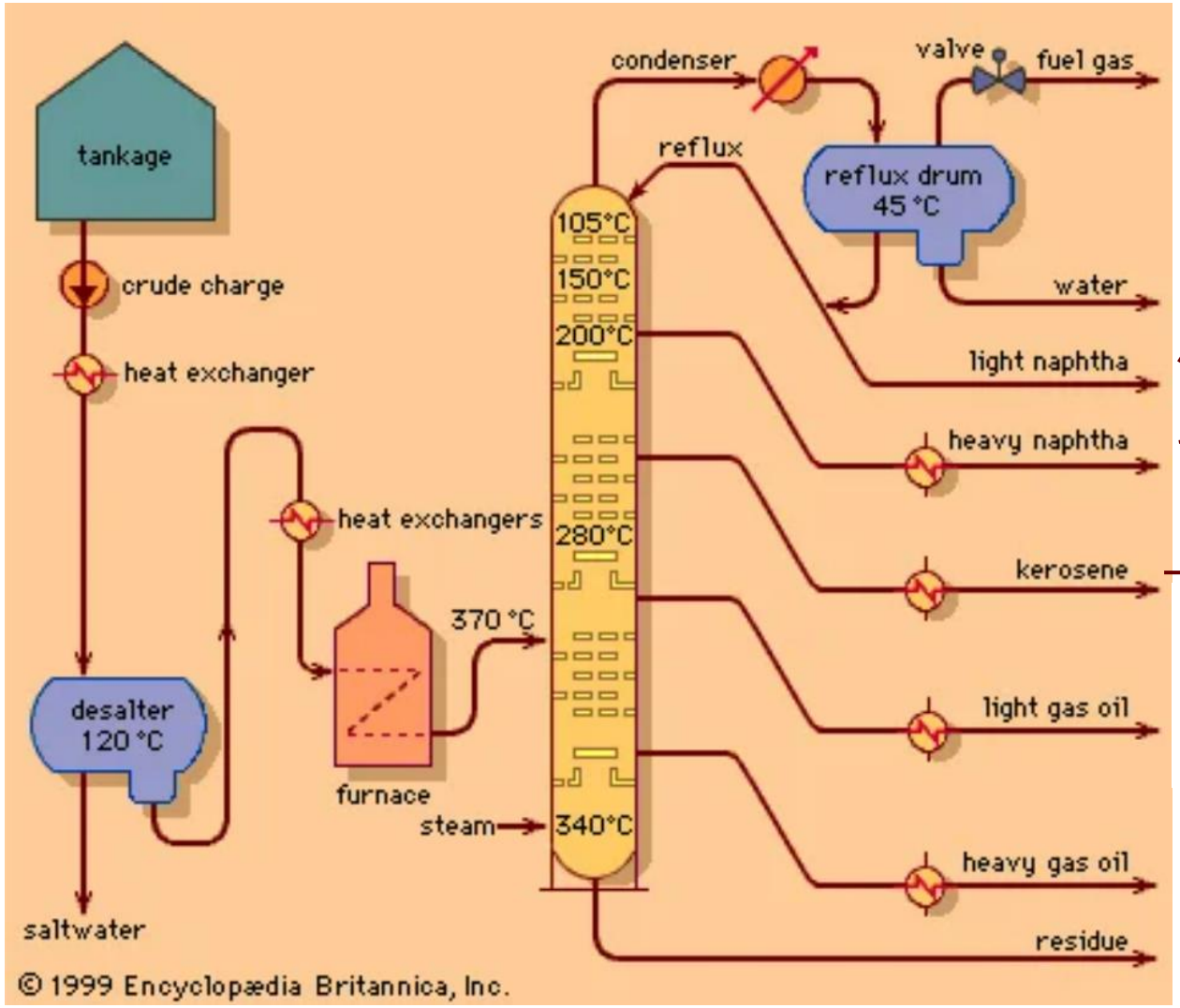
Phospholipid


SAMPLE
No.

Refining

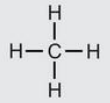
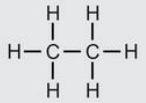
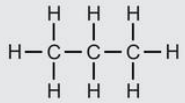
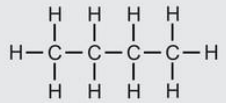
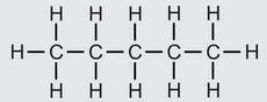
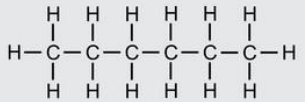
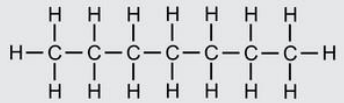
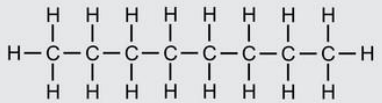
~1840-1860 kerosene separated from crude oil

Oil refining

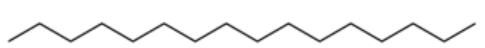


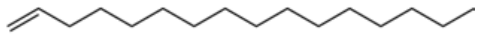
Crude oil components

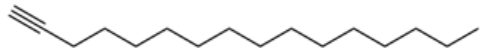
HYDROCARBONS (Alkanes)

	METHANE
	ETHANE
	PROPANE
	BUTANE
	PENTANE
	HEXANE
	HEPTANE
	OCTANE

Aliphatic hydrocarbons

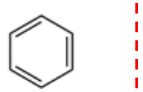

Hexadecane

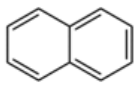

Hexadecene

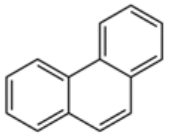

Hexadecyne

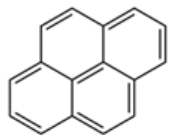

Cyclohexane

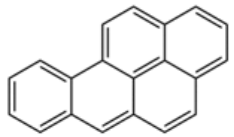
Aromatic hydrocarbons


Benzene

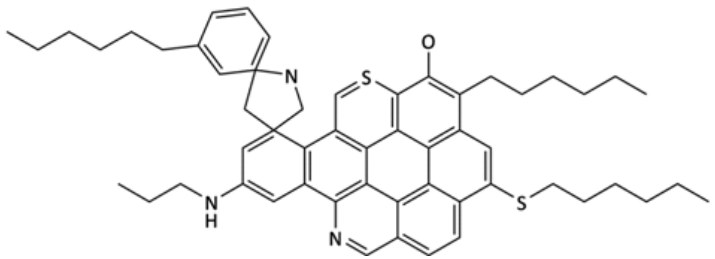

Naphthalene


Phenanthrene


Pyrene

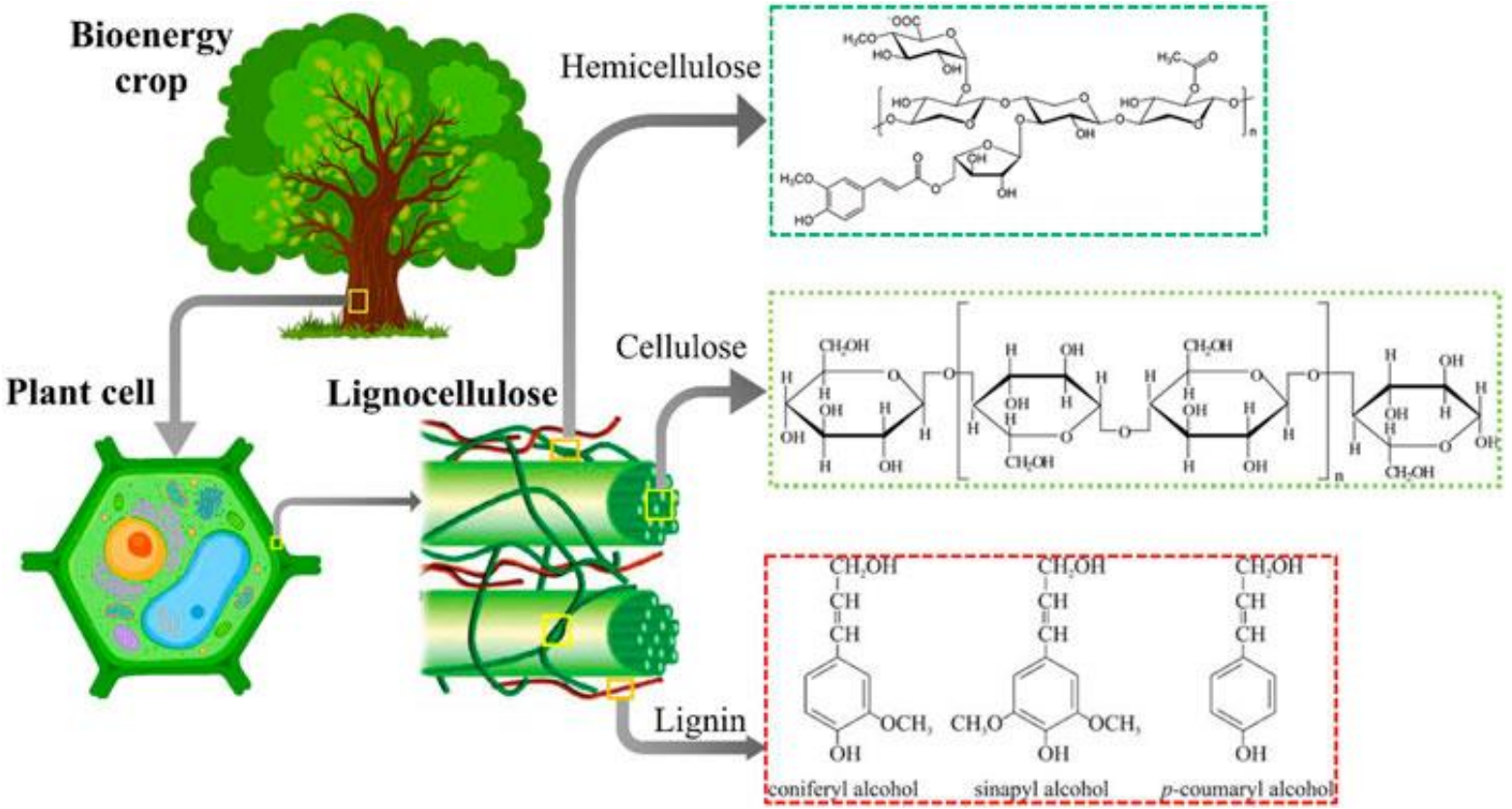

Benzo[a]pyrene

Asphaltene




Development driven by
petrochemical industry

Characteristics of bioresources



Variability:

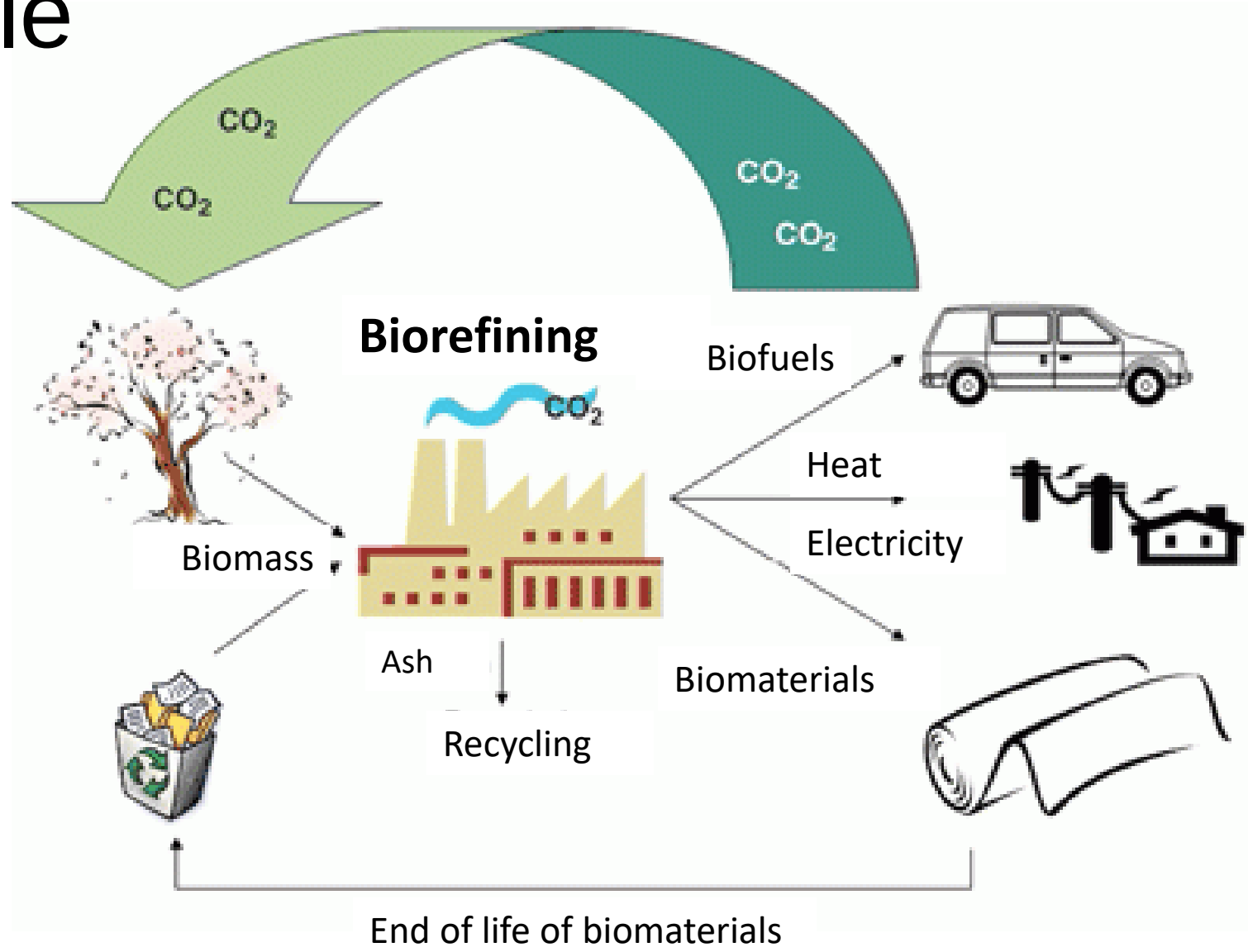
- volume
- composition
- quality

In addition, the structures are complex

Sankaran et al. 2021. https://doi.org/10.3389/fnano.2021.793528

Carbon cycle

Meeting all consumer needs without using fossil resources



https://www.ecomena.org/biorefinery/

Alternative raw materials

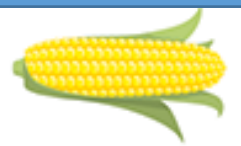
crude oil

Guaiacol

spruce lignin

Coniferyl alcohol

maize carbohydrates



Glucose

rice bran

Ferulic acid

cloves

Eugenol

vanilla beans

Vanillin glucoside

Squalane

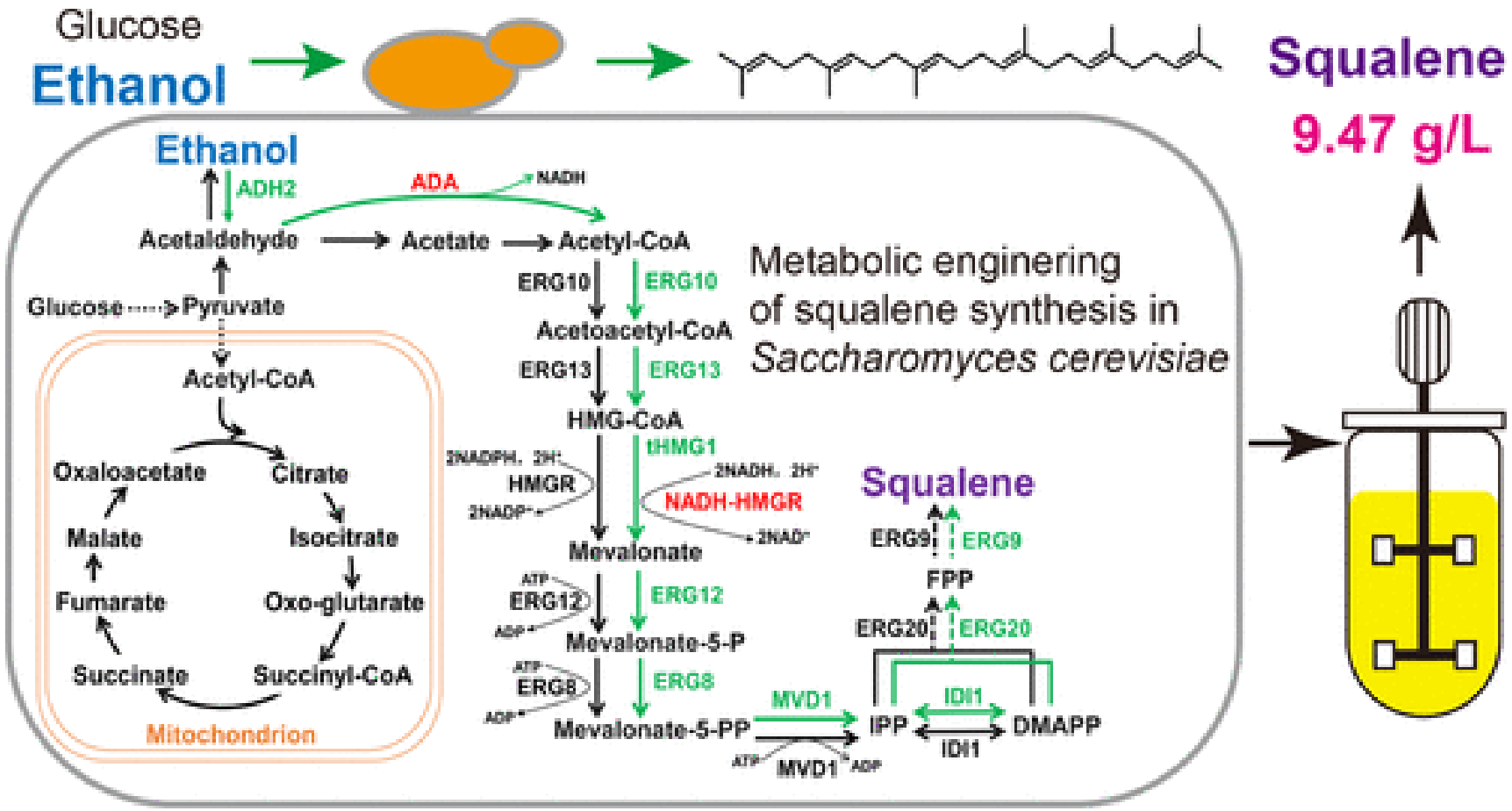
- Moisturiser in cosmetics
- Adjuvant in vaccines

Squalane

Shark liver oil -> 1 tonne of squalane from 3000 sharks

In olive oil 5.64g/100g ->
1 tonne of squalane from
2 ha of olive trees

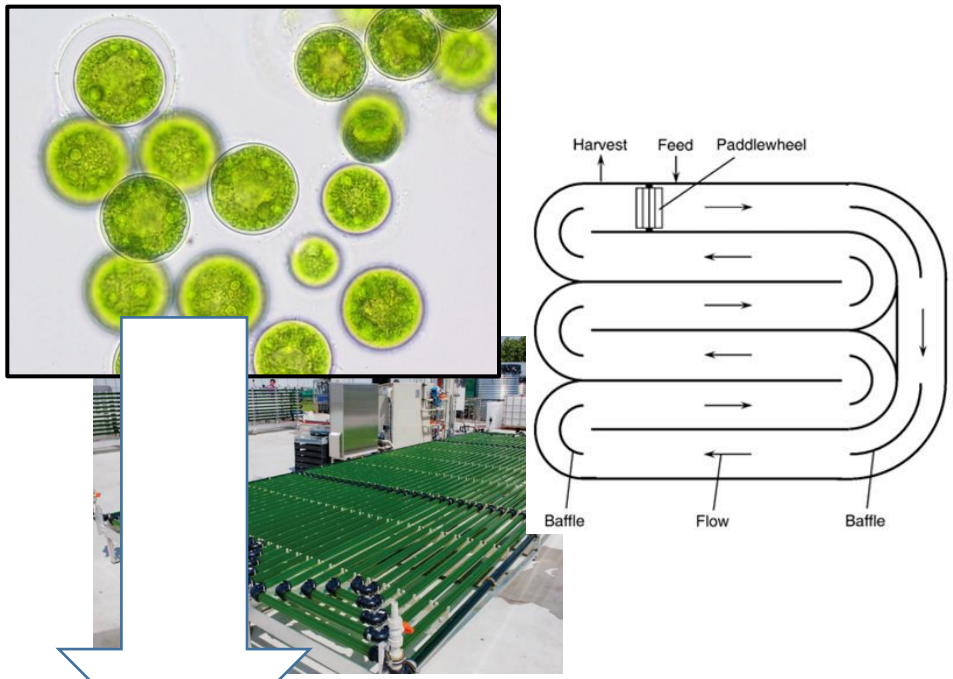
Squalane



106 m^3

Biodiesel

1,7l/day



4,5l/day

ALMONDS

35 - 75 %

Almond shells account for about half of the total fruit weight.

3.2Mt of almonds are produced each year

HIGH VALUE-ADDED PRODUCTS

ANTIOXIDANTS

Polysaccharide-based antioxidants with high activity. Can be used as food additives.

CAPSULE SHELLS

Xylan can be used to form the capsules of medicinal products.

THICKENER

Xylan forms a gelatinous mass and can therefore be used as a thickening agent in food and cosmetics.

PLASTMASS

Combining xylan with L-lactic acid can produce an organic plastic with improved properties

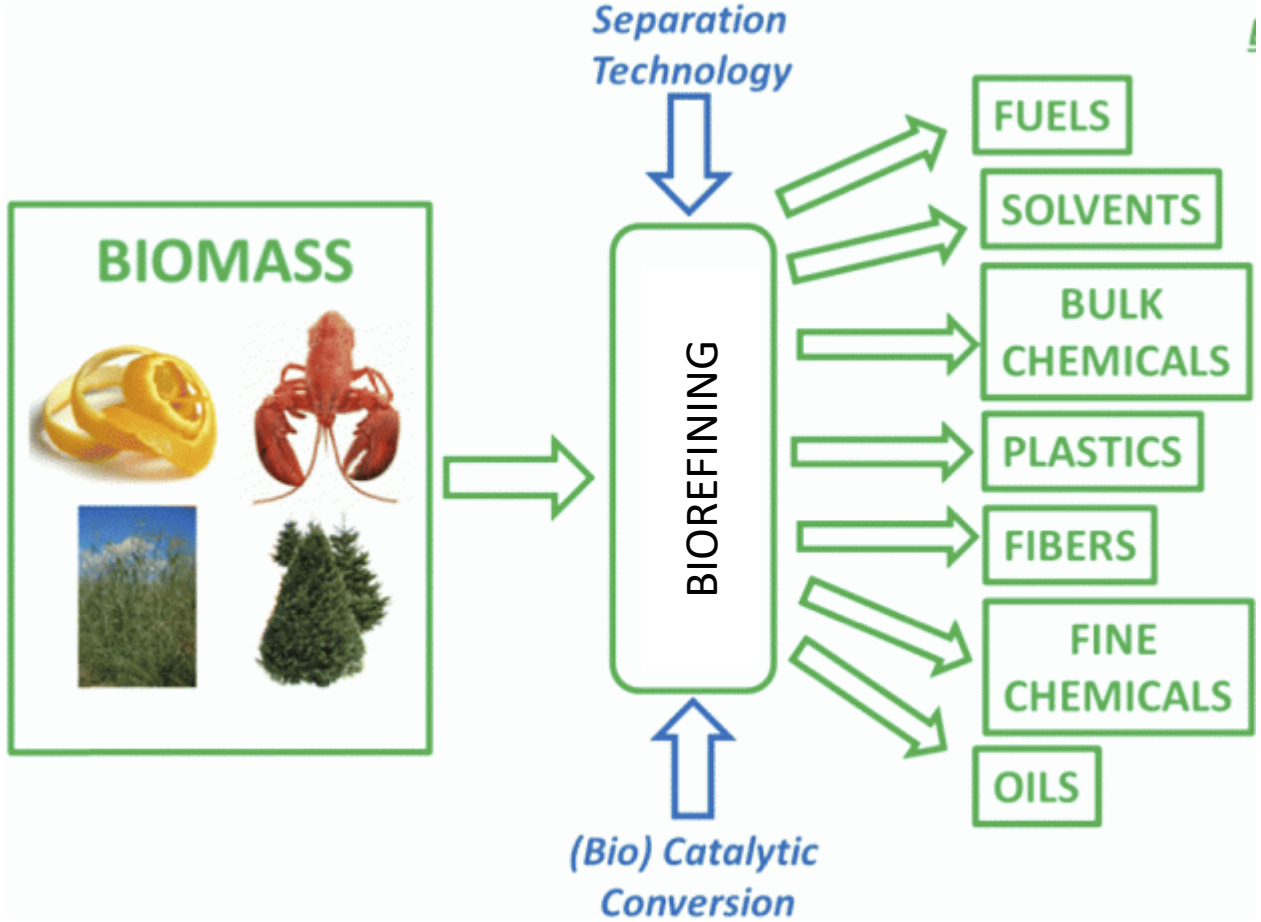
ALMONDS

Recovering energy or producing higher value-added products?

3.2Mt of almonds are produced each year

0.896 Mt xylan = €672 million

Biorefining



Biorefining can be a process, a plant or even a cluster of plants.

Converting biomass into multiple product streams and integrating different technologies and processes in the most sustainable way.

Biorefinery

Product

The primary aim of biorefinery is to produce a product

Residues - energy

Energy

The primary objective of biorefinery is to produce energy

Residues - in high value-added products

According to its technological implementation status

Generation 1 (Simple)

Conventional use of agricultural and forest biomass (sugar-rich biomass: bioethanol; oil-rich biomass: biodiesel; woody biomass: paper). Low flexibility and integration.

Generation 2 (Advanced)

Lignocellulosic biomass as feedstock. Use of all feedstock. Holistic approach. Medium flexibility and integration.

Generation 3 (Additional)

Use of agricultural and organic waste streams. Algae biorefinery. High flexibility and integration.

By its size

Small and medium-sized enterprises

Looks rural. Local access.

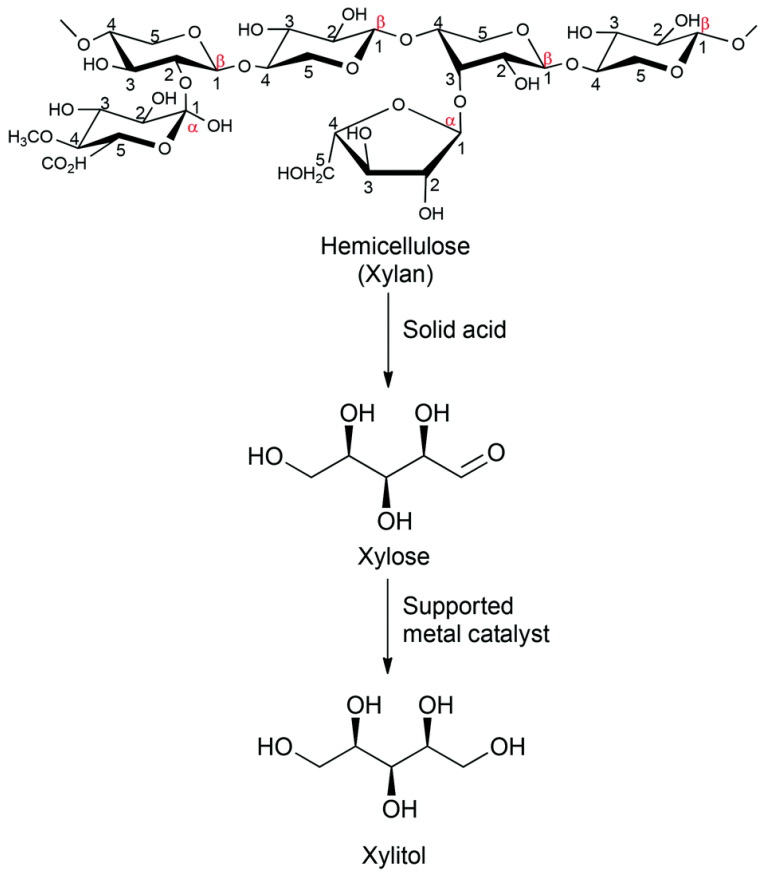
Large production site

Linked to a decentralised network of primary processing companies.

Very large production site

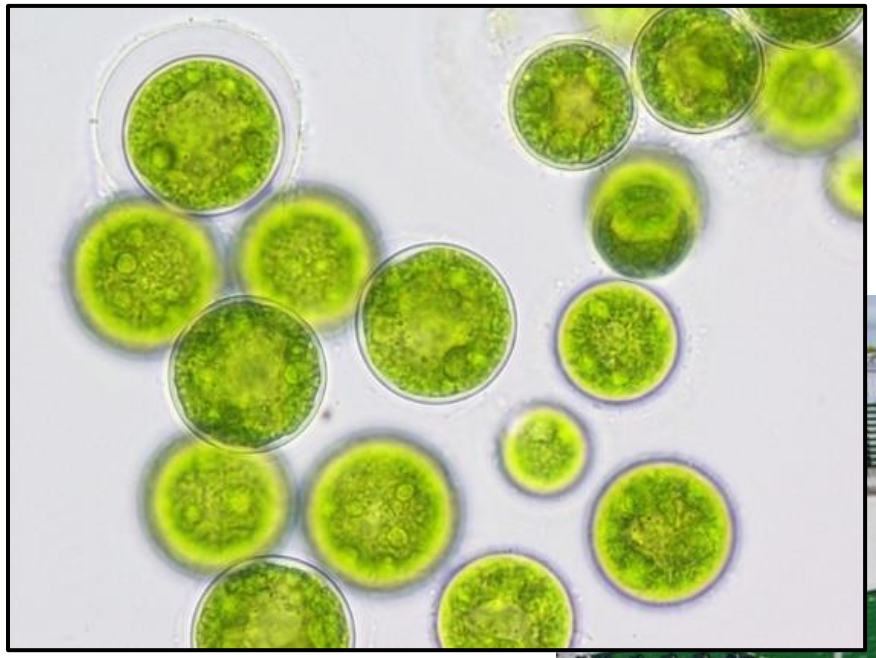
Located close to the port, it mainly uses imported biomass.

Wood biorefinery (2nd generation)

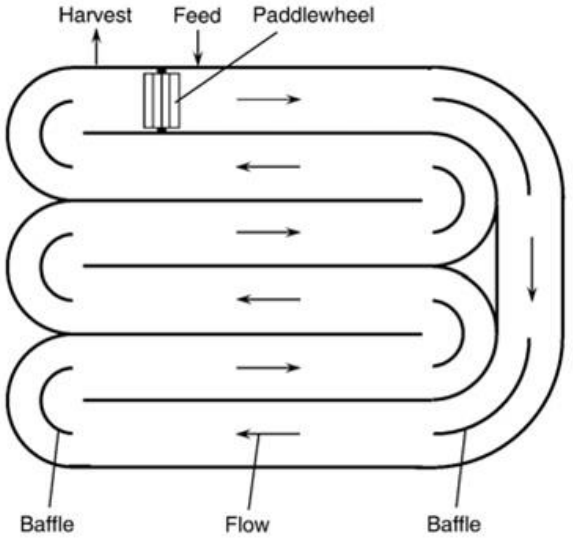


Separating cellulose polymers from hemicellulose can produce higher value-added products such as textiles and sweeteners

Microalgae biorefinery (3rd generation)



- Spirulina
- Oil
- Antioxidants

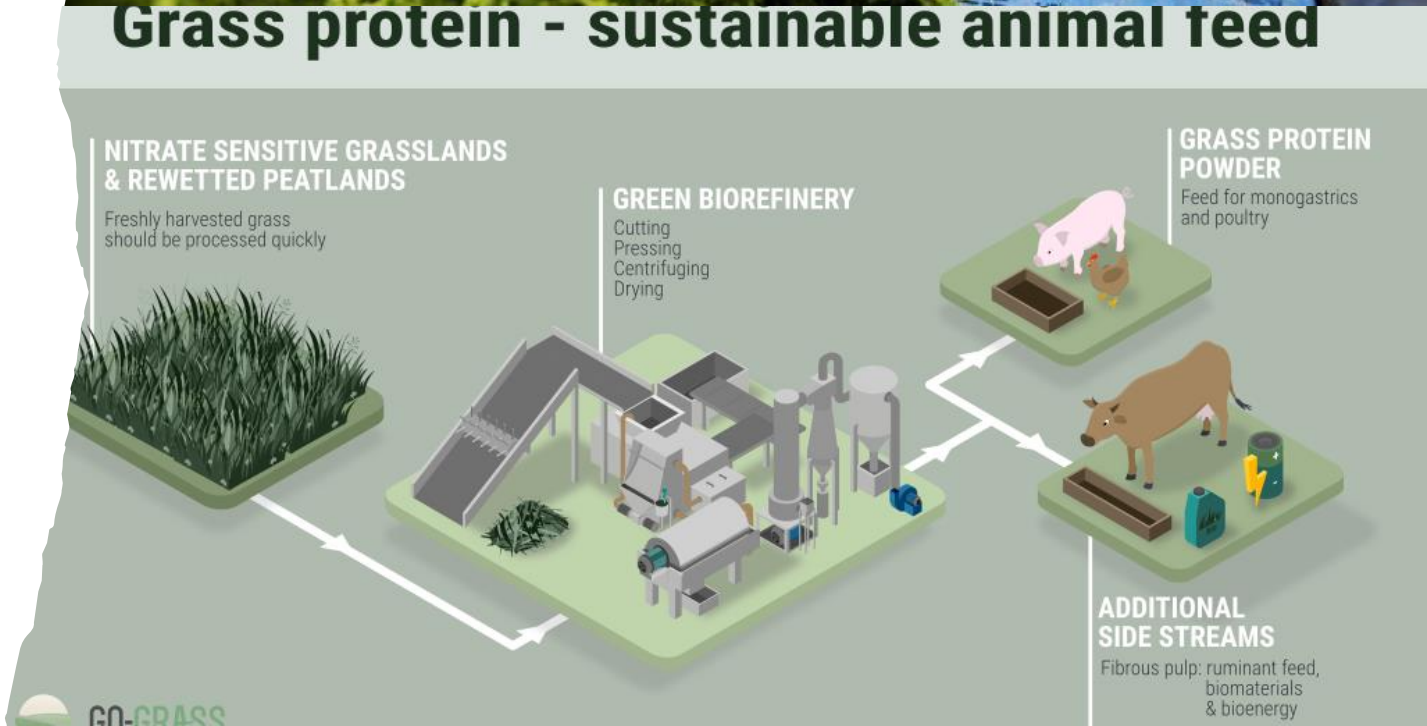


Grass

Separate proteins from fibre

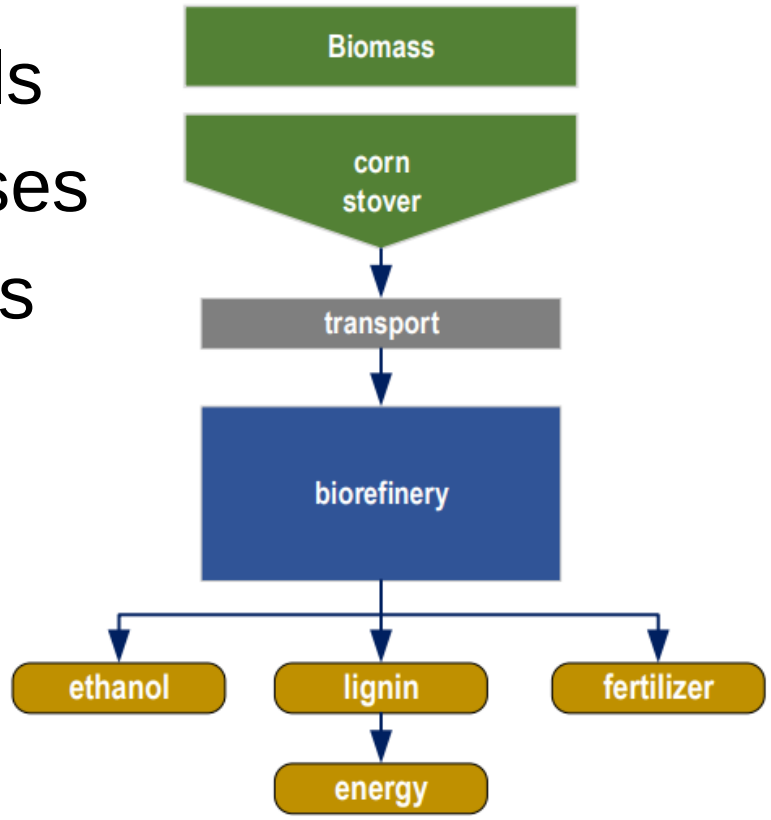
Juice as a feedstock or fertilizer

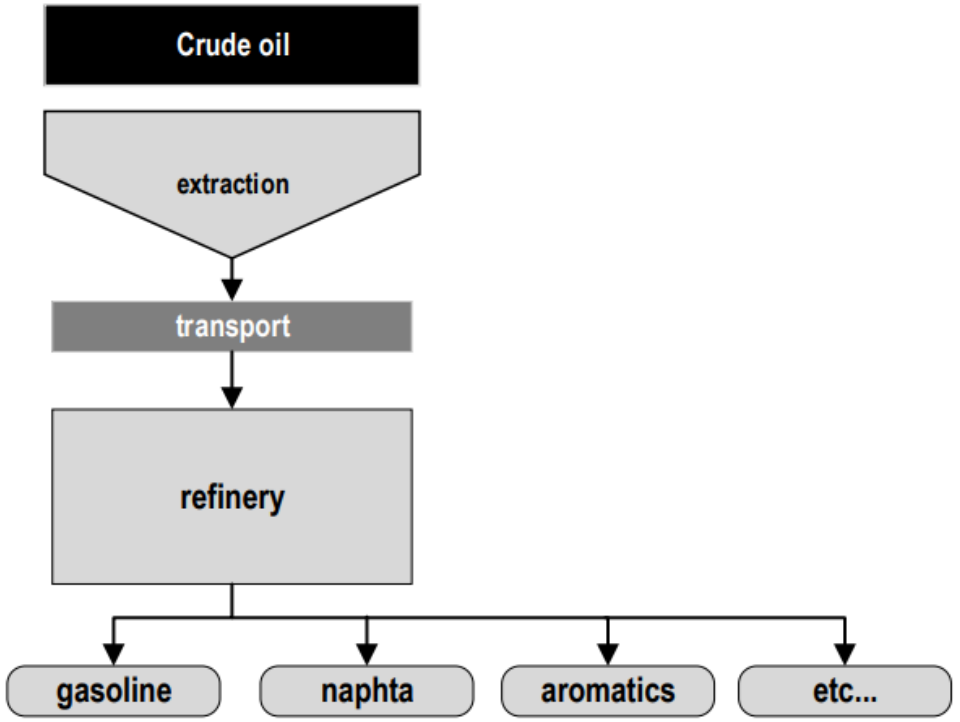
Lactobacillus for fermenting and obtaining lactic acid



Classification of a biorefinery system

1. Platforms
2. Raw materials
3. Processes
4. Products





Platforms

The intermediate stage between raw materials and finished products.

In a biorefinery, the feedstock is usually fractionated into several main intermediates. These intermediates are not necessarily a single well-defined compound on the platform, but a mixture of compounds of different purities. Several feedstocks can lead to a single platform and a biorefinery can have several platforms.

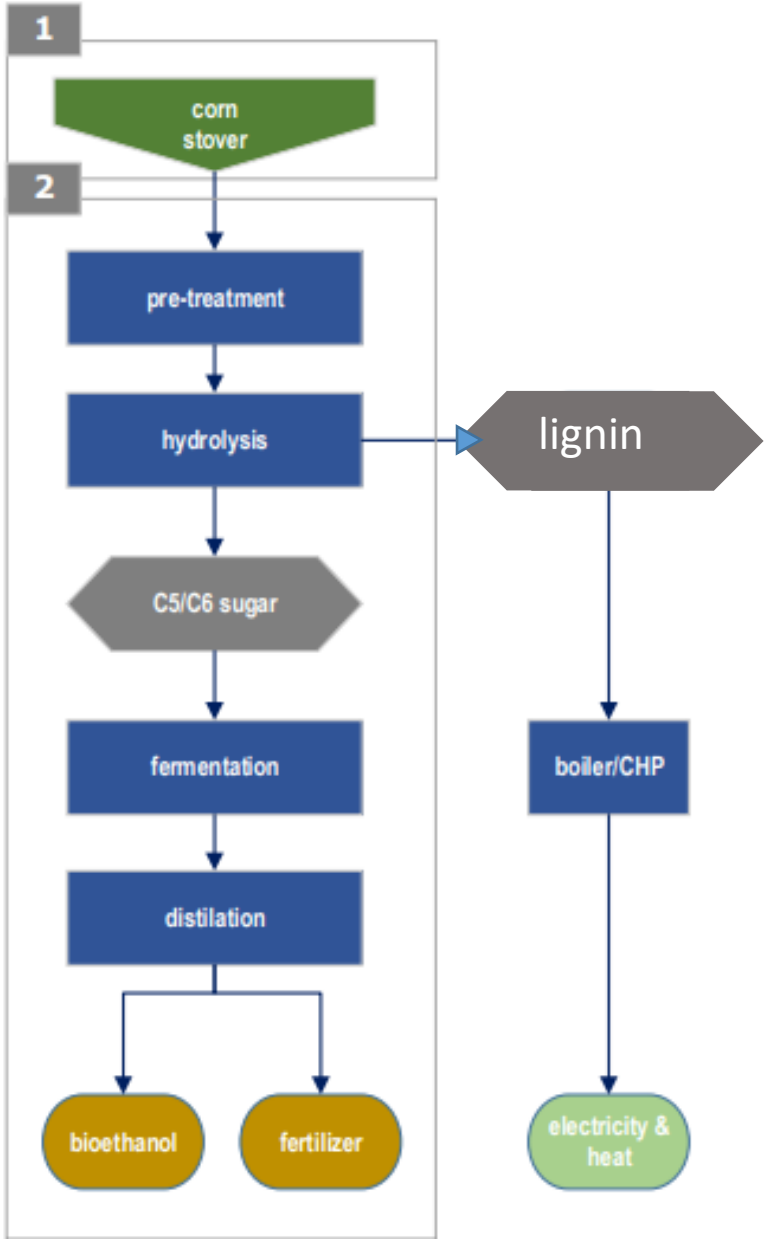
Platforms

- Hydrogen
- Biologically produced synthesis gas
- Biochar
- Biogas
- Carbon dioxide
- Fibre
- Lignin
- Oils
- Proteins
- Pyrolysis oil
- Starch
- Sugars

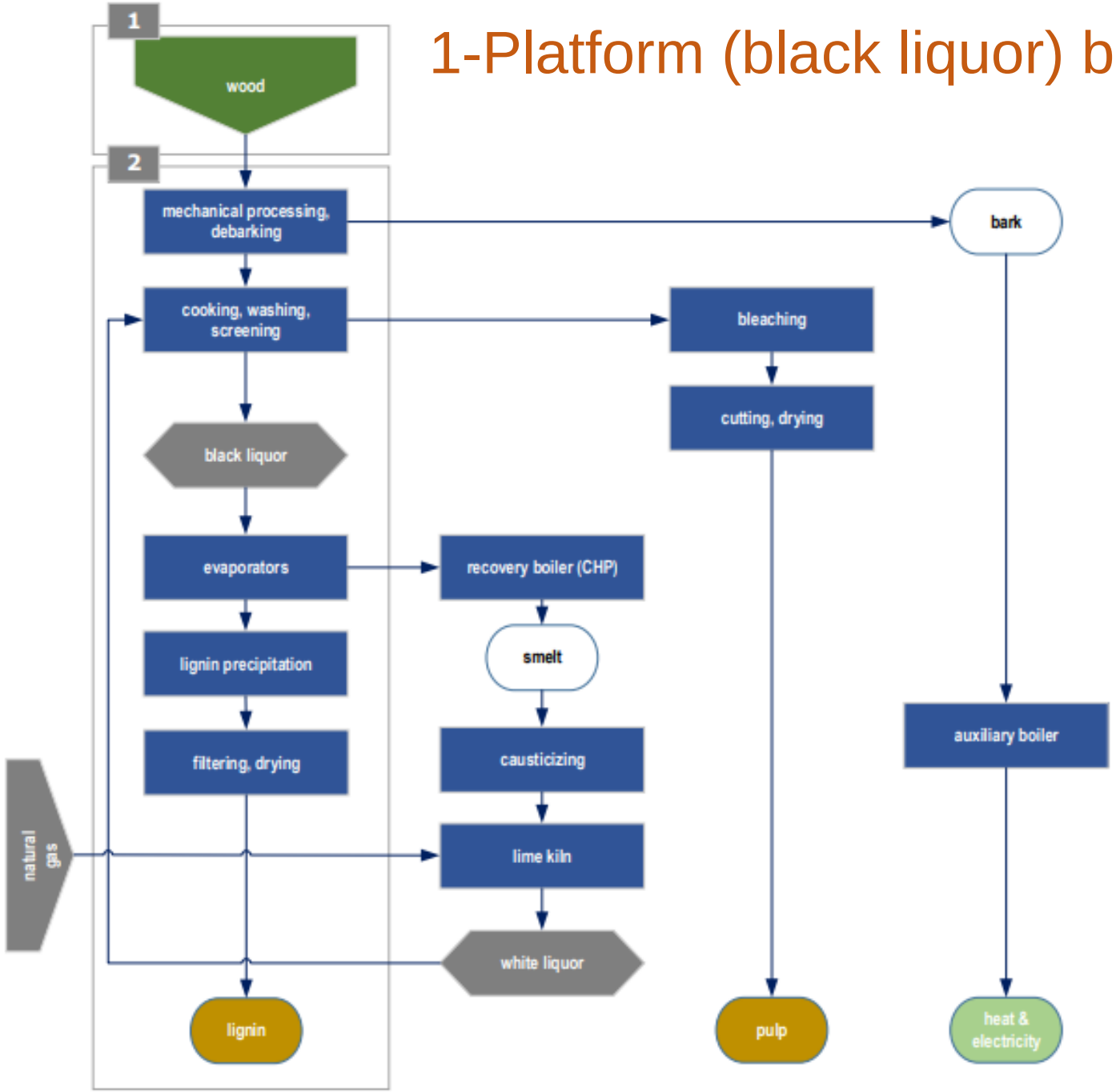
Nomenclature of biorefineries

The name reflects the platforms, products, and raw material

Biorefinery of 2-platforms (C5 and C6 sugars, lignin) for the production of bioethanol, plant manure, electricity and heat from maize stalks



1-Platform (black liquor) biorefinery

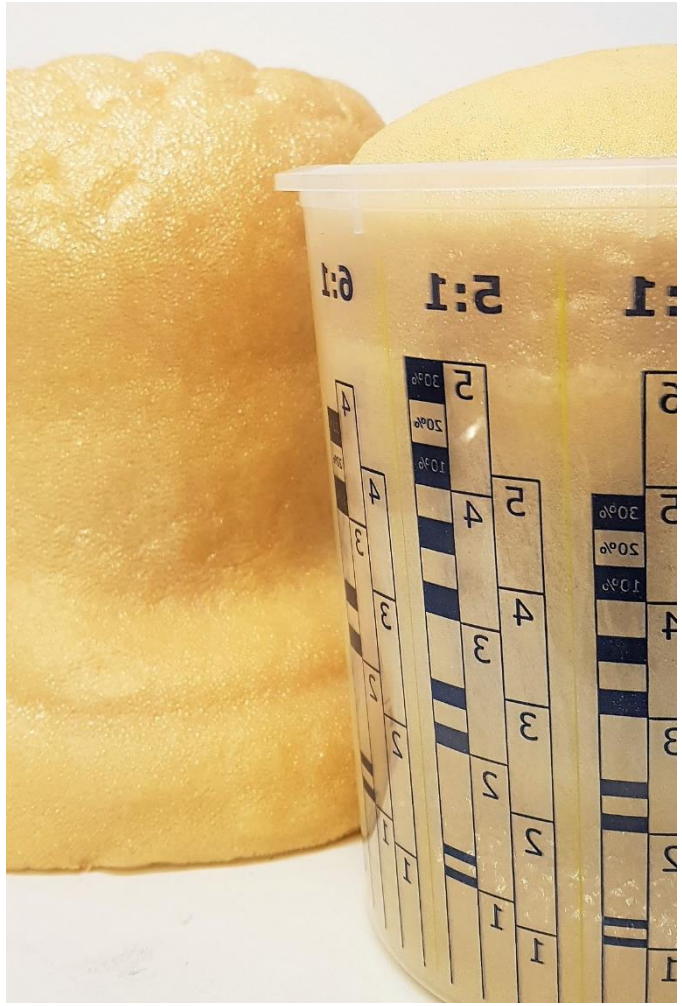


Biorefinery of 2-platforms (black liquor, white liquor)

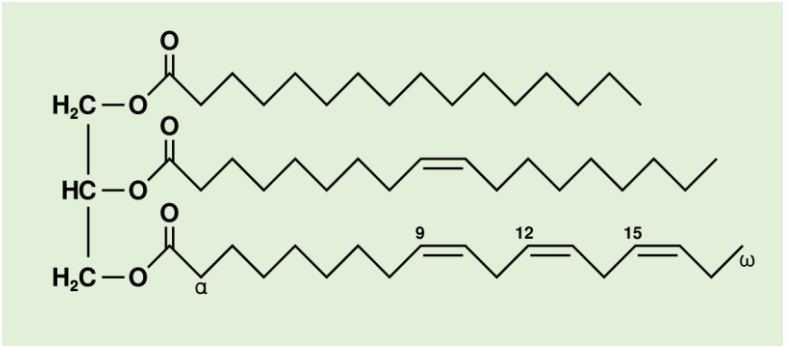
for pulp, lignin and energy production

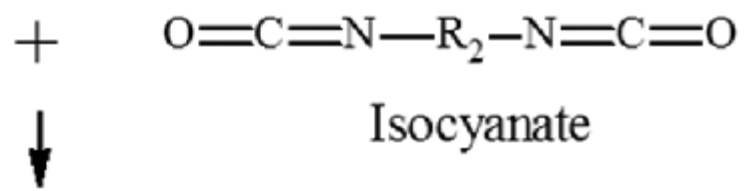
from wood chips

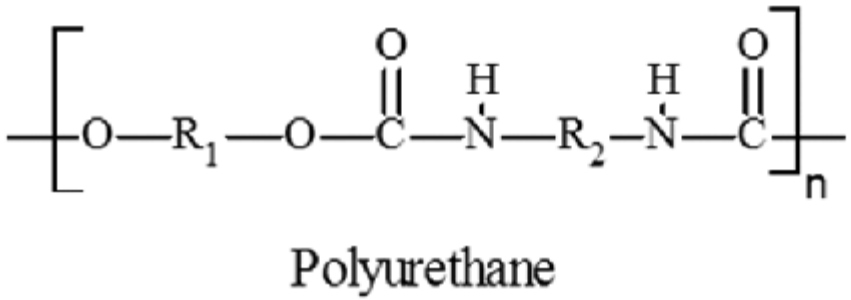
Oil platform



- Biofuels
- Polyurethane

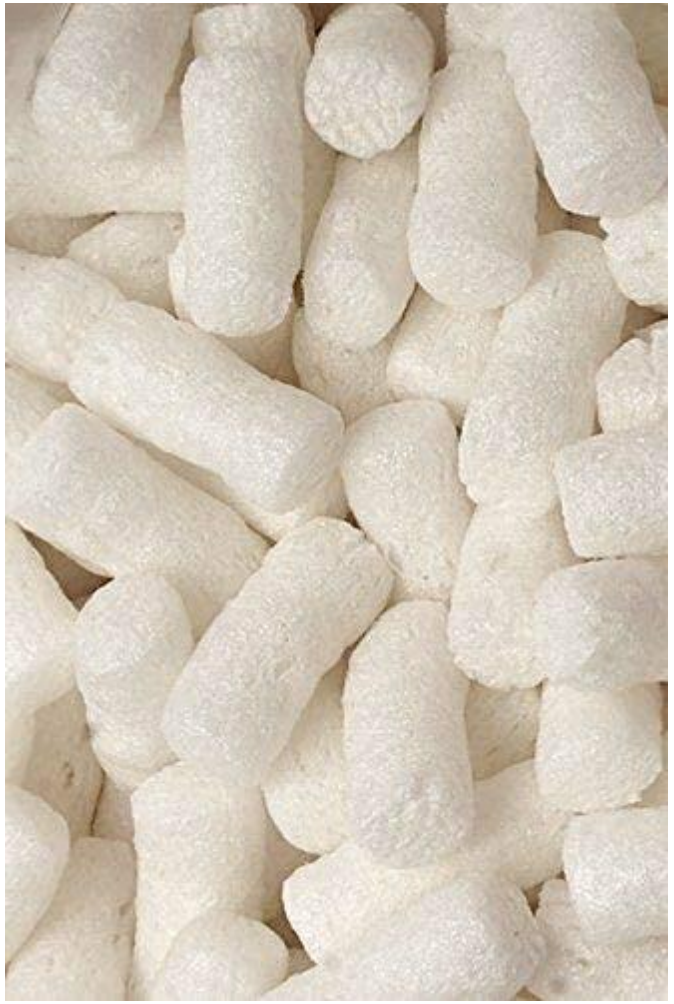






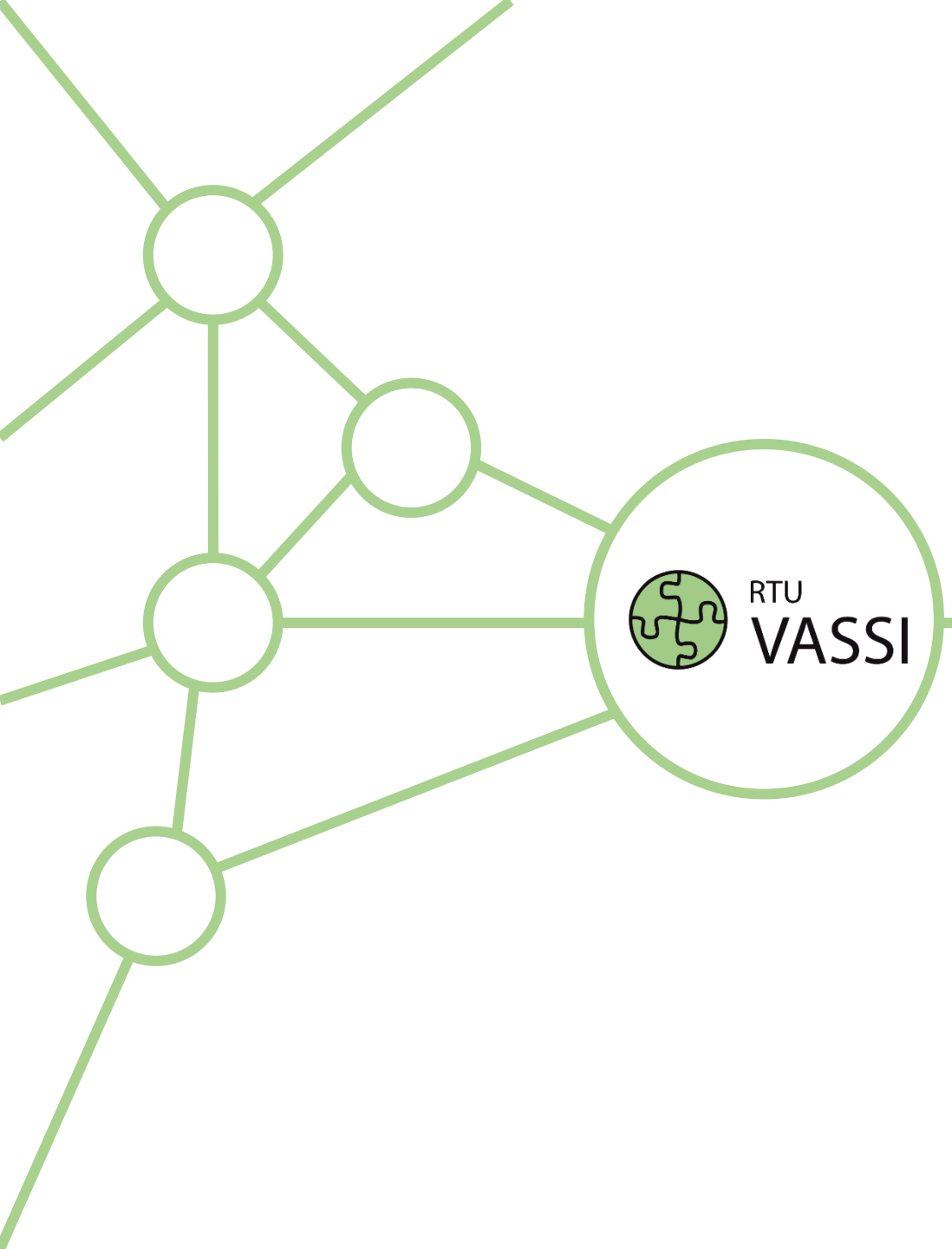
Polyurethane

Platform of solids



Polymer consisting of amylose and amylopectin. Uses:

- in the food industry
- in the production of bio-polymers
- in pharmacy



Practical work

Increase the added value of the forest

Identify the required competences

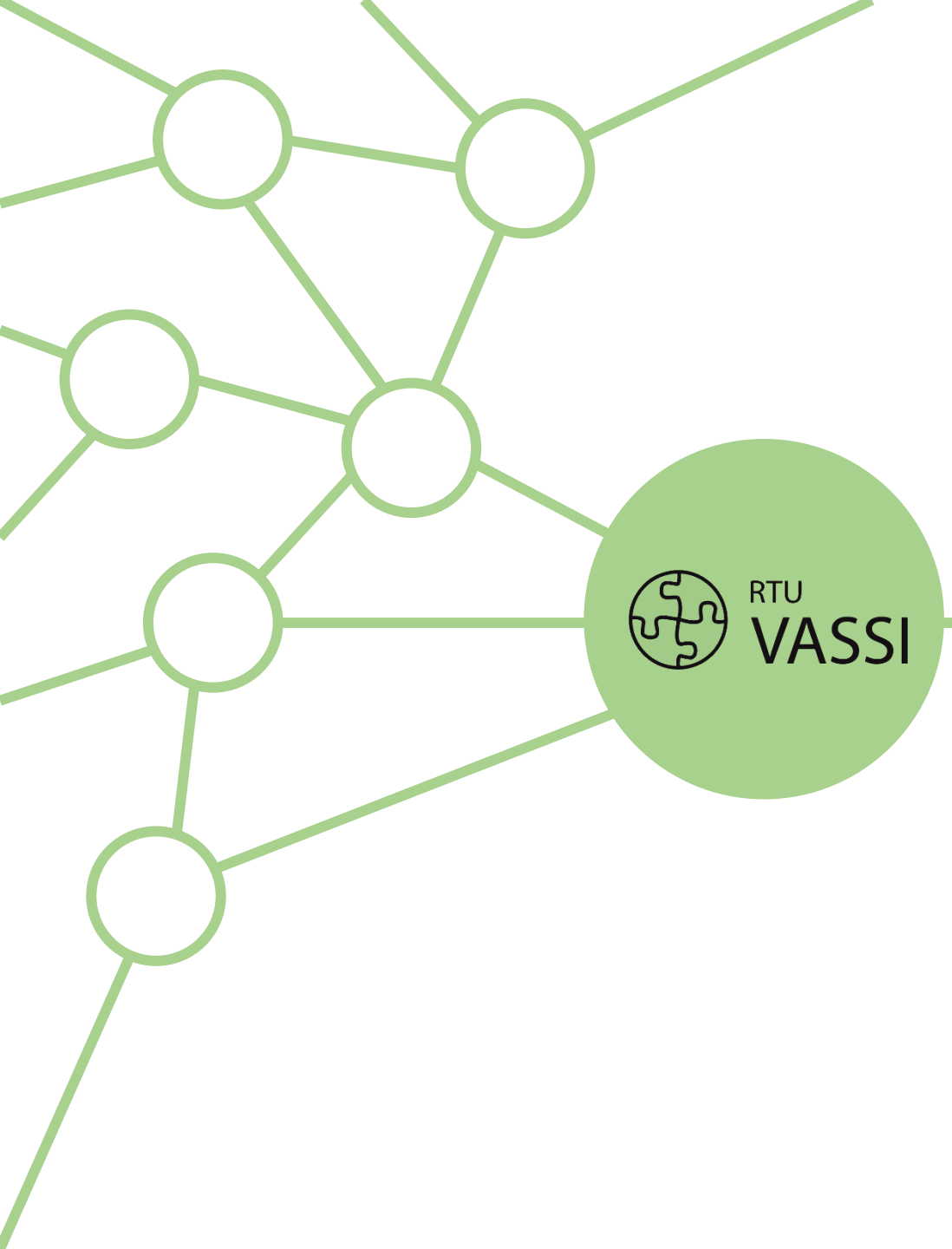
Tasks for the upcoming hour

Products

- Get acquainted with the publications
- Optimize a wood value-chain
- Estimate the bioresource utilization index

Skills

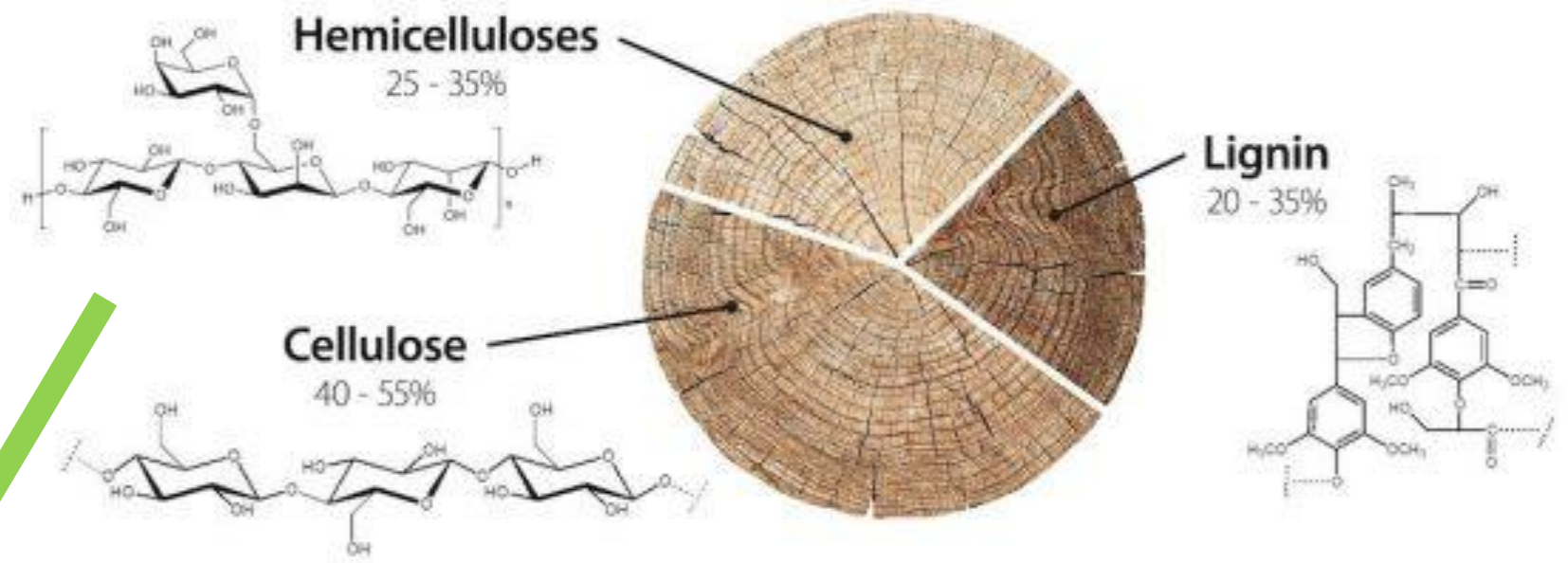
- Identify the skills and professions required for the proposed value chain
- Give an example how you can integrate the necessary skill development in your study course



Time to present!

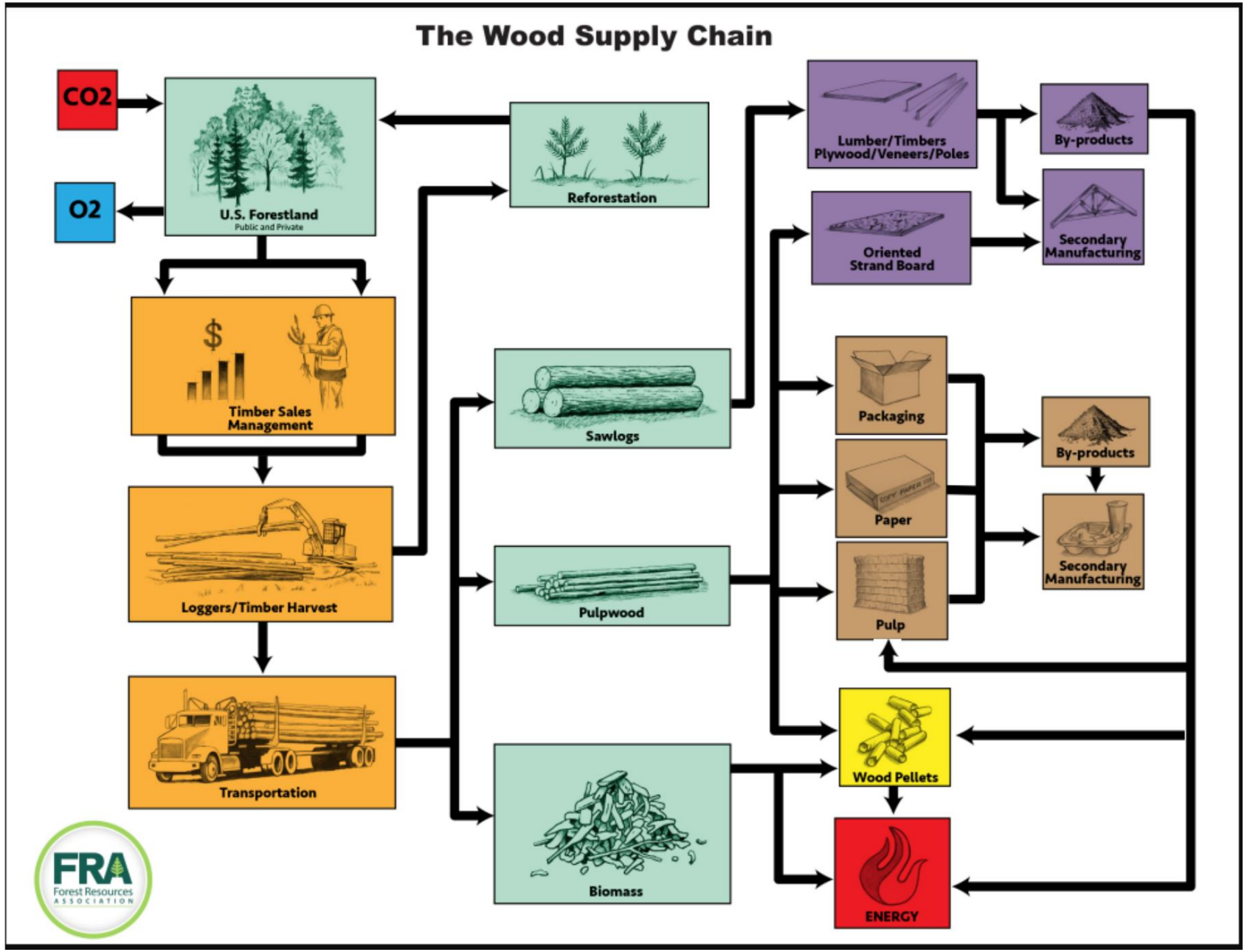
Products & Skills

Paper mill



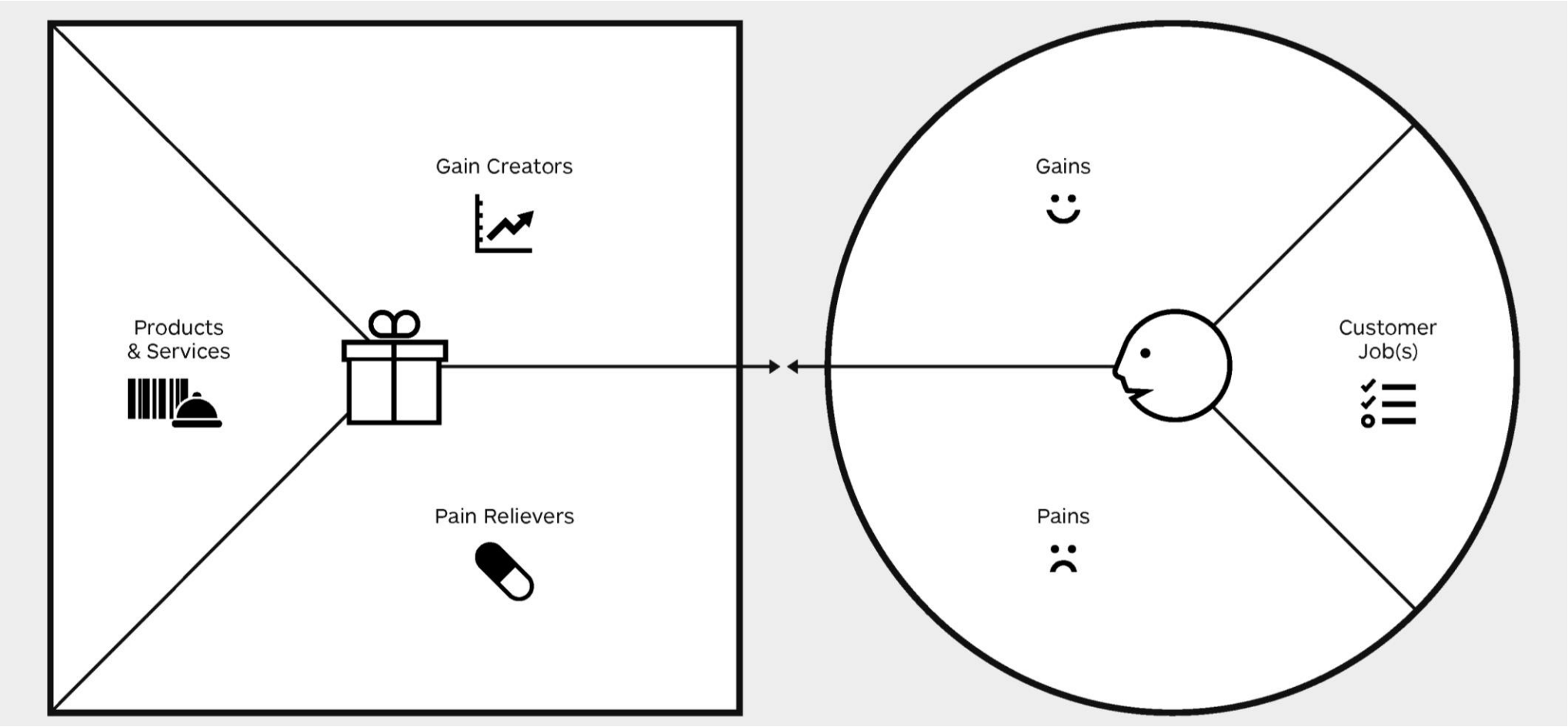
https://www.pulpandpapercanada.com/emerging-enzymes-synbiomics-integrates-pulp-mill-data-into-biocatalyst-toolkit/

Wood value chain example



https://forestresources.org/resources/wood-supply-chain-schematic/

Value proposition/future skills



https://www.designabetterbusiness.tools/tools/value-proposition-canvas

Ecodesign in the bioeconomy

- Use secondary bioresources
- Reduces dependence on non-renewable resources - no glue or screws

Replacing petrochemical products

Thank you!

Videszinatne.rtu.lv

Ilze.vamza@rtu.lv