NATURAL POLYMERS 1
Introduction to the subject

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Who I am and what I am coming from

- **Since 1. 10. 1974 up to 31. 12. 2014**
  - **POLYMER INSTITUTE BRNO, Ltd., Brno, Czech Republic (Industrial Research)**
- **Since then:**
  - **My one man company, working for various INDUSTRIAL COMPANIES converting plastisc**
- **I give lectures at:**
  - **Brno University of technology, Faculty of Chemistry,**
  - **Masaryk University, Fakulty of Science,**
  - ***University Tomas Bata, Fakulta of Technologická (not regulary)***

Subject of the Lectures

- **The Subject gives the Students a GENERAL KNOWLEDGE about the NATURAL POLYMER which are usable for the application in the chemistry usable for a Conservator and Restorer, but also in the other fields of polymer chemistry, its history, present situation and future**
- **Students will be able to CHOICE PROPER POLYMER MATERIALS, eventually their combinations for the Applications in the chemistry of the Conservator and Restorer, but also in the other fields of polymer chemistry**
- **To UNDERSTAND CHEMICAL REACTION NATURAL POLYMERS and make sence of their influence on the Properties of by this way modified NATURAL POLYMERS**
- **To INFORM students also about the INDUSTRIAL PROCESSING OF NATURAL POLYMERS**
- **To UNDERSTAND DIFFERENCES BETWEEN SYNTHETIC AND NATURAL POLYMERS**
- **To be able independently ANALYZE ROLE of NATURAL POLYMERS now days**
- **To stimulate the students' interest for the more detail studying of the NATURAL POLYMERS CHEMISTRY**
- **To be able INDEPENDENTLY COMPLIMENT KNOWLEDGE IN THIS FIELD**

How to integrate this Lectures into the CONTEXT with the other Subjects?

- **Macromolecular chemistry - the basic Lectures** *(source of Knowledge > General Texbook)*
  - **NATURAL POLYMERS** > the Development and the Supplement to the only one basic Lecture there *(source of Knowledge > Specialized Textbook)*
    - **Saccharides** > Specialization on the definite chemical field *(source of Knowledge > Monograph)*
      - **Mono a disaccharides** > narrowing of the Specialization *(source of Knowledge > Specialized Monograph)*
        - » **Analysis of the Monosaccharides** > very narrow *Specialization (source of Knowledge > Very Specialized Monograph)*
          - » **HPLC of the Saccharides** > very narrow *Specialization (source of Knowledge >Original Journals)*

Time schedule

LECTURE	SUBJECT
1	Introduction to the subject – Structure & Terminology of nature polymers, literature
2	Derivatives of acids – natural resins, drying oils, shellac
3	Waxes
4	Plant (vegetable) gums, Polyterpene –natural rubber (extracting, processing and modification)
5	Polyphenol – lignin, humic acids
25.10. & 1. 11.	**Polysaccharides I – starch**
8.11. & 15. 11.	**Polysaccharides II – celullosis**
22. & 22. 11.	**Protein fibres I**
29. 11. & 6. 12.	**Protein fibres II**
13. & 20. 12.	**Casein, whey, protein of eggs**
20. 12.	**Identification of natural polymers**
	Laboratory methods of natural polymers' evaluation

System of Study

- **Lectures are inputted to the information system MU, FCI**
- **Examination is done by colloquium**
- **TIME LIMIT for the Examination – will be agreed**
- **Questions and Comments are sent to my Attention in written (29716@chemi.muni.cz)**
- **……**

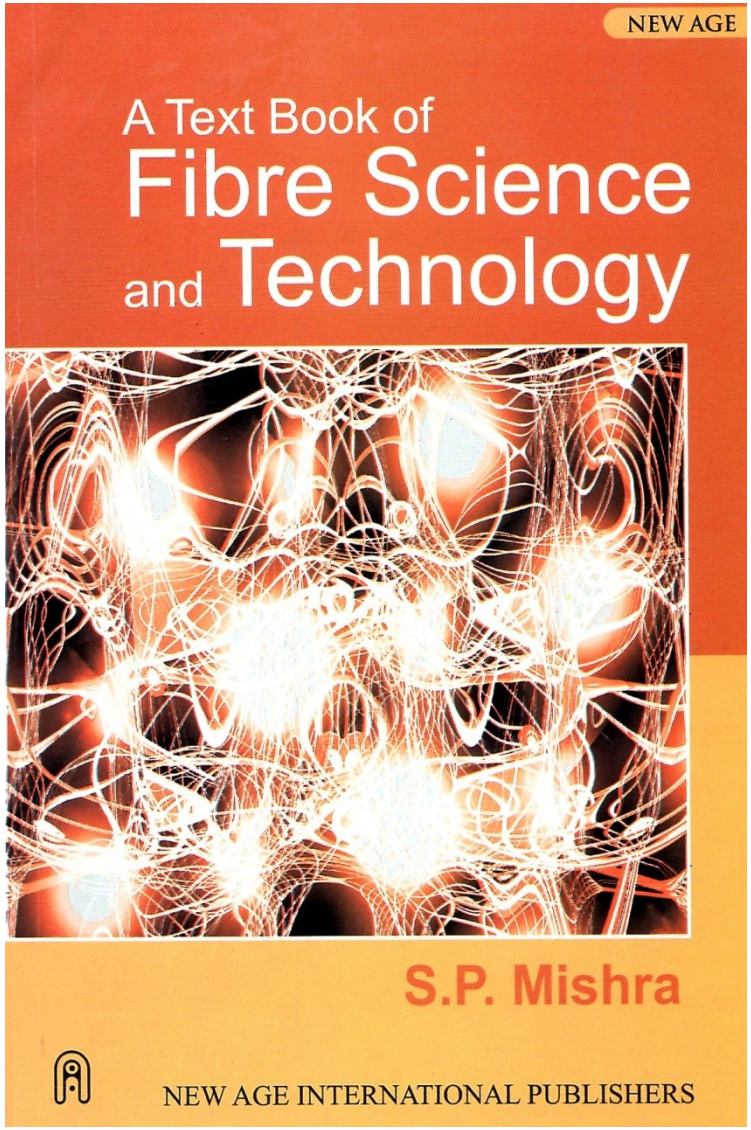
Recommended Literature
NO specialized Textbook

John McMurry:

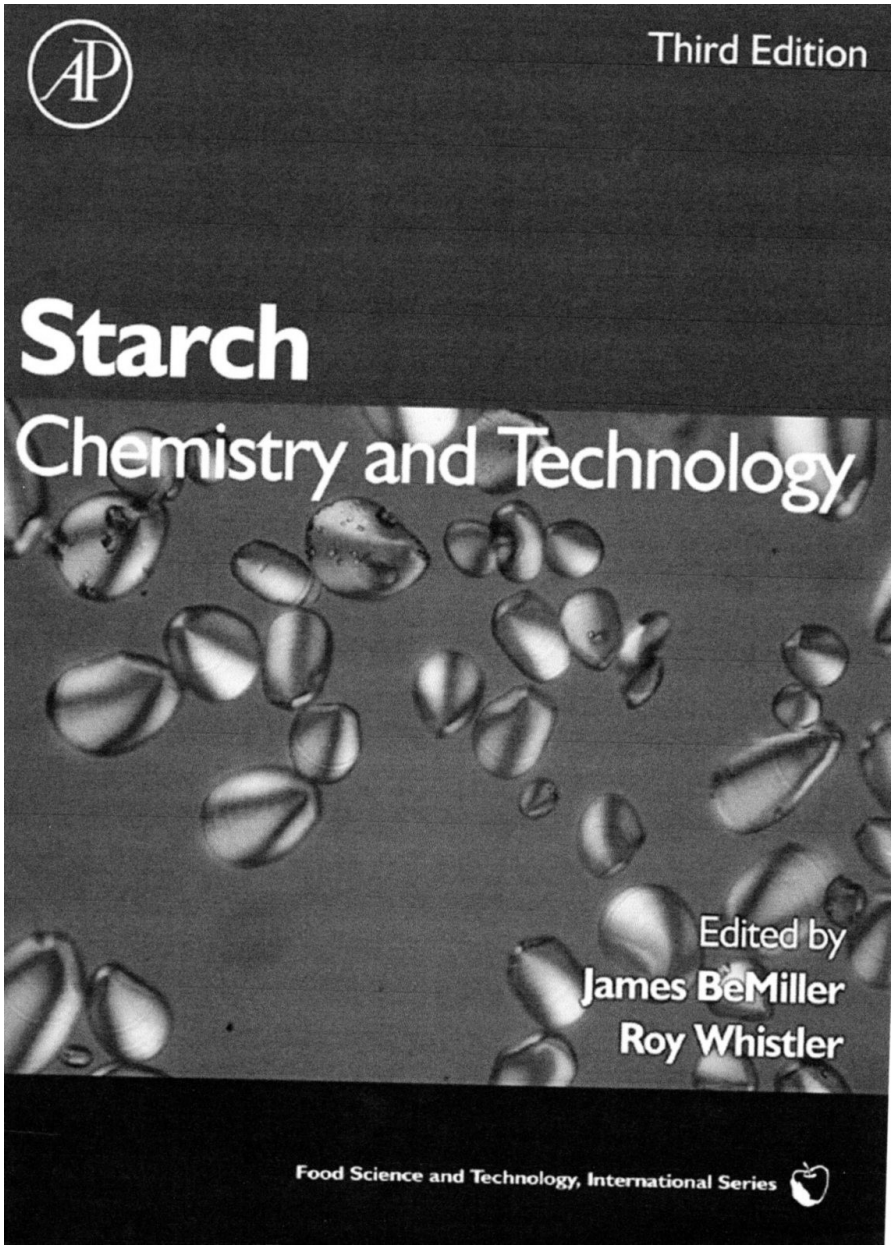
Organic chemistry

- Chapter 25: Biomolecules: Saccharides
- Chapter 26: Biomolecules: Aminoacids, Peptides and Proteins
- Chapter 27: Biomolecules: Lipids

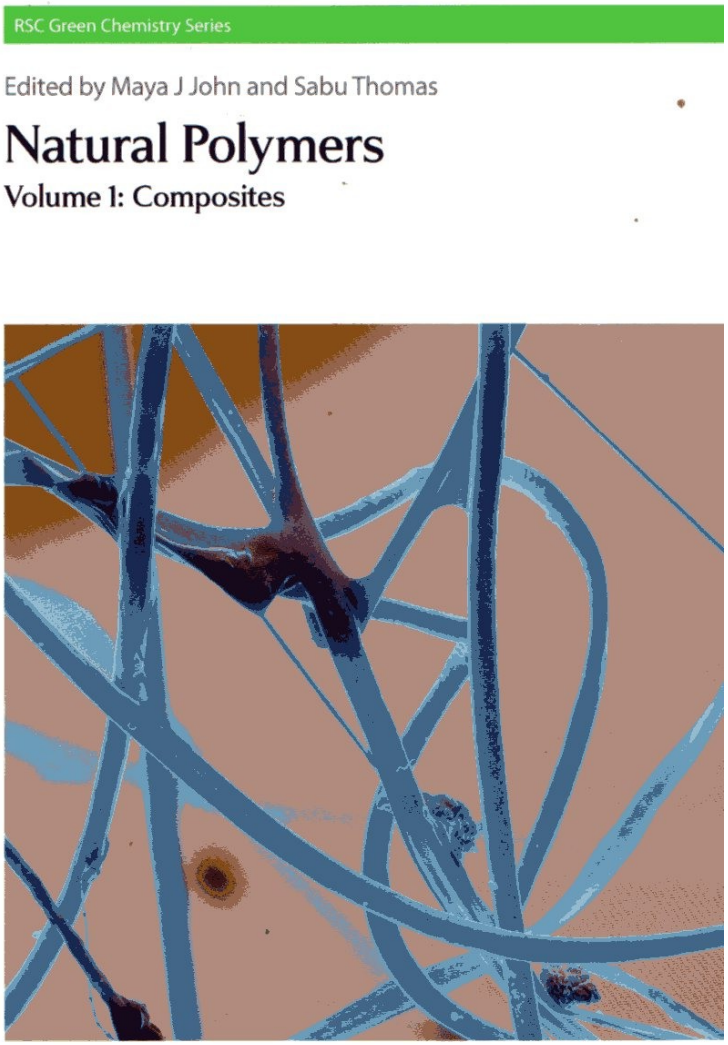
New acquired literature 1



New acquired literature 2



New acquired literature 3



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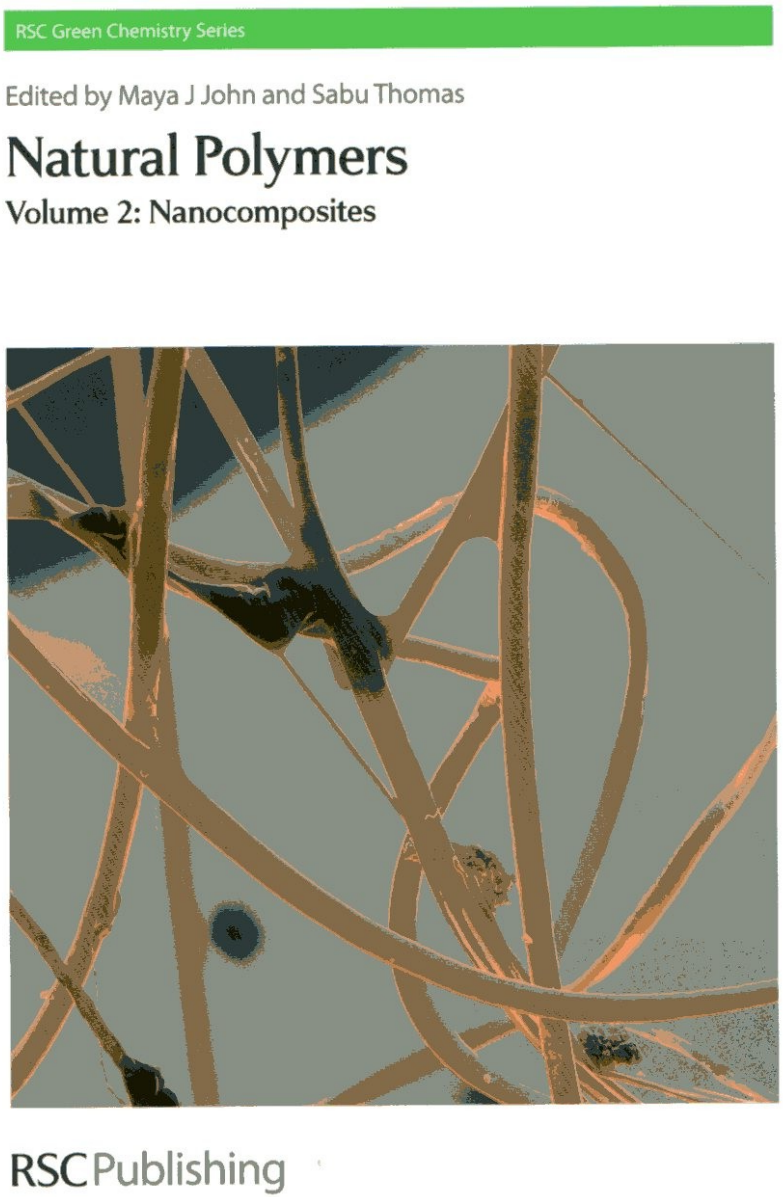


Biomass is the mass of living or/and dead biological organisms in a given area or ecosystem at a given time. Biomass can refer to *species biomass*, which is the mass of one or more species, or to *community biomass*, which is the mass of all species in the community. It can include microorganisms, plants or animals.[4] The mass can be expressed as the average mass per unit area, or as the total mass in the community.

Biomass most often refers to plants or plant-based materials that are not used for food or feed, and are specifically called lignocellulosic biomass.[2] As an energy source, biomass can either be used directly via combustion to produce heat, or indirectly after converting it to various forms of biofuel.

What is and what is NOT the Matter of our Subject here

What is

- NATURAL **oligomers**
- **Waxes**
- NATURAL **POLYMERS**
- Modification of NATURAL **POLYMERS**
- Use (Utilization) of NATURAL **POLYMERS**

What is NOT

- **Enzymes**
- **Hormons**
- **Nucleic acids**
- **Lowmolecular natural substances**

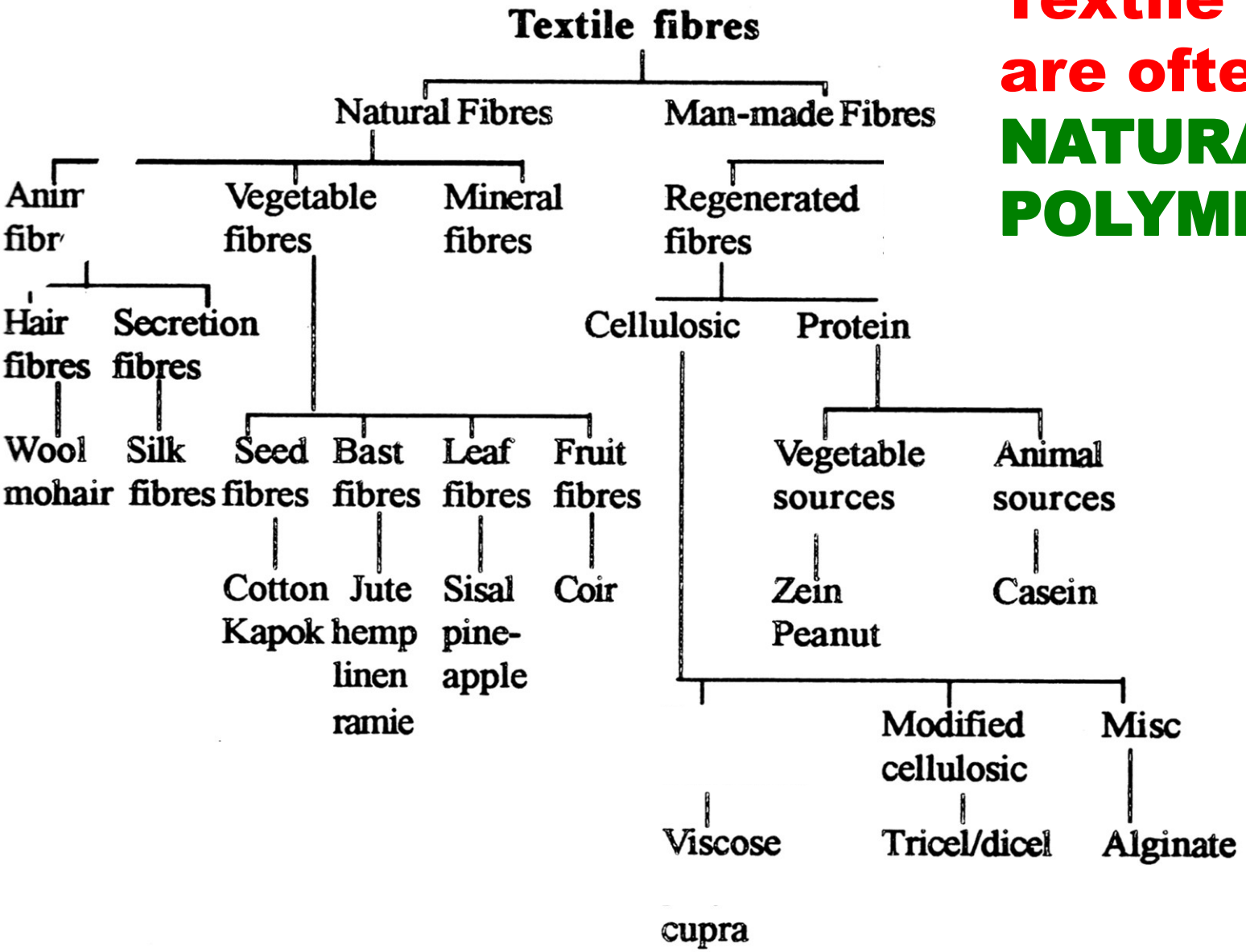
NATURAL POLYMERS – historical Basis of the Polymer chemistry and Plastics

- **Celluloid** > nitrocellulose and camphol
- **Galalith** > casein crosslinked by formaldehyde
- **Viscose fibre** > regenerated cellulose
- ……

Synthetic versus Natural products

- Natural products
- Modified Natural products
- Syntetic products

Textile fibres are often NATURAL POLYMERS!



NATURAL Products Characteristics

- **After SEPARATION and possible CLEANING are possible to be used as are so, as they got from the NATURAL RESOURCES**
- **EXAMPLES:**
  - **Cellulosic fibres** > Cotton (approx. 98 % w/w of Cellulose)
  - **Starch** > Separation from plants (potatoes, wheat, maize)
  - Collagen

Modified NATURAL Products

- **After SEPARATION and potential CLEANING are subjected to chemical reaction (reactions), by this is got the final Product**
- **EXAMPLES:**
  - **Cellulosic fibres** > xanthate > precipitation> **textile fibres**
  - **Starch** > acid + heat > **dextrin paper glue**
  - Collagen > denaturation > **animal glue and gelatine**

Synthetic products

- **Resulting product is got by intentional human endeavour from the artificial substances (monomers)**
- **EXAMPLES:**
  - **Ethylene** > polyethylene
  - **Butadiene + styrene** > butadiene-styrene rubber
  - **Dimethyl terephthalate + ethylenglykol** > PETP (PET) Polyethylene terephthalate

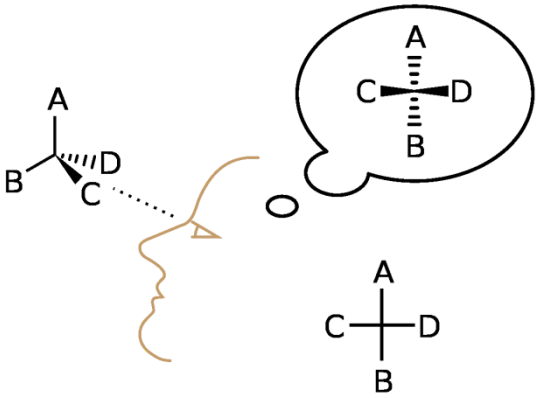
Importance of the NATURAL POLYMERS in the past (history), at present and in the future

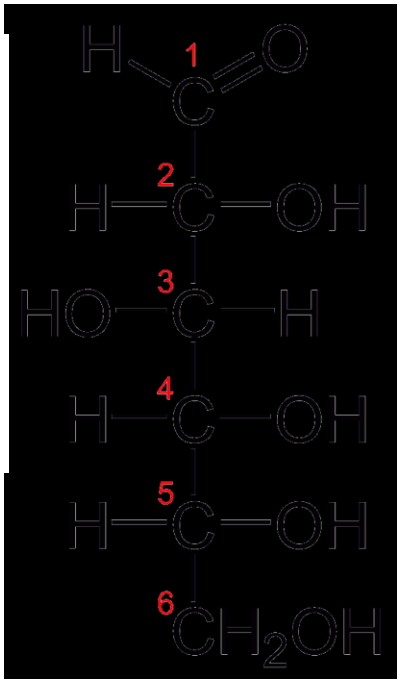
- ***HISTORY:*** ***dominance of NATURAL POLYMERS (especially modified)***
- **At present:** minority role as the technical PLASTICS, competition in the area of glues remains, transfer of importance into food industry, cosmetics and drugs
- **FUTURE:**
  - **Development of the modified NATURAL POLYMERS (probably without paper industry)**
  - **Endeavour to chemical exploitation of the Biomass**
  - **Energy utilisation (biogas, wood gas)**

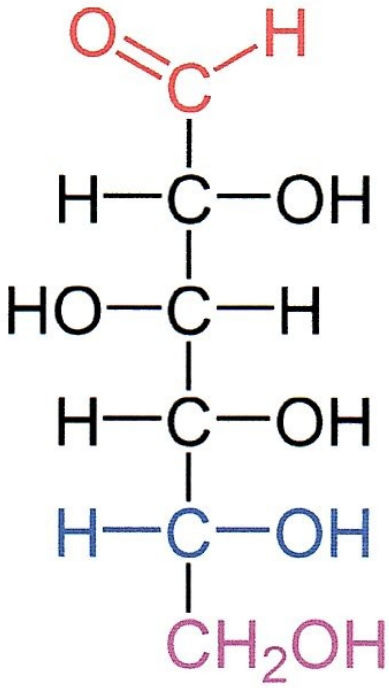
Is ANY USE natural resources of sense?

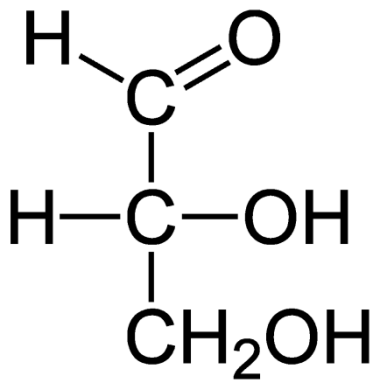
- **What is YOUR MEANING about these utilizations:**
  - **Biodiesel,**
  - **Polylactic acid (PLA),**
  - **Bioethanol,**
  - **Ethylene made of bioethanol,**
  - **……**

What is right to revive yourself 1 ?









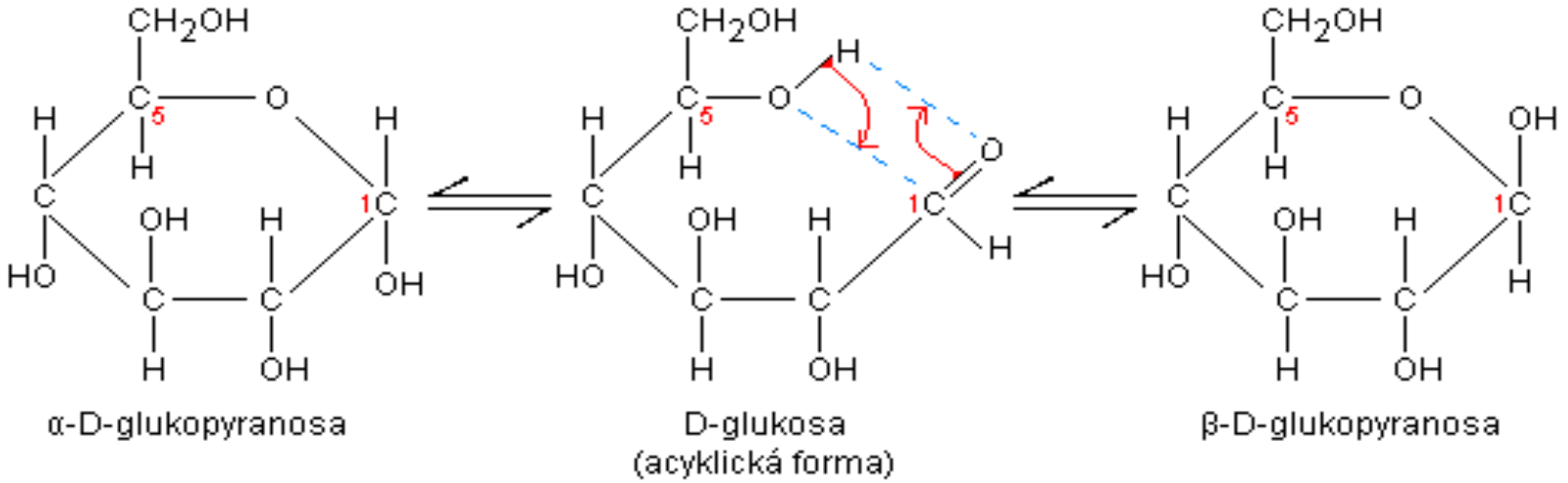
Fischer projection of
D-Glyceraldehyde

Fischer projection of
D-Glucose

Fischer projection
D-Glucose ones more :

- **C1 is up,**
- **-OH on C5 is right**

What is right to revive yourself 2 ?

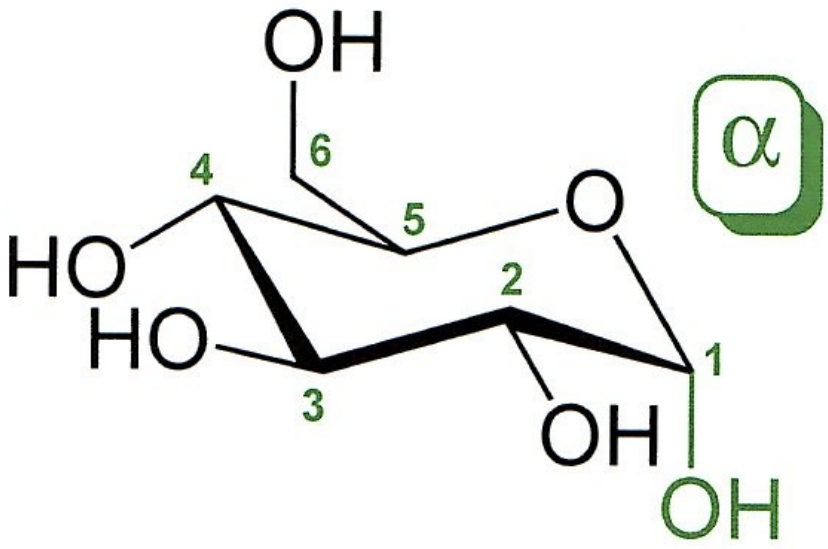


Mutarotation is the change in the optical rotation because of the change in the equilibrium between two anomers, when the corresponding stereocenters interconvert. Cyclic sugars show mutarotation as α and β anomeric forms interconvert.[1] The optical rotation of the solution depends on the optical rotation of each anomer and their ratio in the solution.

Example

For example, if a solution of β-D-glucopyranose is dissolved in water, its specific optical rotation will be +18.7. Over time, some of the β-D-glucopyranose will undergo mutarotation to become α-D-glucopyranose, which has an optical rotation of +112.2. The observed rotation of the sample is the weighted sum of the optical rotation of each anomer weighted by the amount of that anomer present.

What is right to revive yourself 3 ?

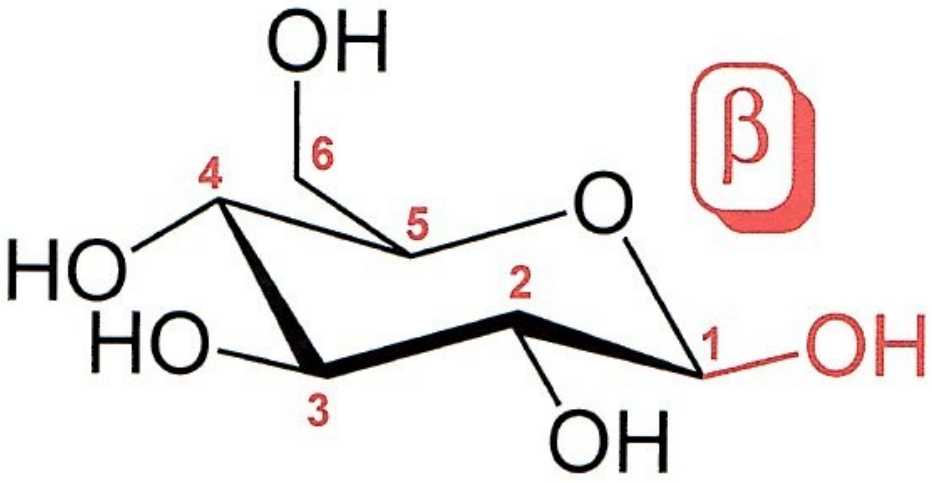


Bonds -OH on C1 and bond C5-C6 are TRANS

α – D – glucopyranose (cyklic form of glucose)

β – D – glucopyranose (cyklic form of glucose)

Bonds -OH on C1 and bond C5-C6 are CIS



What is right to revive yourself 4 ?

- α – D – glucopyranose (cyclic form of glucose, should be of approx. 37 % molar) is in the equilibrium with
- β – D – glucopyranose (cyclic form glucose, should be of approx. 37 % molar) and these both forms further to it coexist with linear form (this should be of approx. 0,002 % molar)
- Form D prevails in the nature

It is the long Way from the Ideas to Implementation

Acid

Feathers

Water

Base

HYDROLYSIS Of Feathers

HYDROLYSIS Of Feathers

Steam

Steam

Neutralisation of waste Acid or Base

Filtration

Thickening

Solution of AMINOACIDS

Drying

Protein-vitamin feeding paste

TRADE NAME

Protein-vitamin feeding dry Matter

Utilisation of the waste Feathers as the Source of Amino acids

Scheme published in the Yearbook „Young technician“ in the year 1962 already!

SIMILAR Project underway NOW! Biopolymers in the Academy of Science of the Czech Republic

- **The Institute of Chemical Processes Fundamentals >**
  Biorefinery Research Centre of Competence
  - **Centre can supply e.g. basic data, so industrial Participants can be suppliers of the edible collagen and the other *protein hydrolysates for the Nutrition***