NATURAL POLYMERS
Polysaccharide I
STARCH 3

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Time schedule

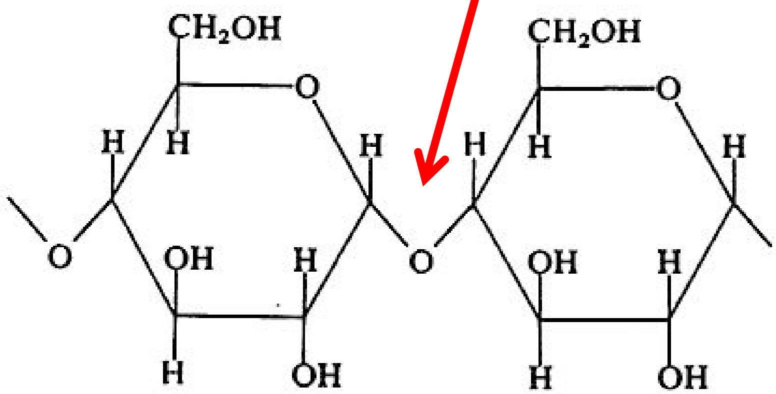
LECTURE	SUBJECT
1	Introduction to the subject – Structure & Terminology of nature polymers, literature
2	Derivatives of acids – natural resins, drying oils, shellac
3	Waxes
4	Plant (vegetable) gums, Polyterpene – natural rubber (extracting, processing and modification), Taraxacum_kok-saghyz
5	Polyphenol – lignin, humic acids
6	**Polysaccharides I – starch**
7	**Polysaccharides II – celullosis**
8	**Protein fibres I**
9	**Protein fibres II**
10	**Casein, whey, protein of eggs**
11	**Identification of natural polymers**
	Laboratory methods of natural polymers' evaluation

Why do we modify the STARCH?

- HIGH VISCOSITY at even low Concentrations
- LOW SOLUBILITY & DISPERSIBITY of the Starch particles
- Strong Tendency to form stiff, threedimesional GEL (it is sometime advantageous, e.g. Cooking of a Blancmange (Pudding))

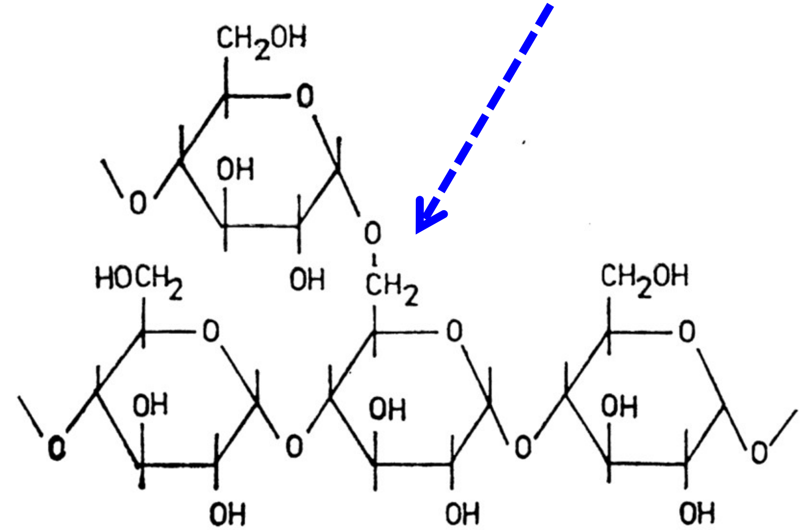
AMYLOSE & AMYLOPECTIN

MAIN CHAIN



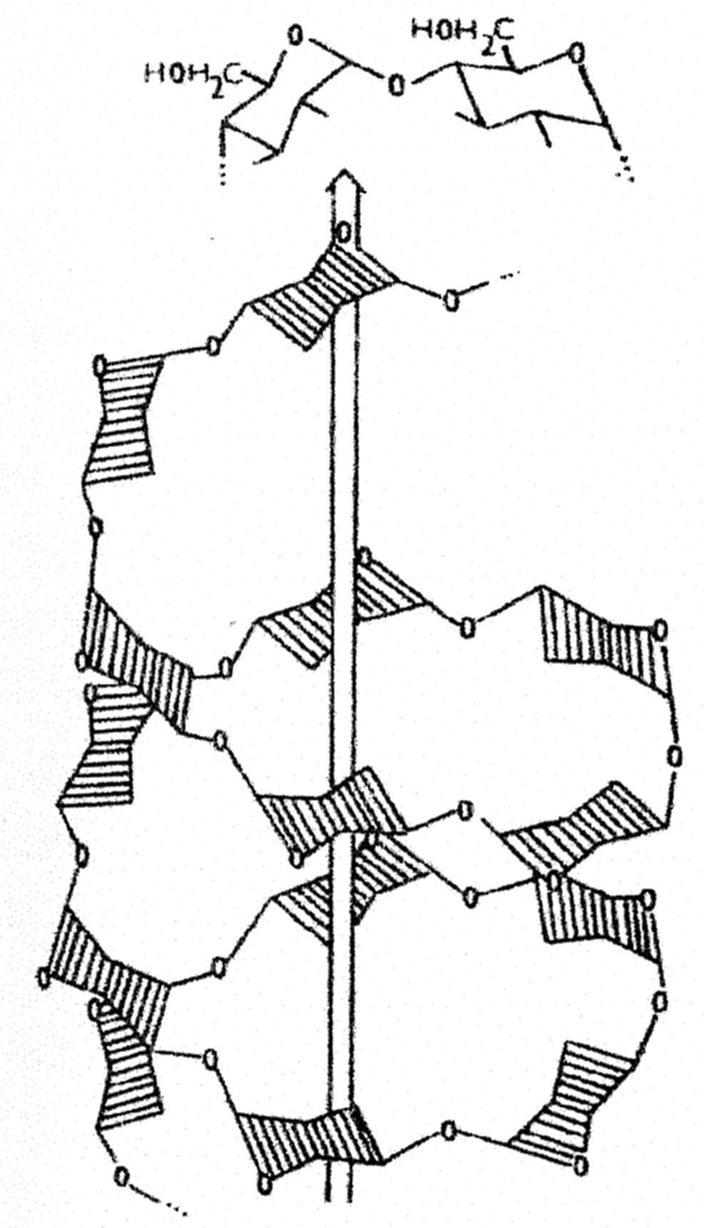
poly(1→4)-α-D-gluko-pyranosa (amylosa)

BRANCHING



(1 → 6)-α-D-glukopyranosyl-D-glukosy

Where are a Potential Reactions Centres in these MACROMOLECULES?

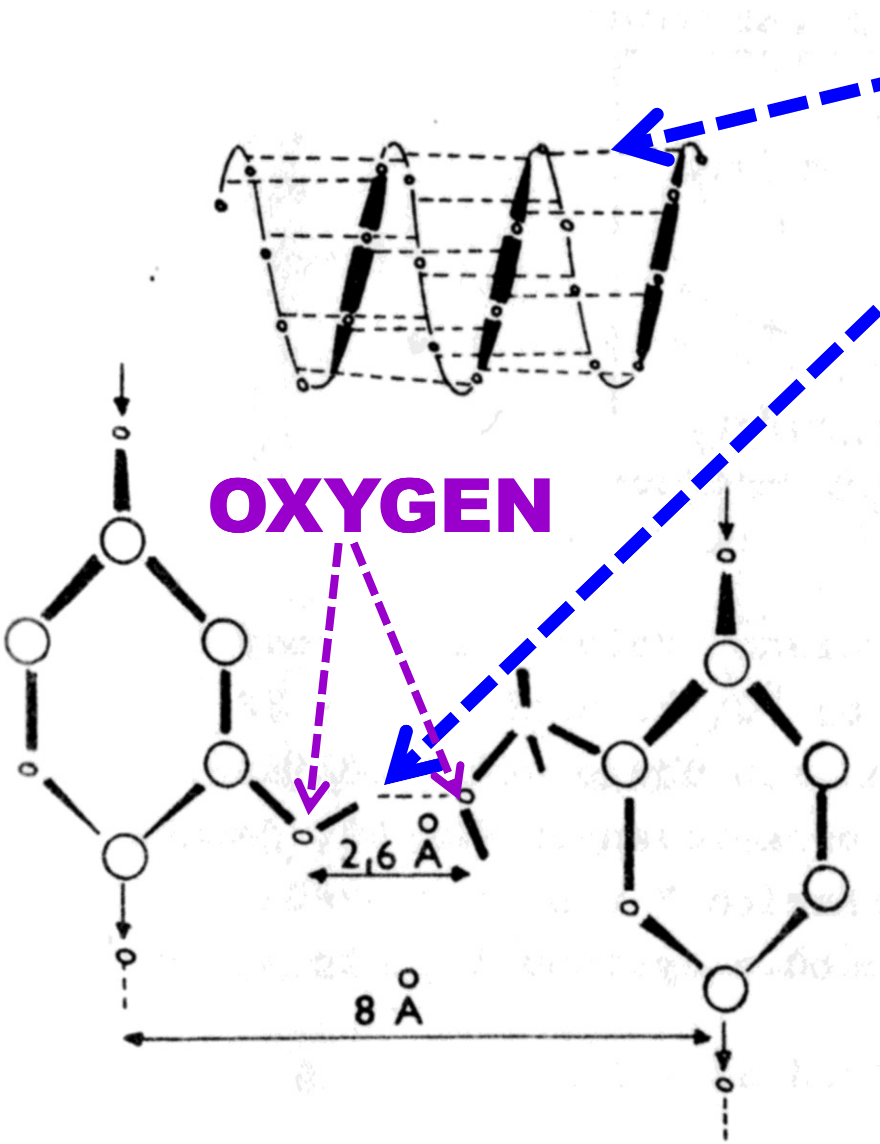


AMYLOSE

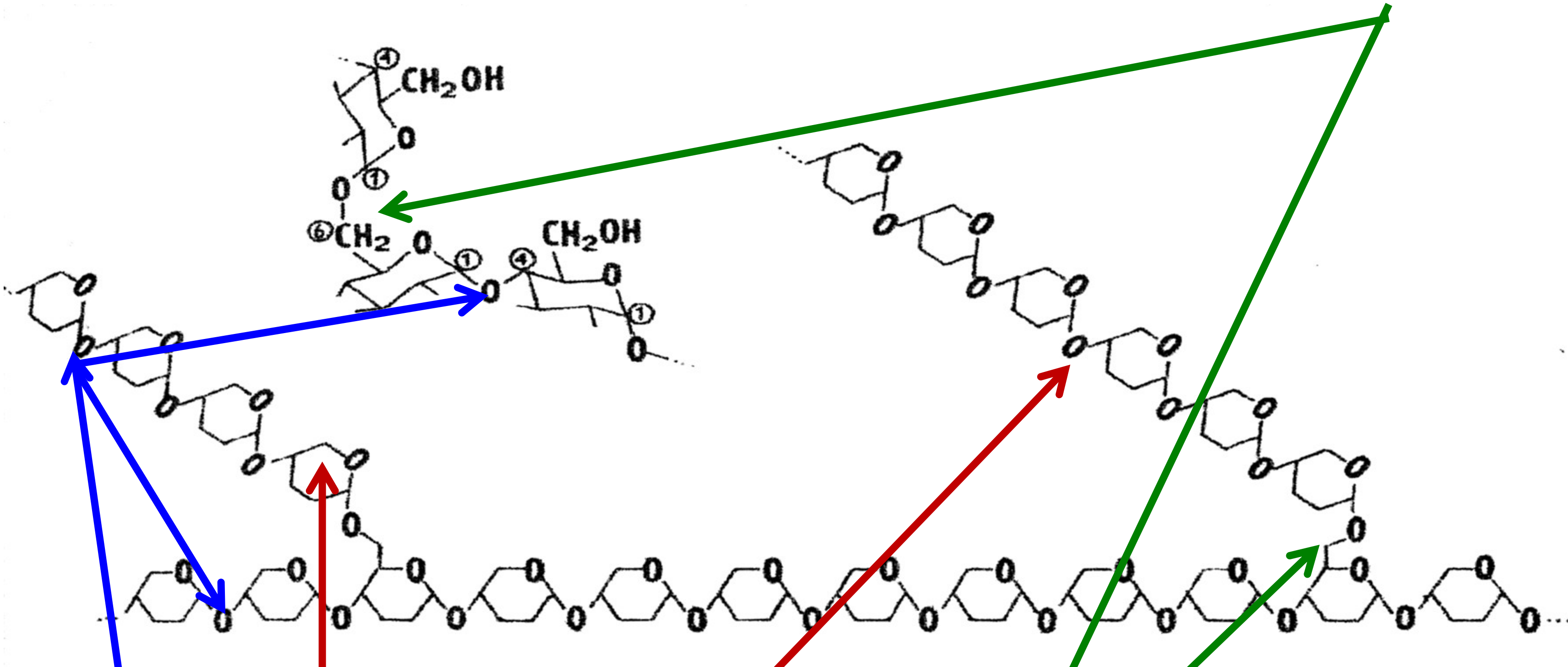
- It forms the HELIX
- Six GLUCOSE units are forming one Chain Spiral (Coil)
- Bond 1 → 4 via –OH
- 300 – 1000 Units in a Macromolecule

AMYLOSE

INTRAMOLECULAR HYDROGEN BONDS



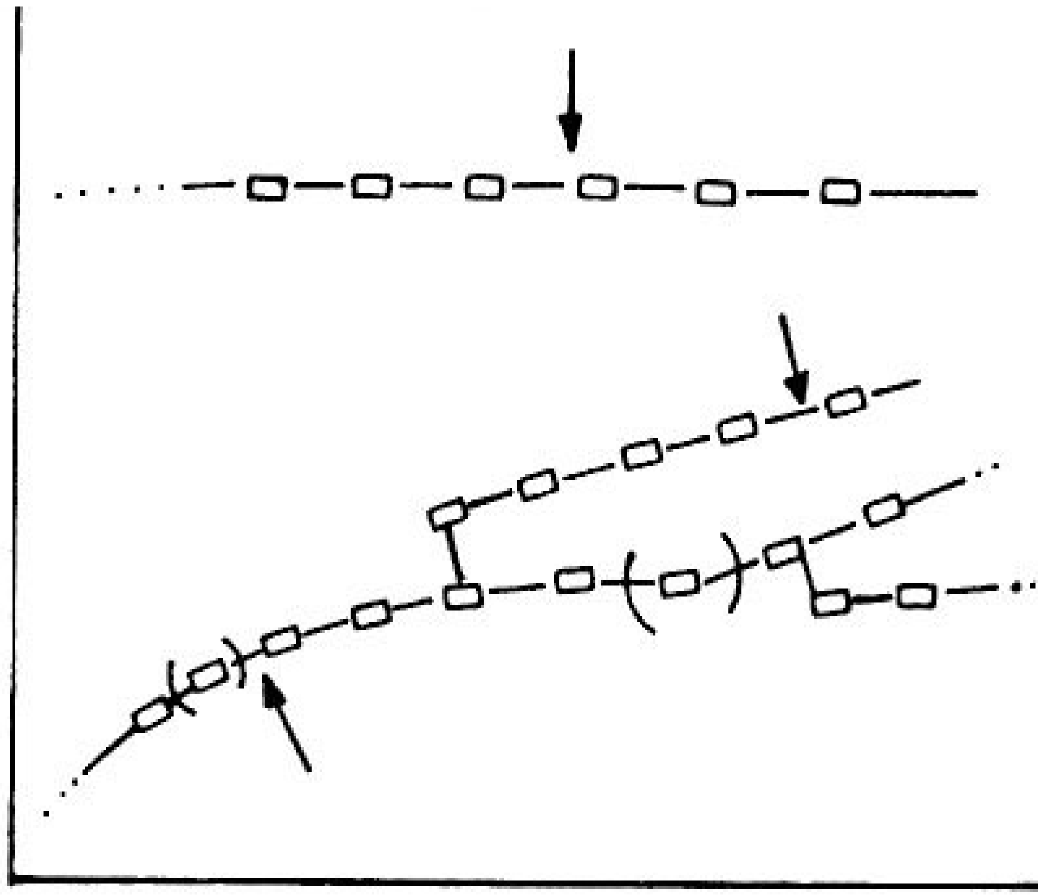
These BONDS (Bridges) go via – OH Groups, no via Water Molecules. Water forms BONDS (Bridges) ***mainly*** between Macromolecules of Amylose, but not only there (AMYLOPECTIN is also employed).



AMYLOPECTIN

- USUALLY doesn't form HELIX (ONLY HAVING VERY LONG BRANCHING CHAINS IS IT POSSIBLE)
- Bond 1 → 6 via –OH and via – CH_2OH in the Point of Branching
- Bond 1 → 4 via –OH in the Main Chain and also in side Chains
- 15 – 25 Units in the Branches

Process of ENZYMATIC modification of Starch

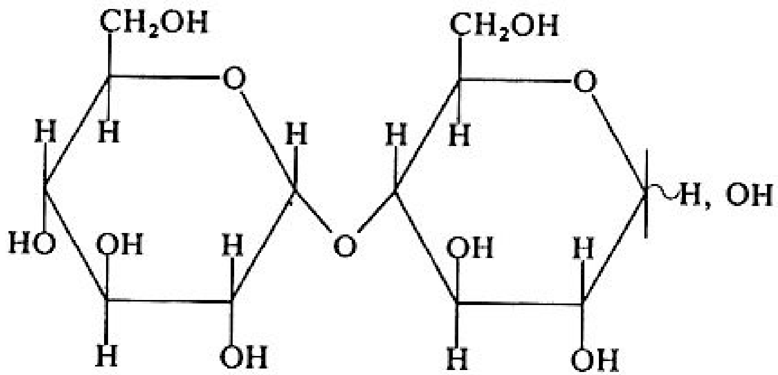


RAPID DECREASE OF THE SOLUTION (PASTE) VISCOSITY

Chain scission by Enzym Amylase

Process of ENZYMATIC modification of Starch to MALTOSE

Chain scission to **MALTOSE** by Enzymes α and β AMYLASES

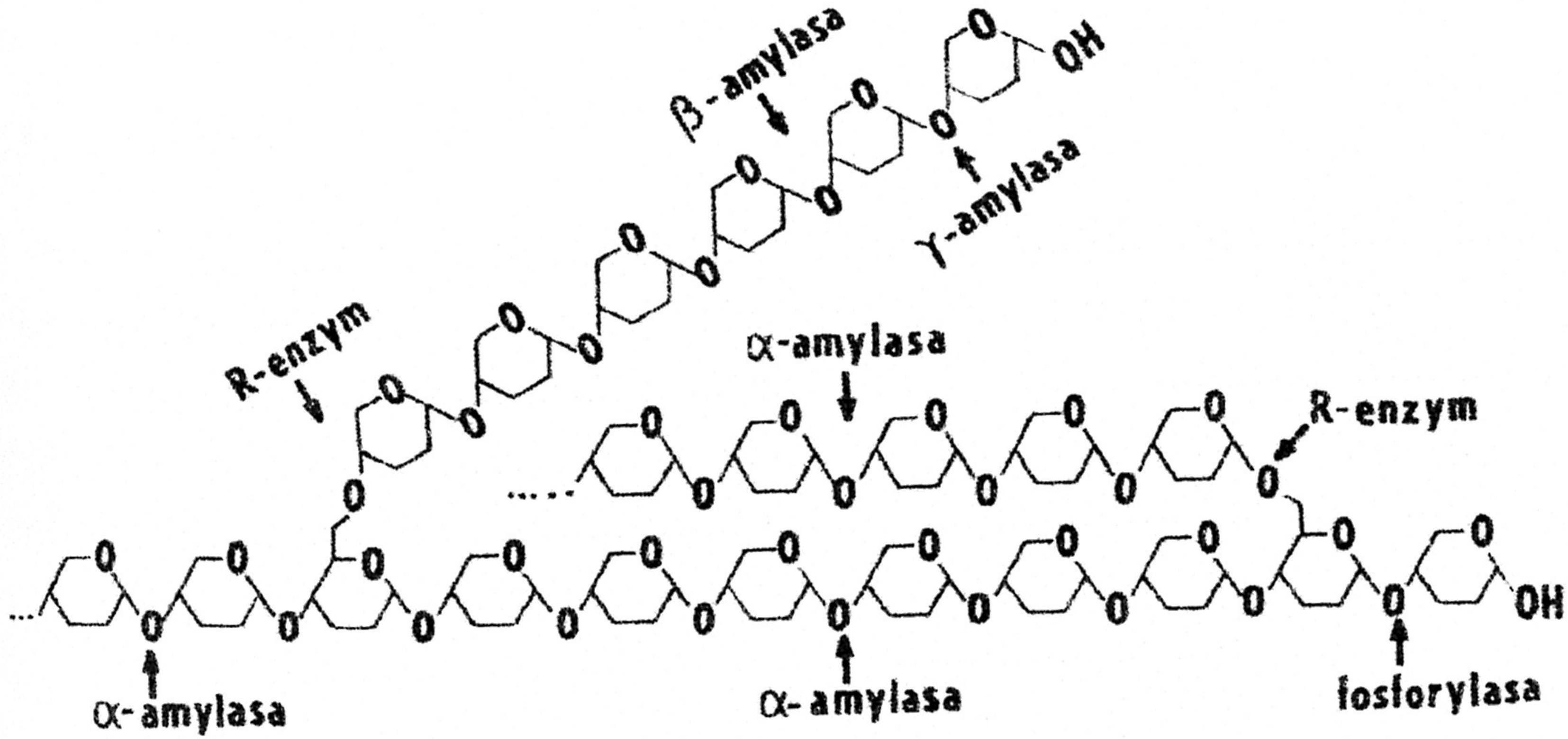


maltosa

MALTOSE is possible further scission up to GLUCOSE by Enzyme ***MALTASE***

Extent of Conversion accordingly it is possible classify these Products to:

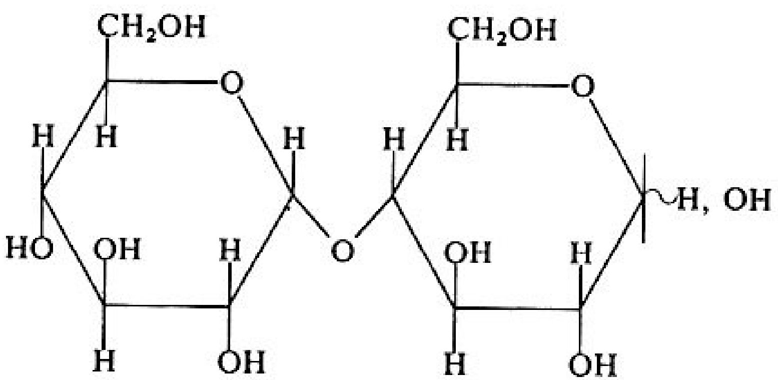
1. **Liquid syrups**
2. **Dried or thicken syrups**
3. **Glucose**



AMYLOSE Chain scission by Enzymes (α, β, γ Amylases, Phosphorylase, R-enzyme ...

Process of HYDROLYTIC modification of Starch

Acid catalysis using HCl or H_2SO_4 with Neutralisation after the end of Hydrolysis



maltosa

It is possible to combine HYDROLYTIC and ENZYMATIC Chain scission

Extent of Conversion accordingly it is possible classify these Products to:

1. **Liquid syrups**
2. **Dried or thicken syrups**
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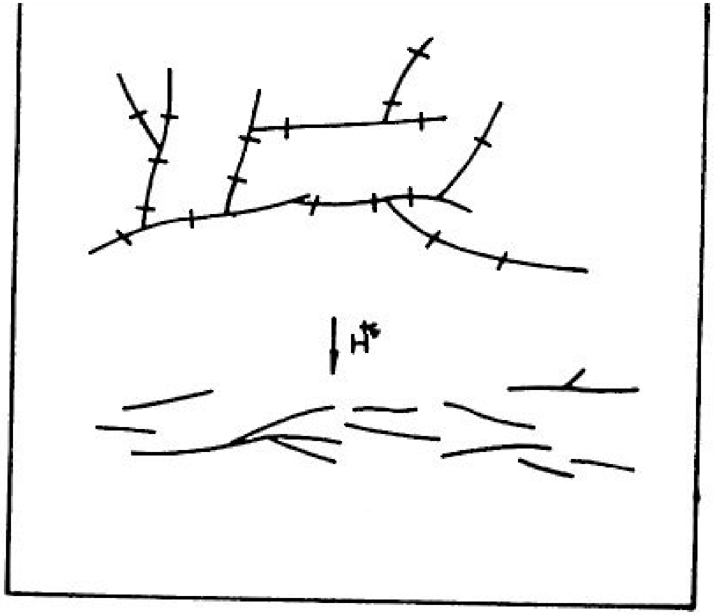
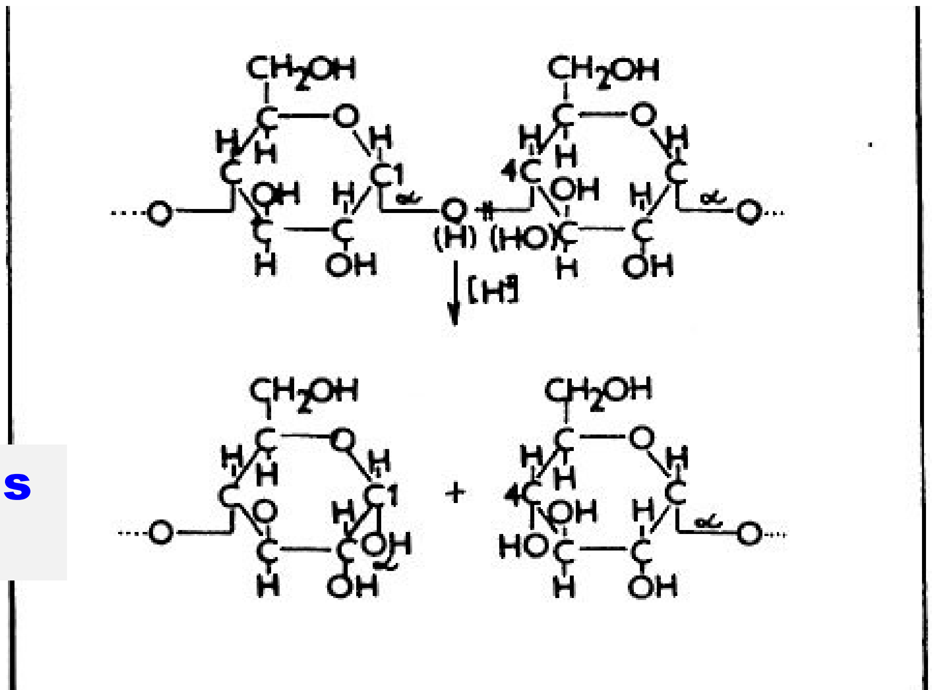
Process of HYDROLYTIC modification of Starch



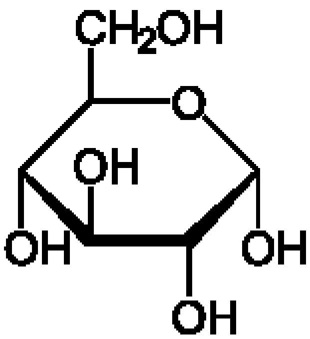
Chain scission – Chemical catalysis by H^+

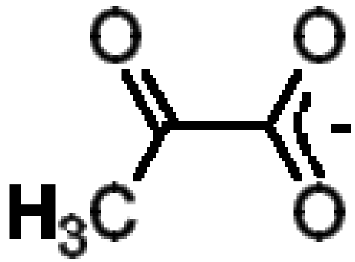
There are not valid Proofs, if this Process is random or are there some Bonds in the Chain preferred



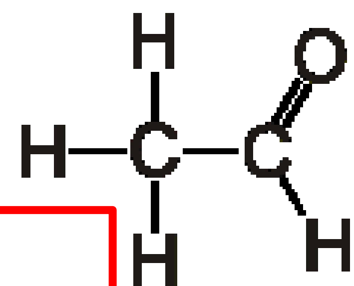
Chain scission – Chemical catalysis by H^+

ENZYMATIC USE OF GLUCOSE
from Saccharide to Alcohol

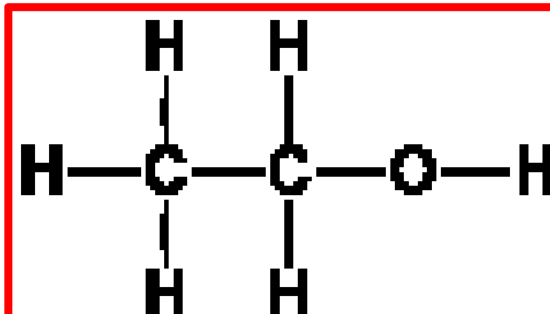




Pyruvite of conjugated Base
of the Pyruvic acid

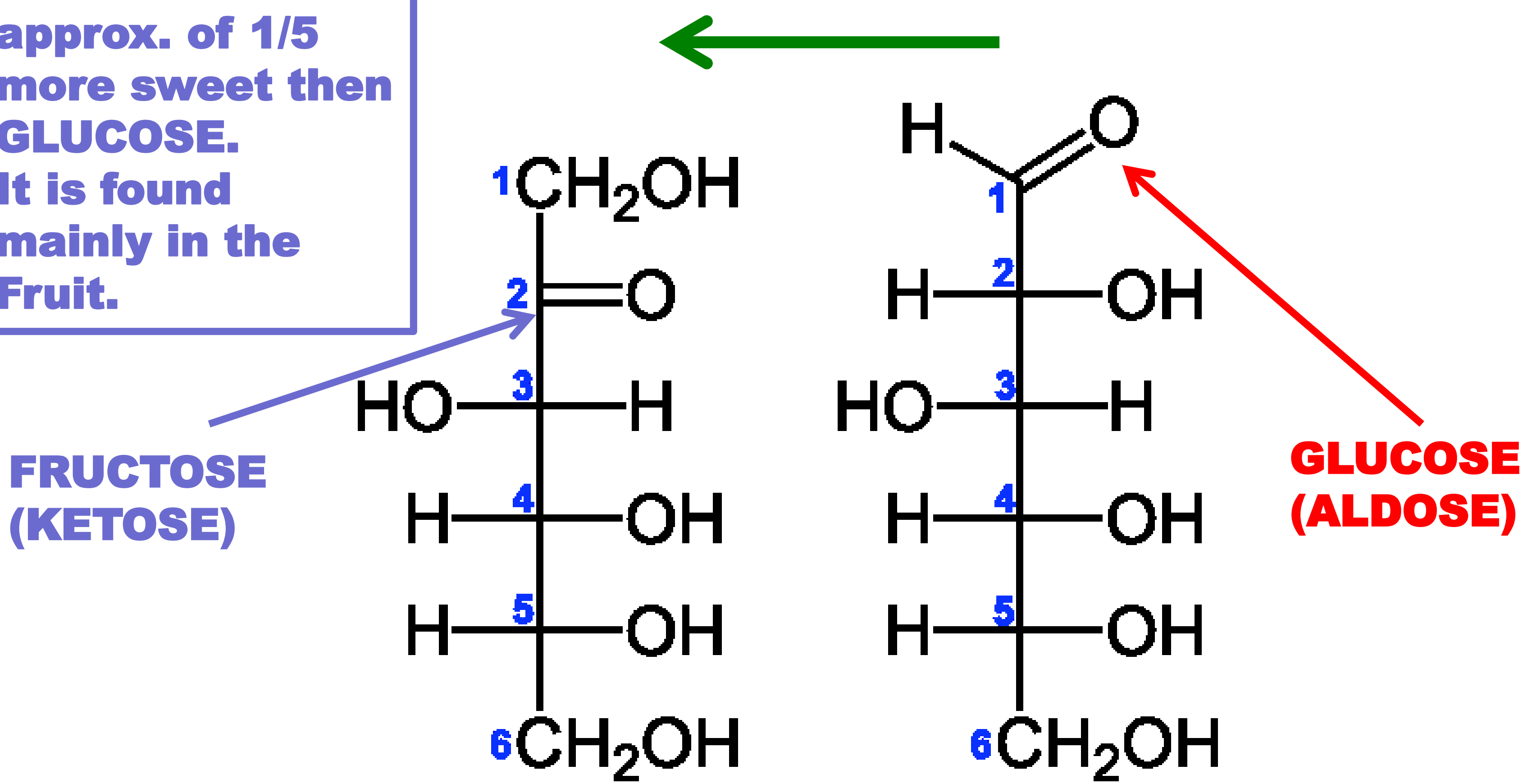


Vodka (in Russian)
Gorilka (in Ukrainian)
Schnaps (German)
Whisky (ENGLISH)
Rye whiskey, Grain alcohol (Czech)
Potato Spirit > Domestic RUM



ENZYMATIC *(Xylose isomerase)*
isomerisation of GLUKOSE to FRUCTOSE

**FRUCTOSE is approx. of 1/5 more sweet then GLUCOSE.
It is found mainly in the Fruit.**



D-xylose aldose-ketose-isomerisation

GENERAL SORTING OF the POLYMER REACTIONS

- **POLYMERANALOGIC REACTIONS**
  - **It doesn't occur any DESIRABLE Chain scission of the MAIN Macromolecules' Chains**
- **DESTRUCTION REACTIONS**
  - **It occurs a DESIRABLE Chain scission of the MAIN Macromolecules' Chains**

Both Reactions are usual at POLYSACCHARIDES

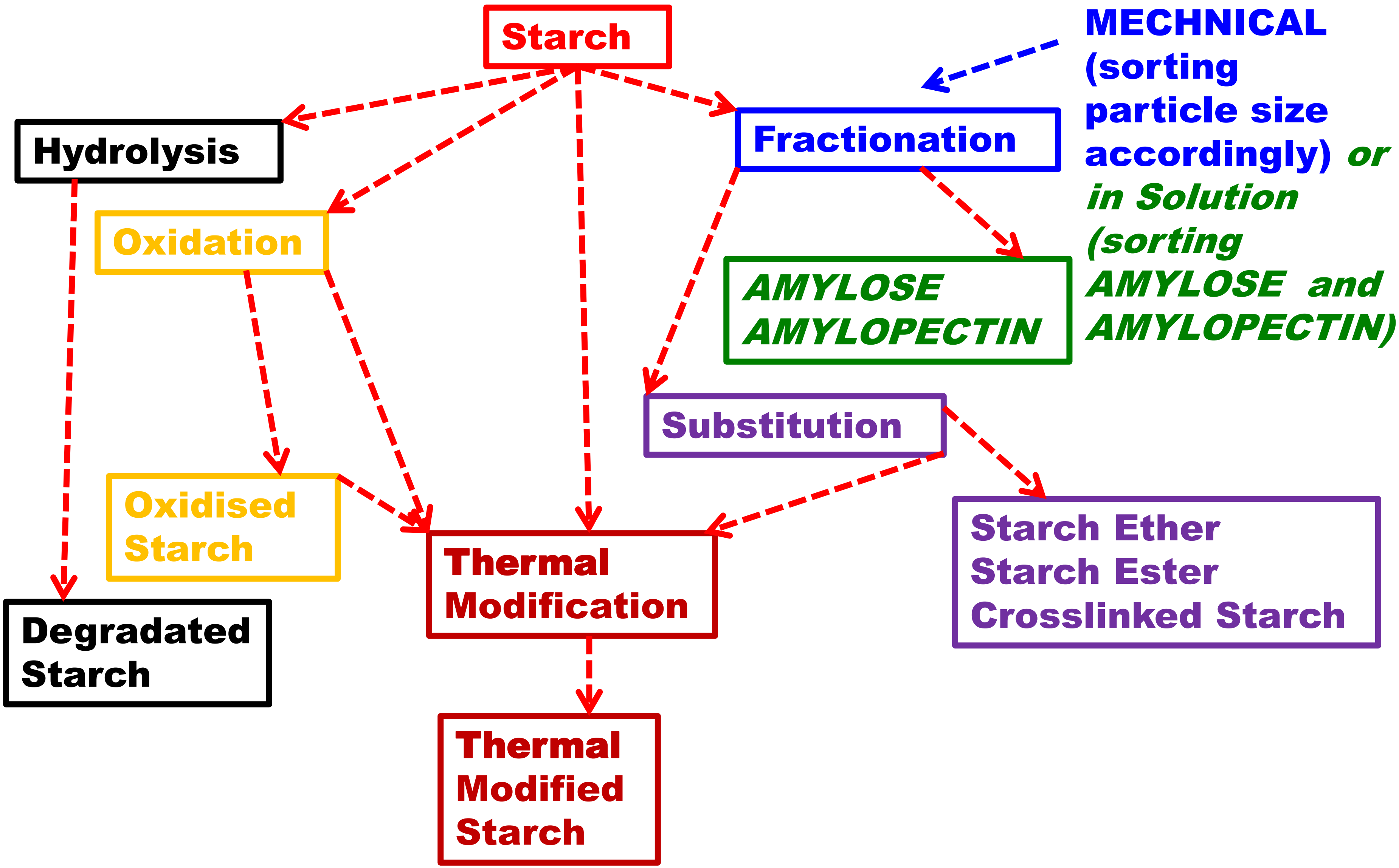
Summary of the STARCH MODIFICATIONS

- **Enzymatic**
- **Thermal**
- **Chemical**
  - **Hydrolysis**
  - **Oxidation**
  - **Esterification (several variants)**
  - **Starch Xanthate**
  - **Starch Carbamate**
  - **Starch ethers**
- **Crosslinking**
- **Grafting**

Principal Use of STARCH

STRACH PROPERTIES	INDUSTRIAL BRANCH
Viscosity increasing	Food Industry
Gels’ Formation	
Water Retention	
Adhesive Properties	Paper Industry
Film Forming	Textile Industry
Biodegradable Properties	Biodegradable products, e.g. Bags etc.
Protective Colloidal Films	Polymer Dispersions

Starch Modification 1



Classification of the Starch Modification technology according to the Chemical Connections

Starch Modification 2

Starch
↓
Water → Starch Suspension Preparation
↓
Substances for Modification and Catalysts → Modification Reaction
↓
Chemicals to interrupt the Main Reactions → Interruption of the Reactions
↓
Water → Rafination → Waste Water
↓
Fitration → Waste Water
↓
Drying
↓
Processing of the Dry Matter

It could be or is MECHNICAL (sorting Particle size accordingly)

It is the case of mainly the Heterogeneous Reaction

Basic Scheme of the Starch Modification

There is great Effort to do these Processes in the SUSPENSION! WHY?

Starch Modification 3

1. **Chemical Modification in the Water Suspension**
   - Hydrolysed Starch
   - Oxidised Starch
   - Starch Ether
   - Starch Ester
   - Crosslinked Starch

PREFERED

2. **Chemical Modification in the Water Solution**
   - Hydrolysed Starch
   - Oxidised Starch
   - Starch Ether

3. **Chemical Modification in the Organic Solvent Solution**
   - Starch Ether
   - Starch Ester

4. **Thermal Modification in Dry State**
   - Degradated Starch
   - Oxidised Starch
   - Starch Ester
   - Crosslinked Starch

5. **Thermal Modification in presence of Water**

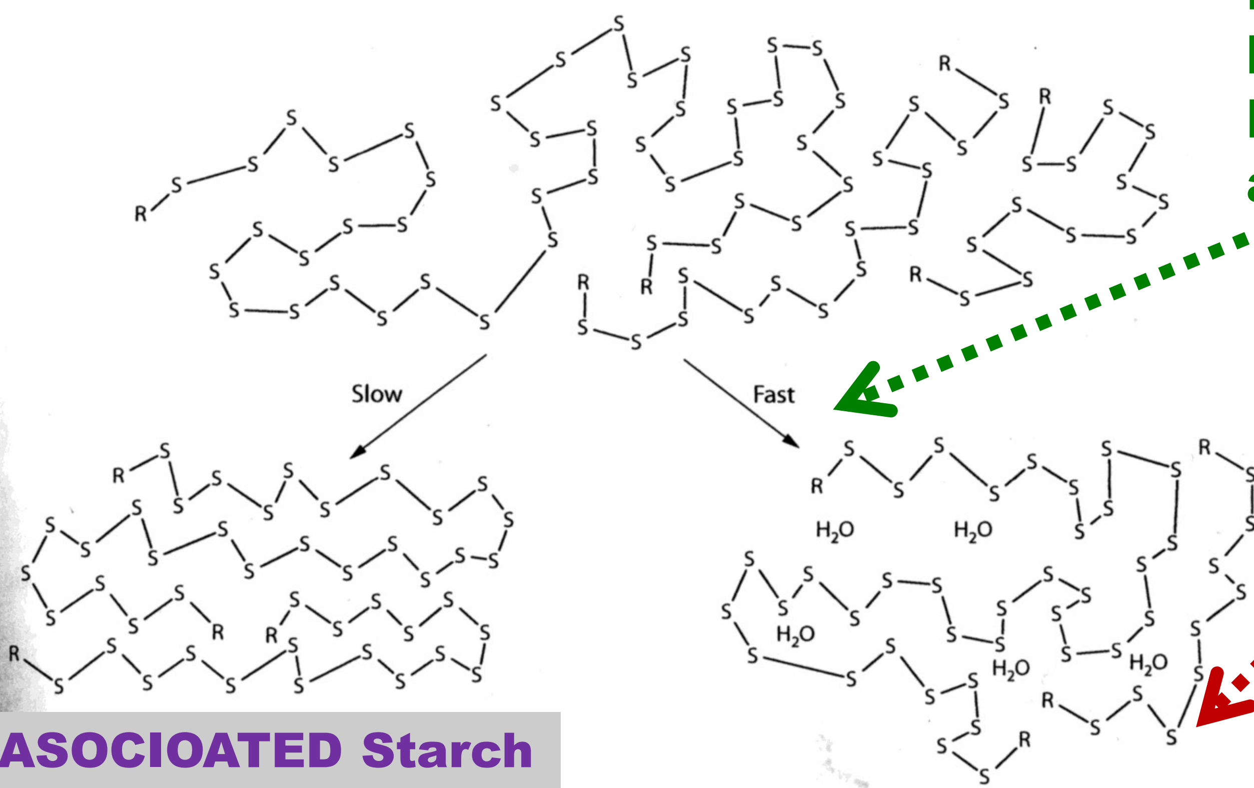
Starch Thermal Modification – EXAMPLE 1

- **Starch Water Suspension Cover on the heated Roll**
- **Starch Paste formation, Hydrogen bonds between Starch Molecules breakage,**
- **Water is so rapidly evaporated, that Hydrogen bonds between Starch Molecules can’t arise again**
- **Dry Starch is formed from no-associated Macromolecules**
- **Such Dry Starch is easy soluble in Water**

Starch Thermal Modification 2

Formation of Starch Paste and Hydrogen bonds between Starch Molecules breakage

Water is so rapidly evaporated , that Hydrogen bonds between Starch Molecules can't arise again



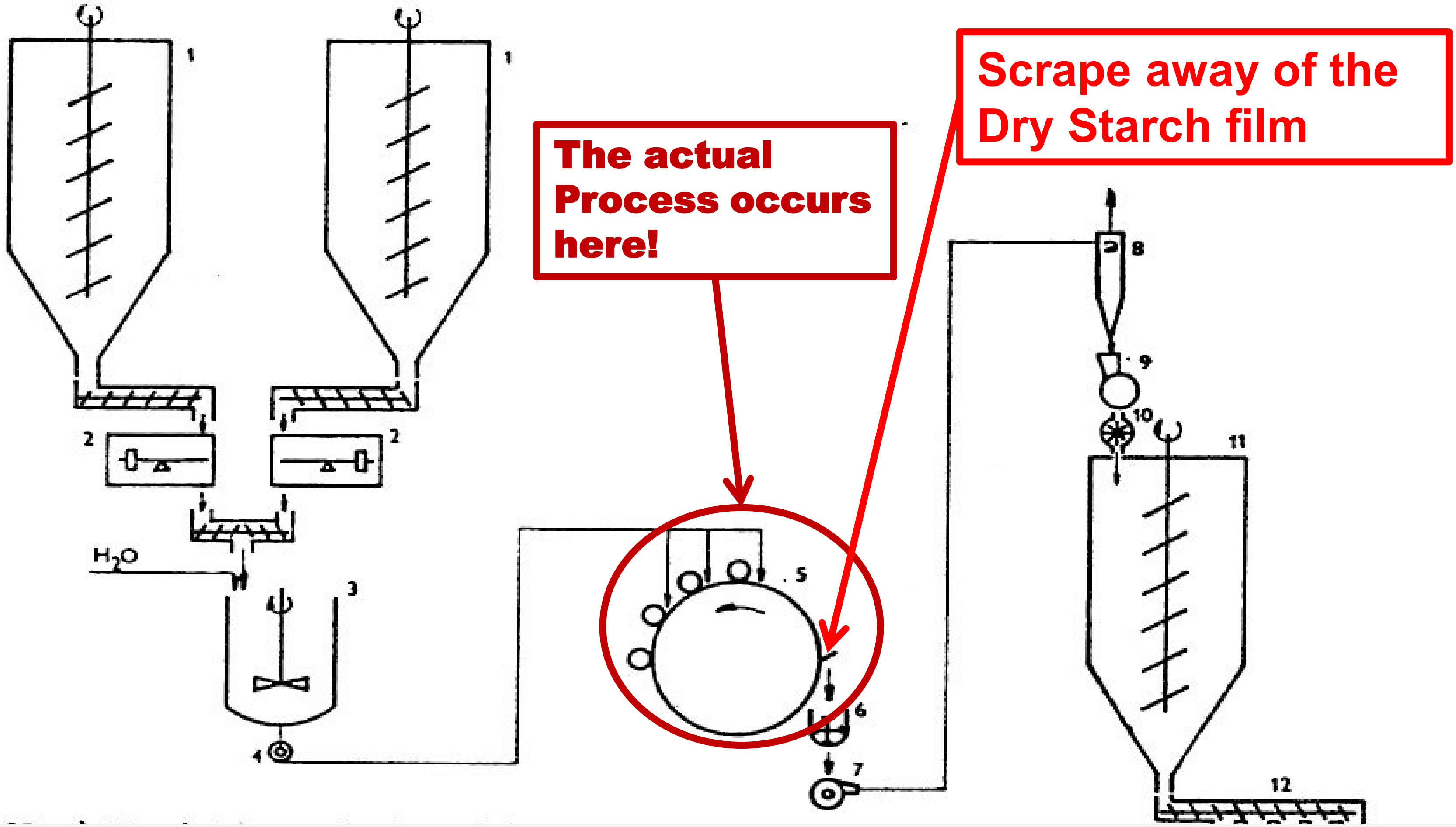
Dry Starch is formed from no-associated Macromolecules

ASOCIOATED Starch MOLECULES

…rated aqueous solution as a function of cooling rate.

…018

Starch Thermal Modification – Technology Diagram 3

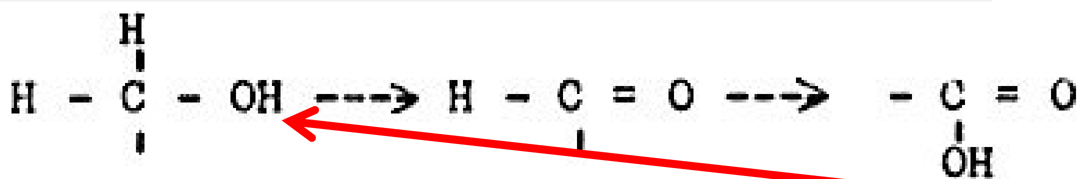


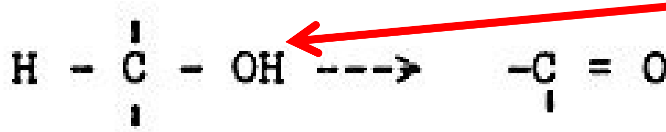
The Classical Thermal Starch Modification

1) Dry Starch Hopper, 2) Automatic balances, 3) Mixer, 4) Metering pump, 5) **Heated Roll**, 6) Pregrinder, 7) Fan, 8) Cyclon, 9) Impact Mill, 10) Turnstile, 11) Dry product Hopper

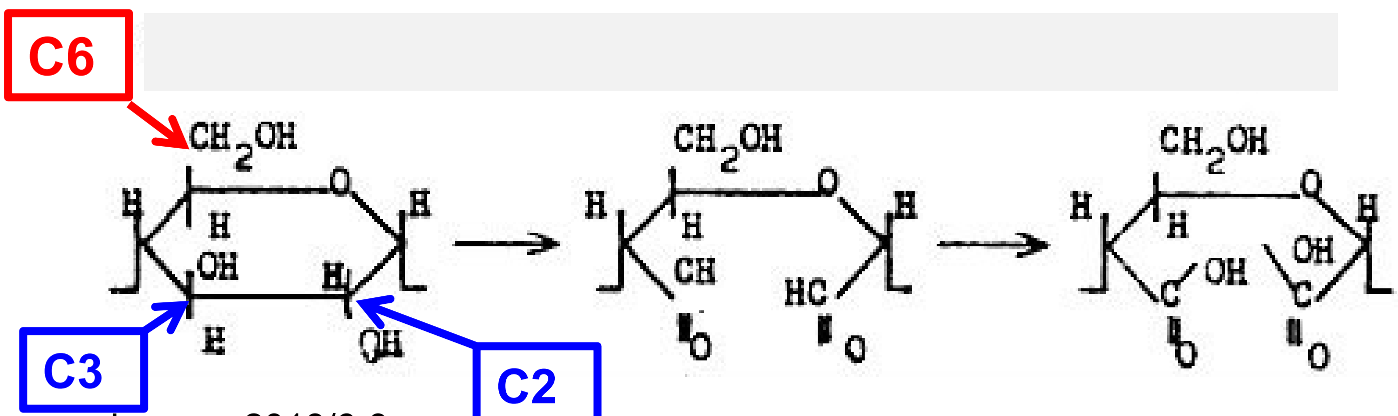
NONSELECTIV Oxidation of Starch 1

Oxidation of the CARBONYL GROUP in the OPEN FORM of GLUCOSE to -COOH





Oxidation of the –OH in CYKLIC FORM of GLUCOSE to =C=O and then up to -COOH

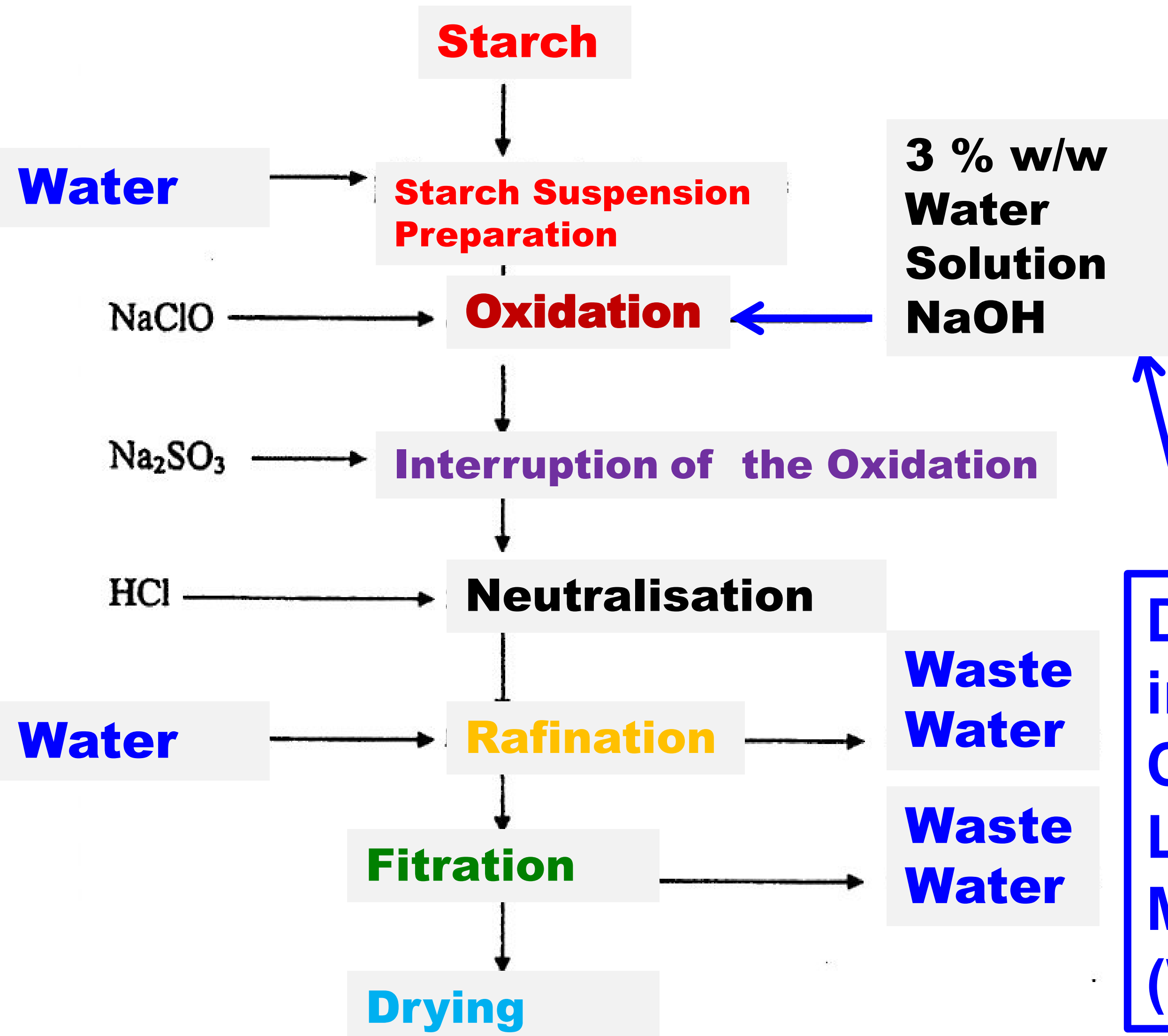


Oxidation of the CYKLIC FORM of GLUCOSE by opening between C2 a C3

Oxidation of Starch

- The most Important Modification Reactions
- It can be done in both low and high pH Regions
- The most Important is the **Oxidation by sodium hypochlorite** in the pH Region approx. 8 – 9 (slightly basic conditions)
- It is used mainly for the Potato Starch, having high Capillarity and low Tendency to Retrogradation

NONSELECTIV Oxidation of Starch – Technology Diagram

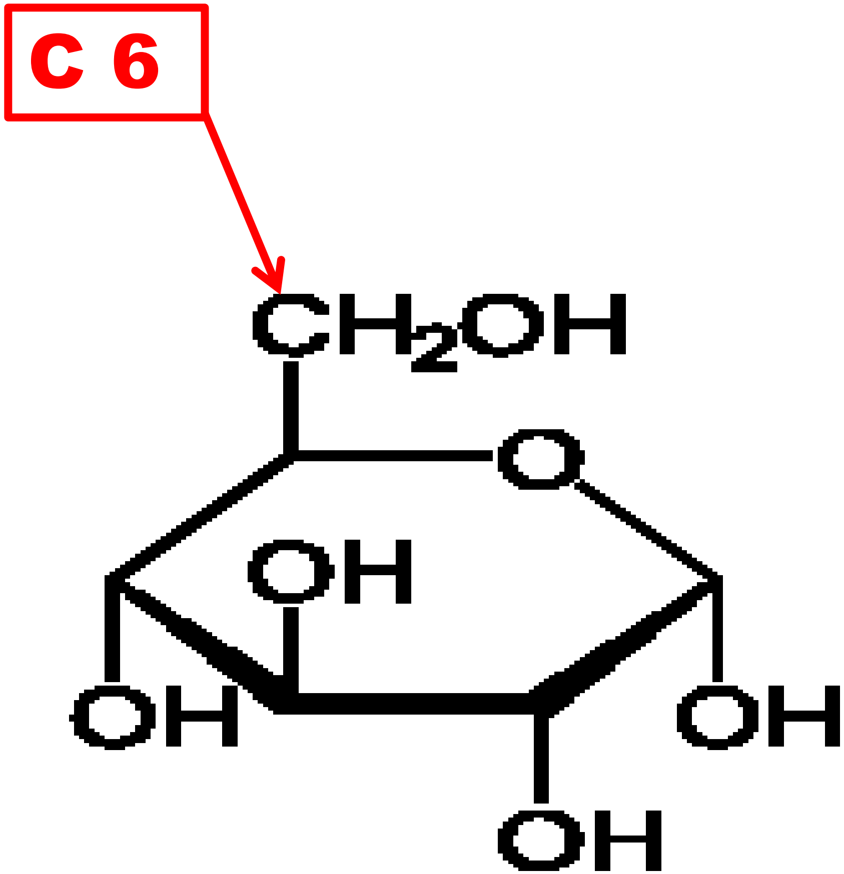


TYPICAL FORMULATION

- pH = 8 – 9
- TEMPERATURE = 35 – 43 °C
- Reaction time = 2 – 8 hours
- activ chlorine (NaClO) = 3 – 45 g/kg Starch

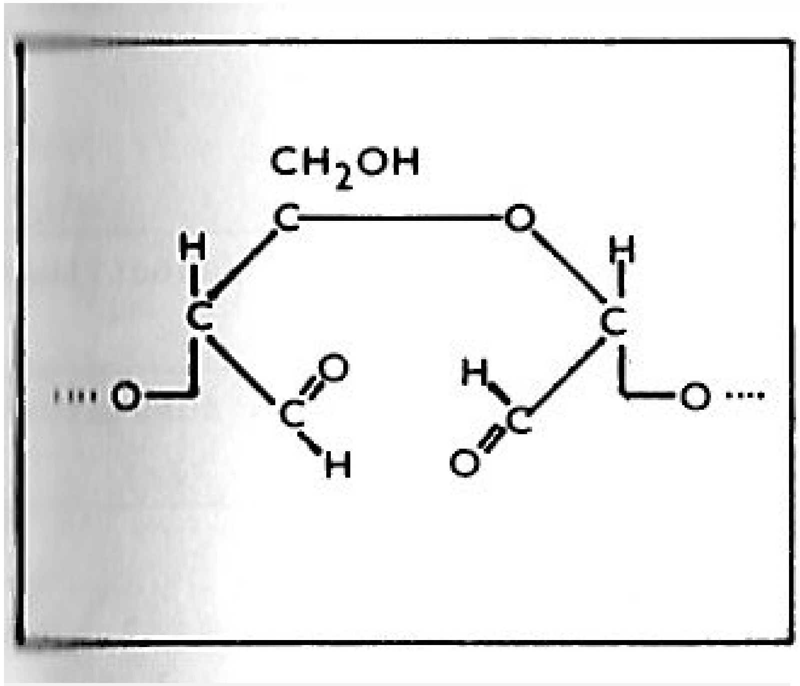
DEPOLYMERISATION in ALKALINE CONDITION > LOWERING of the MOLECULAR MASS (WEIGHT)

SELECTIV Oxidation of Starch on C 6 from –OH on – COOH using HNO_3



The Polymerisation Degree is not changing at such Oxidation – **POLYMERANALOGIC CONVERSION**

SELECTIV Oxidation of Starch to Starch dialdehyde



Starch dialdehyde

Such Oxidation is performed by Periodic acid in the Special configuration so, that the Periodic acid is regenerating by Electrolysis

The Polymerisation Degree is not changing at such Oxidation ***in the Ideal case*** – **POLYMERANALOGIC CONVERSION**

Starch Oxidation - SUMMARY

- Higher Oxidation > Higher **Chain scission > Lower Viscosity**
- Higher **Chain scission > Lower Binding ability**
- Higher **Chain scission >** Higher Dispersion Stability. It is lower Retrogradation Tendency
- **High Porosity (Capillarity) Starches are suitable for Heterogeneous Reaction, because having higher Surface able to be Reaction Site**

DEXTRIN PRODUCTION 1

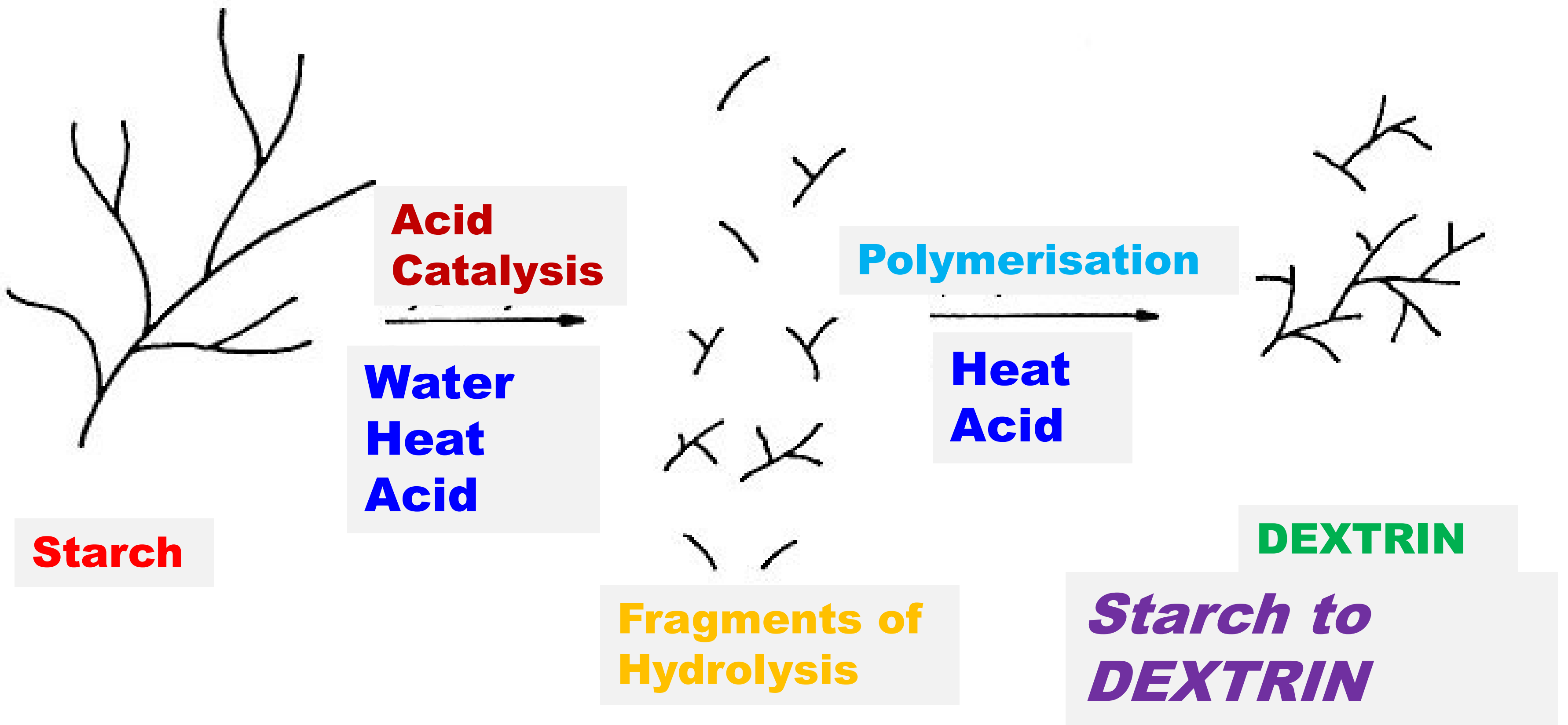
HCl, HNO_3,
Potassium aluminum sulfate → Solution of the Modification Substances → Starch Impregnation by Modification Substances

Starch
↓
Starch Impregnation by Modification Substances
↓
Agein

12 – 24 hours, for going through of Acids and/or Bases & Solutions of Additives Starch Particles → Agein

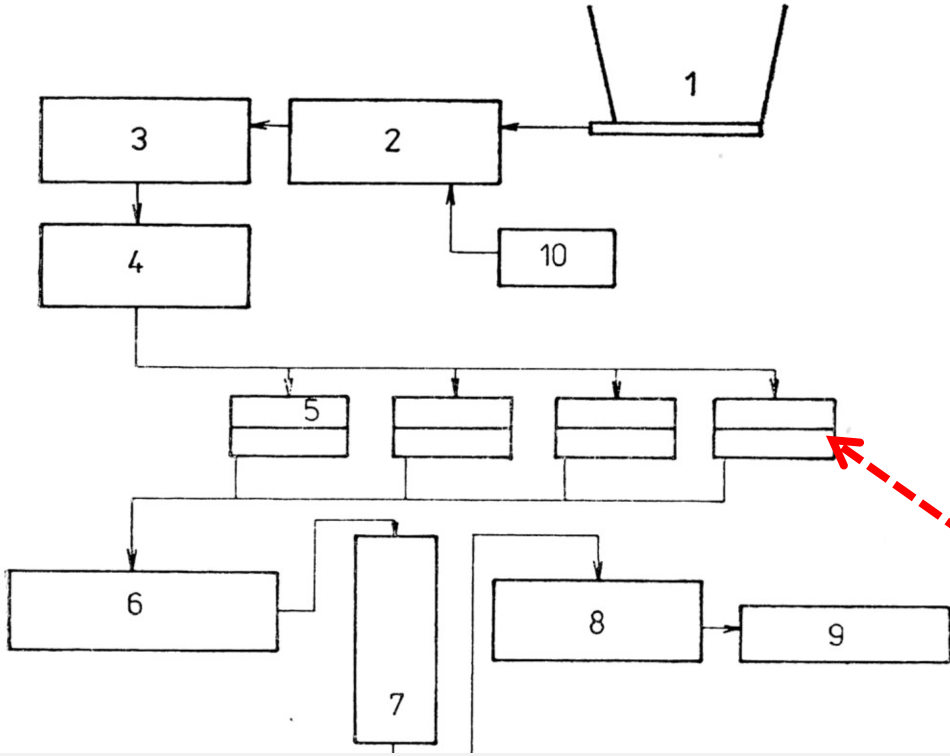
↓
Predrying
↓
Roasting
↓
Chilling
↓
Neutralisation ← Solution of Substances for Neutralisation
↓
Classification by Sieve (screening)

DEXTRIN PRODUCTION 2



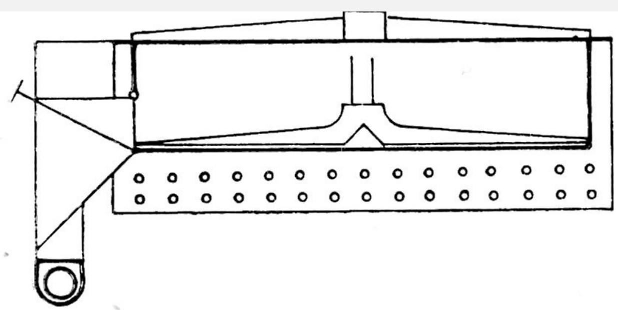
It is fact STARCH HYDROLYSIS followed by POLYMERISATION (COMBINATION) of FRAGMENTS

DEXTRIN PRODUCTION DIAGRAM



DEXTRIN FACTORY:

1) Starch Hopper, 2) Acid Addition, 3) Agein, 4) Predrying, 5) Pans, 6) Dextrin Chiller, 7) Humidification Tower, 8) Homogesitation and Screening , 9) Dextrin Packaging, 10) Tank for Acid or Potassium aluminum sulfate Solution



DEXTRINATION CLASSICAL PAN heated by Gas

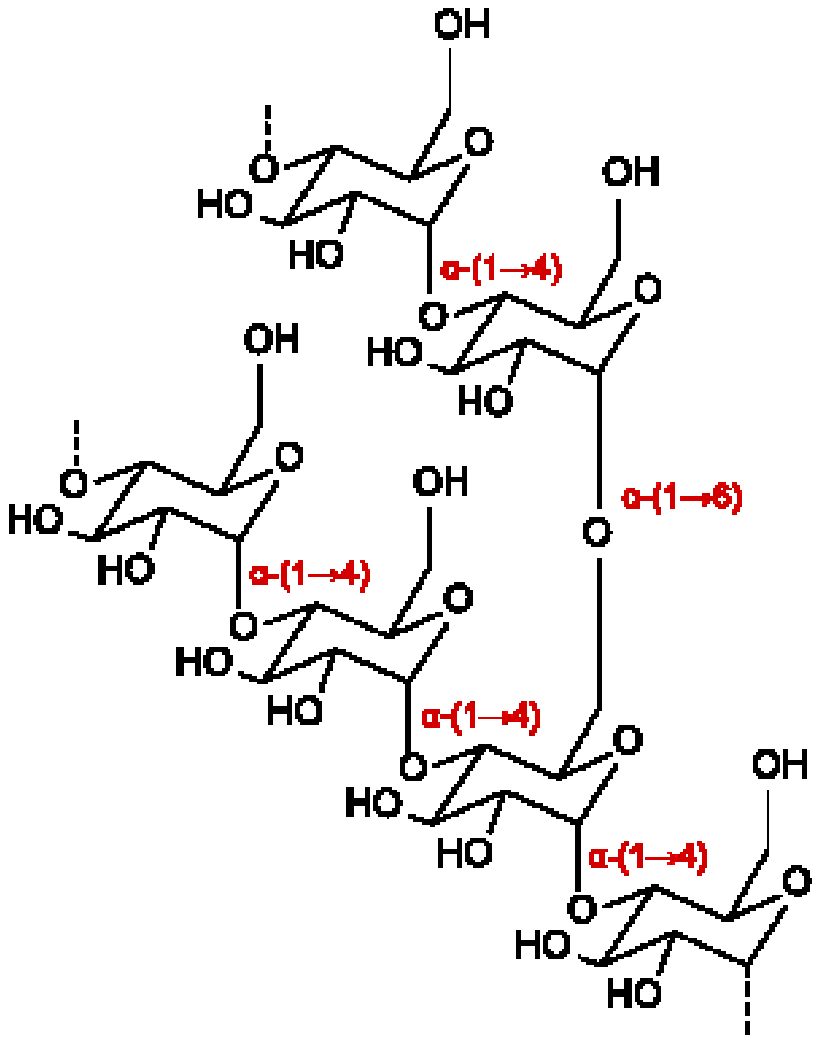
DEXTRIN – BASIC CHARACTERISTICS

Characteristic	Starch	DEXTRIN TYPE			
		White	Light yellow	Yellow	Yellowbrown
Approximate Production Conditions		T = 135 °C, 0,05 – 0,15 % w/w HCl	T = 150 °C, 0,05 – 0,15 % w/w HCl	T = 165 °C, 0,05 – 0,15 % w/w HCl	T = 180 °C, 0,05 – 0,15 % w/w HCl
MW	AMYLOSE 30 000-160 000 & AMYLOPECTIN 100 000 - 1 000 000	$20 – 30.10^3$	15000 - 2000	8000 - 3000	Approx. 2000
Solubility in Water	0	30 – 70 % w/w	Approx. 95 % w/w	Approx. 97 % w/w	Up to 99 % w/w
DE	0	2 – 3 % w/w	2 – 5 % w/w	2 – 8 % w/w	2 – 5 % w/w ?
Colour of the Iodine Complex	Blue	Blue -vilolet	Red-vilolet	Red	No Colour
Viscosity	→ Decreasing →				

DE – Dextrose Equivalent = GLUCOSE EKVIVALENT = %w/w reducing saccharides in dry dextrin

Starch itself is not reducing SACCHARIDE

DEXTRINS’ STRUCTURES



Process of so called „DEXTRINATION“ occurs also during e.g. baking of Bread! It is the brown Bread Crust

DEXTRINS' PROPERTIES & THE OTHER DEXTRIN TYPES

- Colour from WHITE over Yellow to Brown
- They are usually fully soluble in Water

Energy Gels and Bars

OTHER TYPES OF DEXTRINS

Maltodextrin

is a shortchain starch sugar used as a food additive. It is produced also by enzymatic hydrolysis from gelled starch and is usually found as a creamy-white hygroscopic spraydried powder. **Maltodextrin is easily digestible**, being absorbed as rapidly as glucose, and might either be moderately sweet or have hardly any flavor at all.

Cyclodextrin

The cyclical dextrins are known as cyclodextrins. They are formed by enzymatic degradation of starch by certain

bacteria, for example, *Bacillus macerans. Cyclodextrins have toroidal structures formed by 6-8 glucose residues.*

DEXTRINS' USE

Yellow dextrins

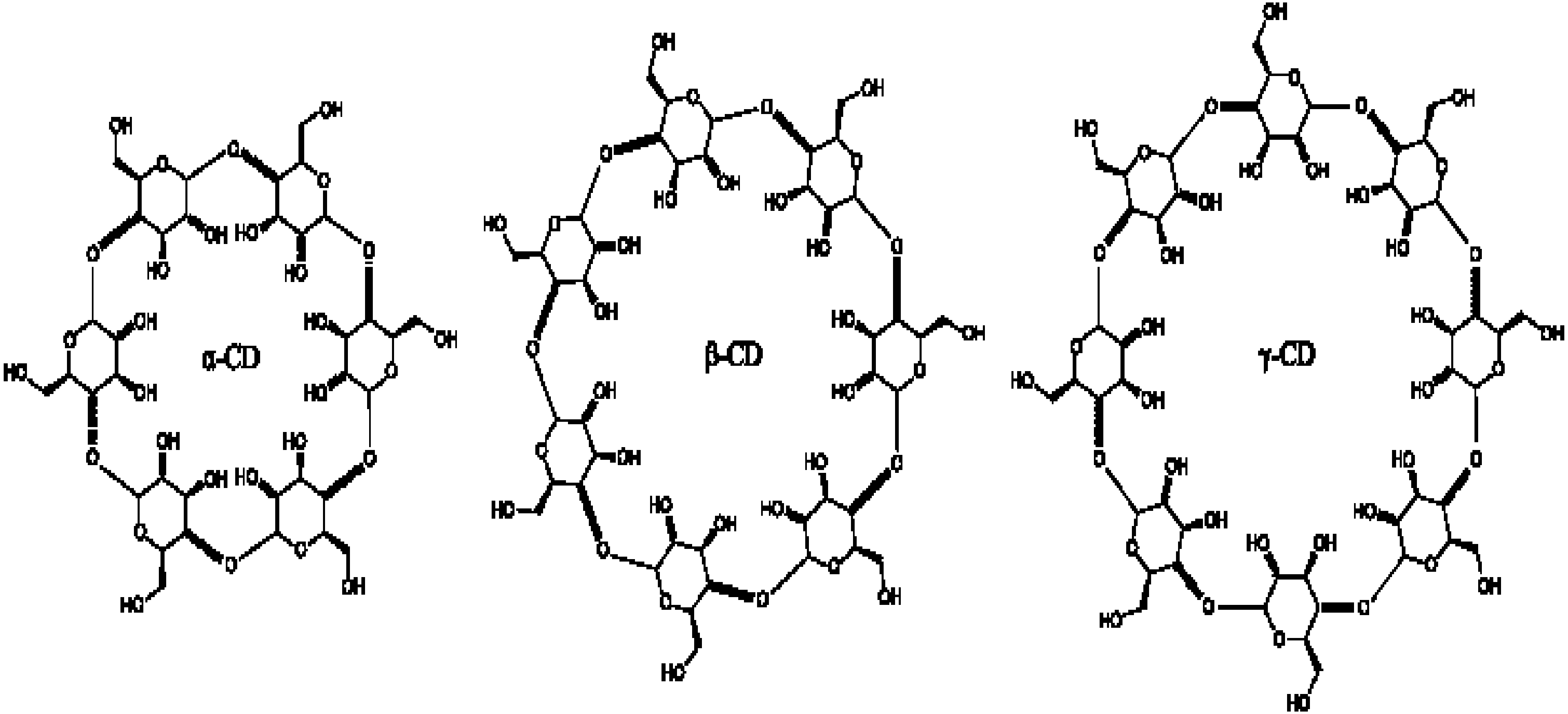
- **water-soluble glues in remoistable envelope adhesives and paper tubes,**
- **in the mining industry as additives in froth flotation, in the foundry industry as green strength additives in**
- **sand casting, as printing thickener for batik resist dyeing, and as binders in gouache paint.**

White dextrins

- **a crispness enhancer for food processing, in food batters, coatings, and glazes, (E number 1400)**
- **a textile finishing and coating agent to increase weight and stiffness of textile fabrics**
- **a thickening and binding agent in pharmaceuticals and paper coatings.**
- **As pyrotechnic binder and fuel, they are added to fireworks and sparklers, allowing them to solidify as pellets or "stars."**
- **Due to the rebranching, dextrins are less digestible; indigestible dextrin are developed as soluble fiber supplements for food products.**

CYCLODEXTRINS

In CYCLODEXTRIN molecule can be absorbed ethanol (alcohol) and so is formed so called „alcohol in Powder“, which is releasing alcohol when pouring in Water



DEXTRINS - SUMMARY

- PROBABLY the most Commonly used Product of the Starch Modification
- It is substantial chemical transformation of Starch
- Very wide Types' Range of Use
- Well sophisticated both continual and discontinuous technology
- Process is employed at least since 19. Century

Acetylation of Starch

$$\text{škrob} - OH + (CH_3CO)_2O + NaOH \dashrightarrow \text{škrob} - O - \underset{\displaystyle \overset{\|}{O}}{C} - CH_3 + CH_3COONa + H_2O$$

$$(CH_3CO)_2O + 2\ NaOH \dashrightarrow 2\ CH_3COONa + H_2O$$

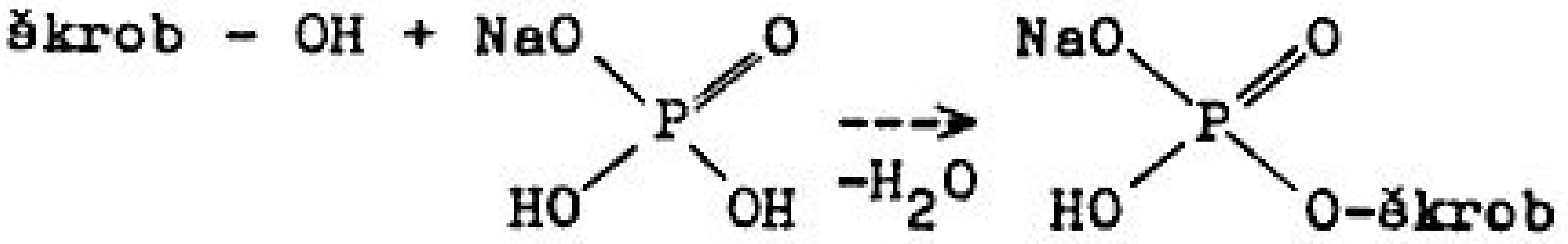
$$\text{škrob} - O - \underset{\displaystyle \overset{\|}{O}}{C} - CH_3 + NaOH \dashrightarrow \text{škrob} - OH + CH_3COONa$$

Side Reaction
lowering the Output

Starch Monophosphate

Sodium Monophosphate is employed here!

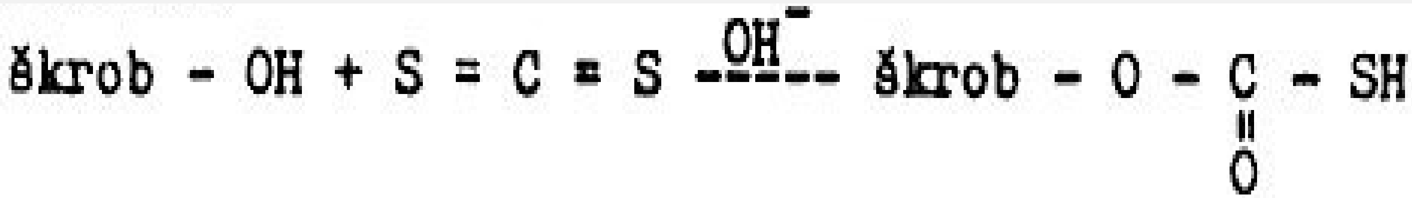
Starch Monophosphate is resulting via the Following Reaction:



- **The Result is ANIONIC STARCH with LOW SUBSTITUTION LEVEL (*0,02 – 0,1 g substitution Agent per 1000 g dry Starch*). That is enough for good Water solubility in the cold Water.**
- **The Crosslinking can occur simultaneously, but where is HIGH SUBSTITUTION LEVEL (0,1 – 0,2 g substitution Agent per 1000 g dry Starch), sometimes even over 1 (Corn Starch no swelling even in the Boiling Water even)**

Starch Xanthate

Starch Xanthate is resulting via the Following Reaction of CS_2 and Starch



Starch alkylethers

$$\text{Starch} - OH + OH^{-} \rightleftharpoons \text{Starch}\ O^{-} + H_2O$$

$$\text{Starch} - O^{-} + CH_3CH_2 - Cl \dashrightarrow \text{Starch}\ O - CH_2CH_3 + Cl^{-}(HCl)$$

Starch alkylether

Starch Carbamate

$$\text{Starch} - OH + H_2N - \underset{\underset{O}{\|}}{C} - NH_2 \xrightarrow{-NH_3} \text{Starch} \cdot O - \underset{\underset{O}{\|}}{C} - NH_2$$

Starch Hydroxymetylether

Starch $- OH + OH^- \rightleftharpoons$ Starch $O^- + H_2O$

Starch $- O^- + CH_2 - CH_2$ (epoxide, bridging O) $\rightleftharpoons$ Starch $O - CH_2 - CH_2 - O^-$

Starch $- O - CH_2 - O^- + H_2O \longrightarrow$ Starch $O - CH_2CH_2OH$

Starch Hydroxymetylether

Starch Carboxymettylether

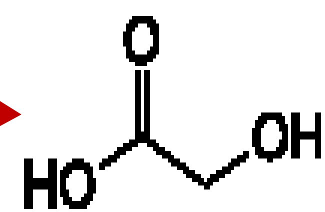
Starch $- OH + ClCH_2COONa + NaOH \longrightarrow$ Starch $O - CH_2COONa +$
$+ NaCl + H_2O$

Reaction Mechanism is showing the following Equation:

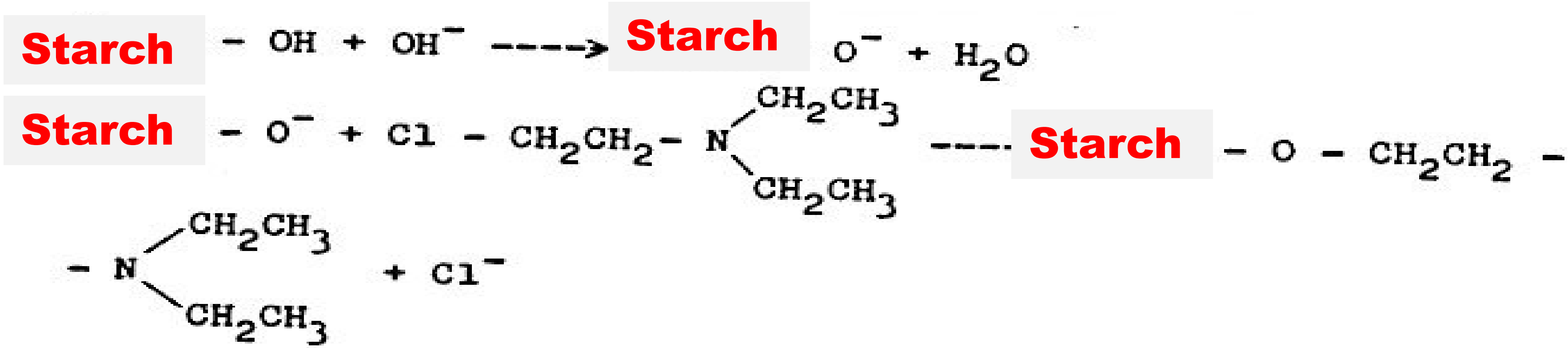
Starch $- OH + OH^- \longrightarrow$ Starch $O^- + H_2O$

Starch $- O^- + H_2C - C = O$ (bridging O) $\longrightarrow$ Starch $O - CH_2 - C(=O)O^-$

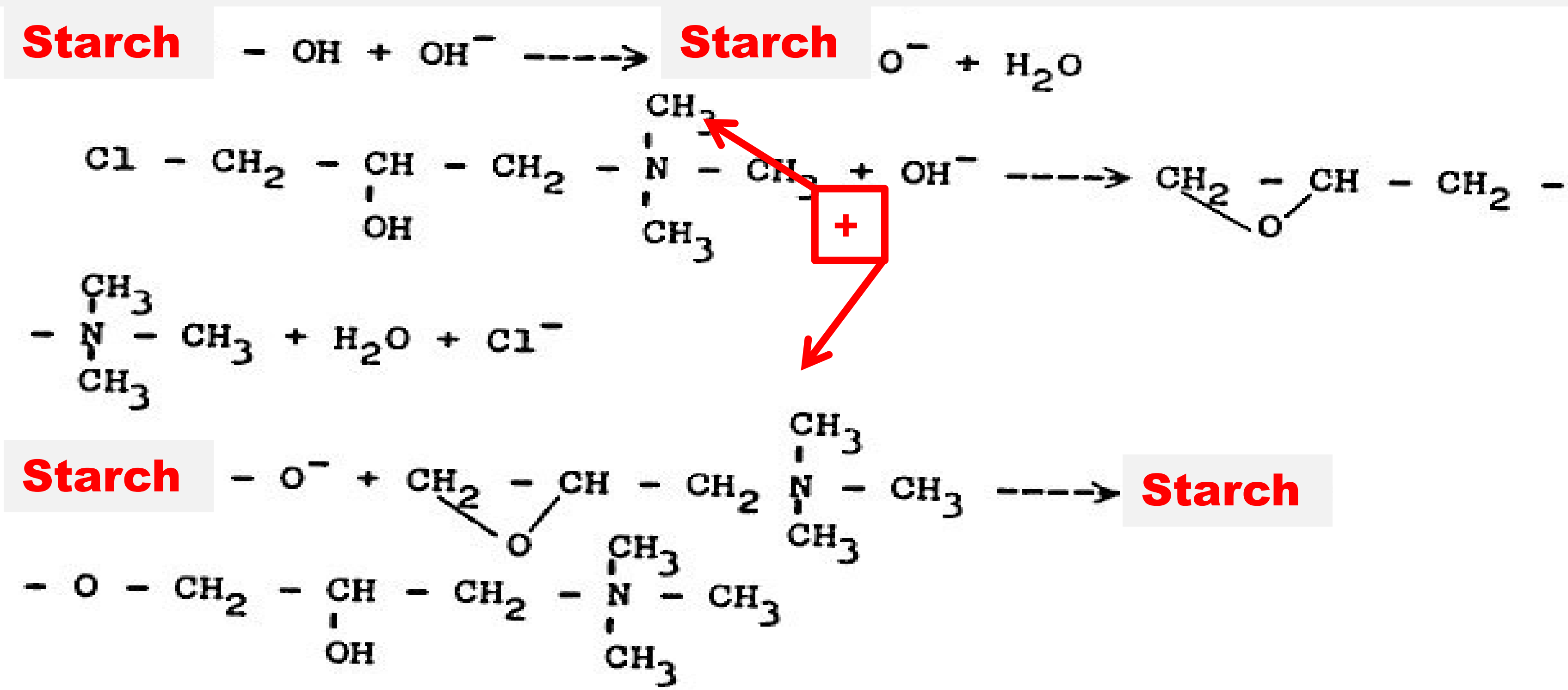
Glycolic acid Lactone



Cationic Starch 1



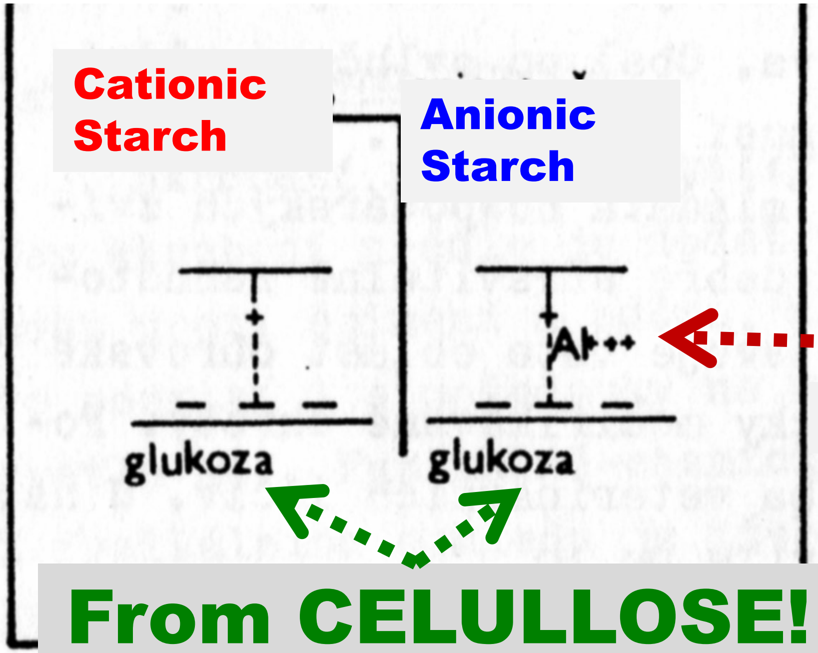
Starch Quaternary Derivatives are resulting via Reaction of Starch with Halogen Quaternary Derivatives of amonium Base

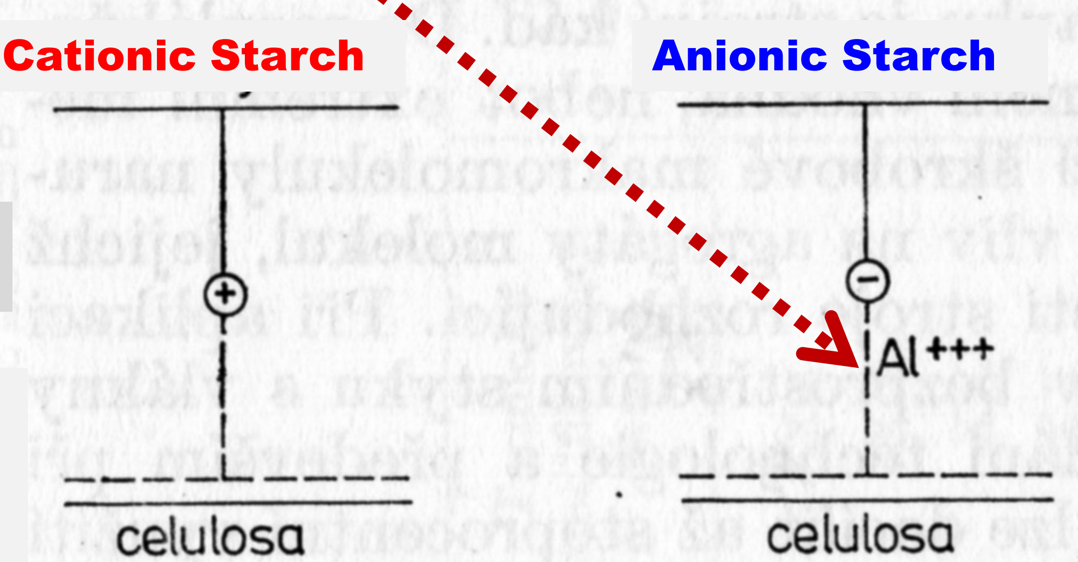


Cationic Starch 2 – PAPER PRODUCTION

Addition of the CATIONIC STARCH improves Retention so called Extremely short Fibres, which arise from both waste Paper and Paper production Waste

ANIONIC STARCH needs for acting Cation Al^{+3}, usually from $KAl(SO_4)_4$ (Potassium aluminum sulfate)

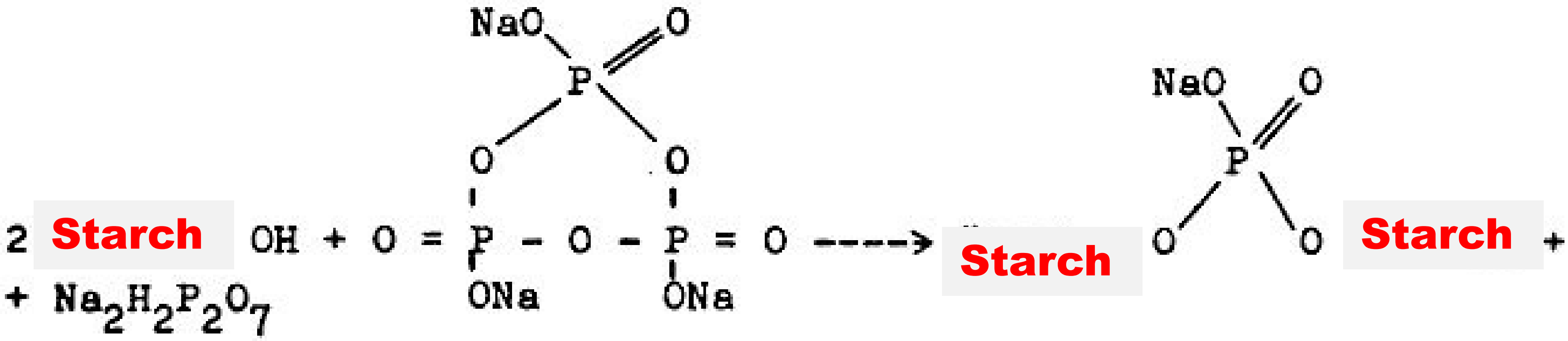




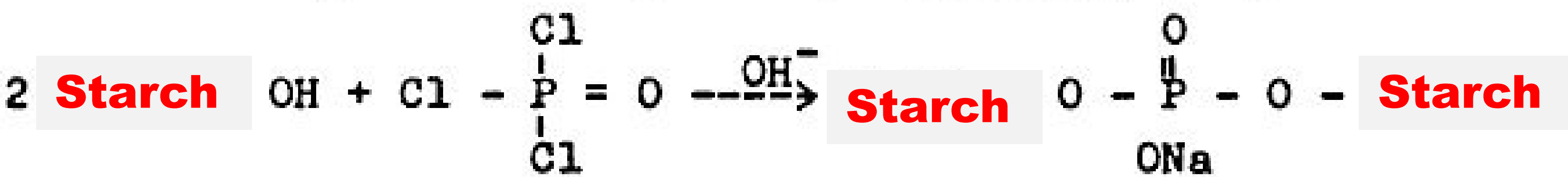
From CELULLOSE!

Diagram showing Influence of Ionogenic Starch Derivatives

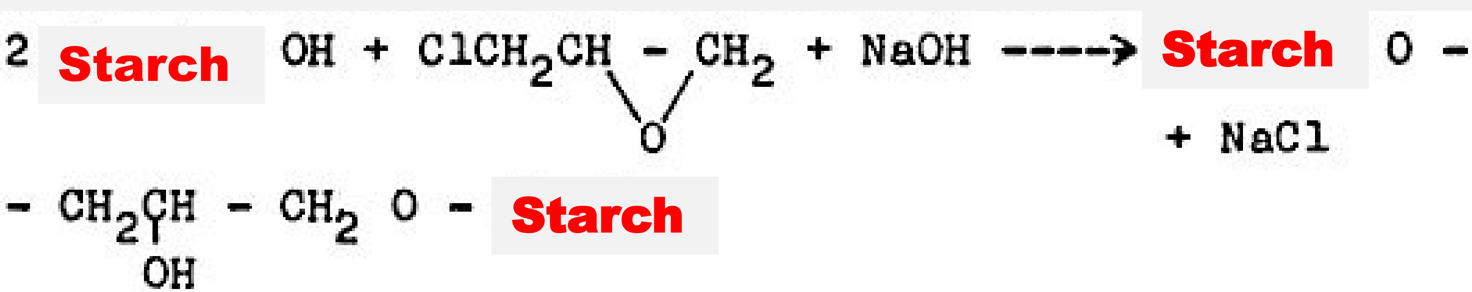
Crosslinked Starch 1



Starch Diphosphate can results from the following Reaction also:

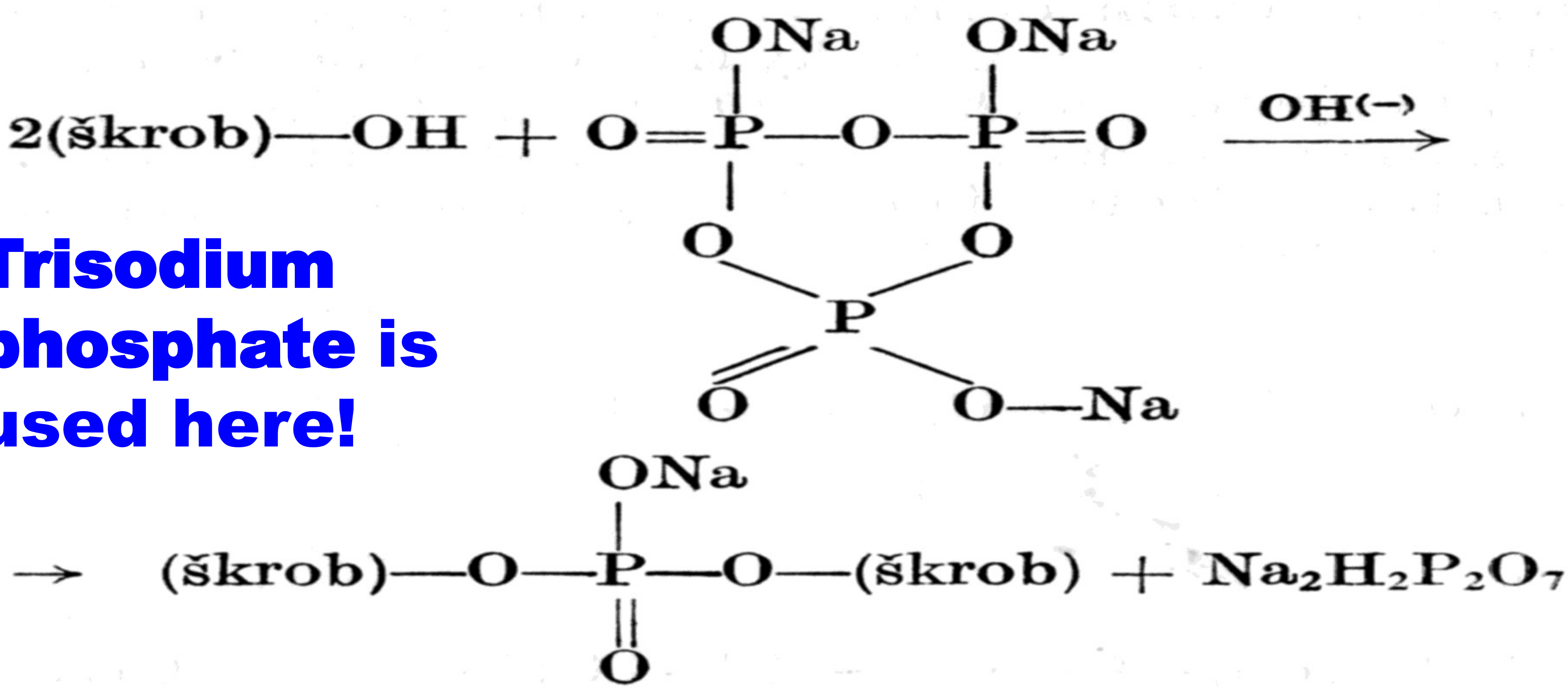


Starch Diether results via the following Reaction of Starch and Epichlorhidrine in alkaline Medium :



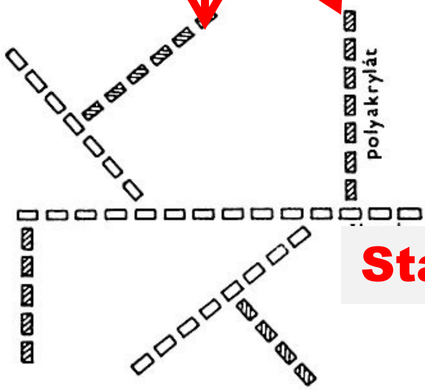
Crosslinked Starch 2

- Crosslinked Starch has HIGH SUBSTITUTION LEVEL sometimes even over 1 g substitution Agent per 1000 g dry Starch > Powdering agents in Pharmacy
- ANIONIC STARCH can be formed simultaneously, but there is LOW SUBSTITUTION LEVEL (0,02 – 0,1 g substitution Agent per 1000 g dry Starch),



Trisodium phosphate is used here!

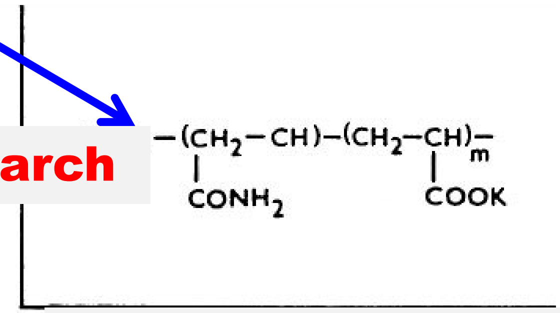
Graft & Block Starch copolymers



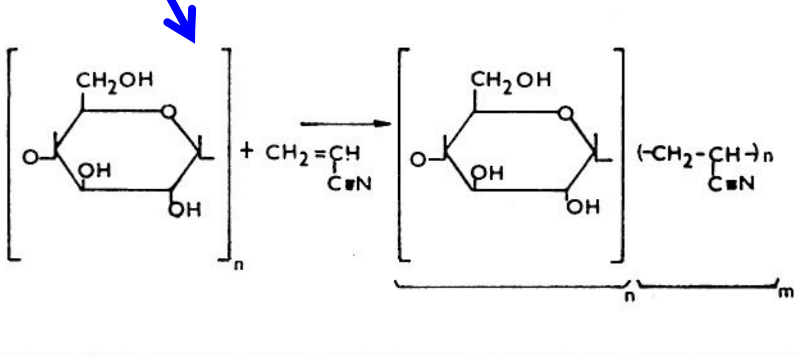
Starch

Starch grafting Diagram

Starch



Starch Block Copolymerisation Diagram



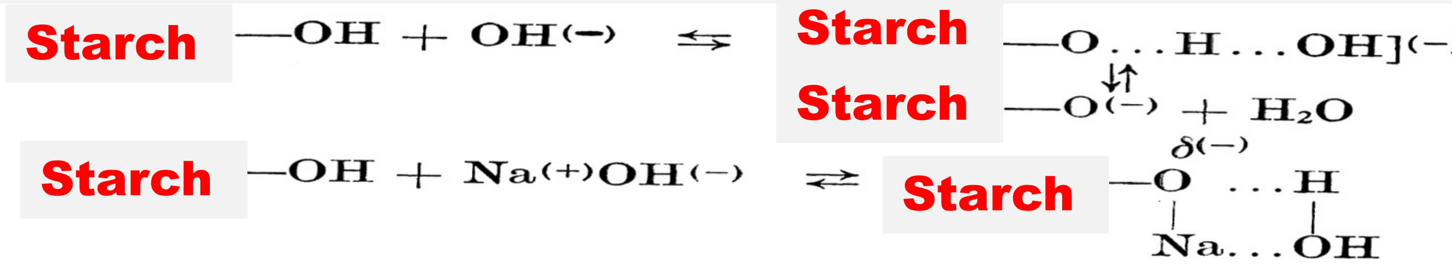
Starch Block Copolymerisation Diagram

Use of the Modified Starches

- **Paper Production and Treatment**
- **Food Industry**
- **Textile Industry**
- **Glues**
- **Pharmacy**
- **Flocculants for Waste Water Treatment**
- **..................**

Starch Glue (Adhesive)

The Reactivity of Starch in Nucleofilic Substitutions is generally increased by Activation by Alkali via forming the alkali Salt, sometime formulated as STARCH – ALKALI COMPLEX



LABORATORY EXAMPLE OF THE STARCH GLUE PREPARATION

Approx. 20 g of Starch mix with 50 ml of cold Water and pour into approx. 200 ml of boiling Water containing 5 g NaOH. Boil at permanent mixing. The Glue is finished, when the Viscosity has increased and the Solution is clear enough. The Glue is finished then. Add approx. 10 Drops of Formaldehyde to avoid Moulding.

The Potato and Corn Starches Mixture is usually used by Industry

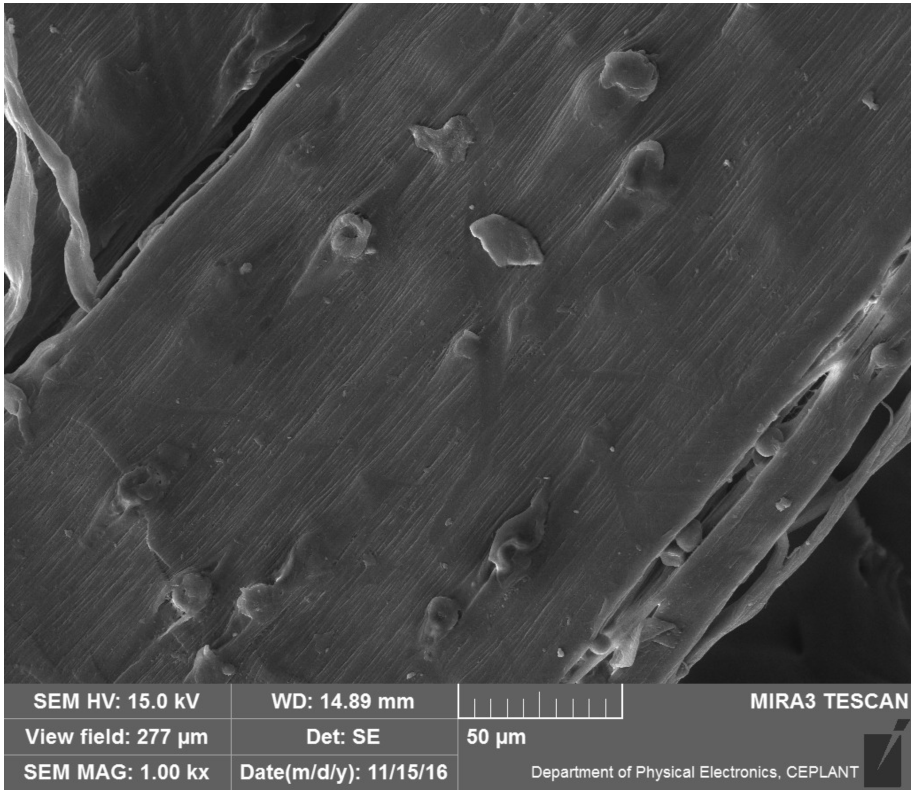
Starch as the BIODEGRADABLE ADITIVE to Synthetic THERMOPLASTICS

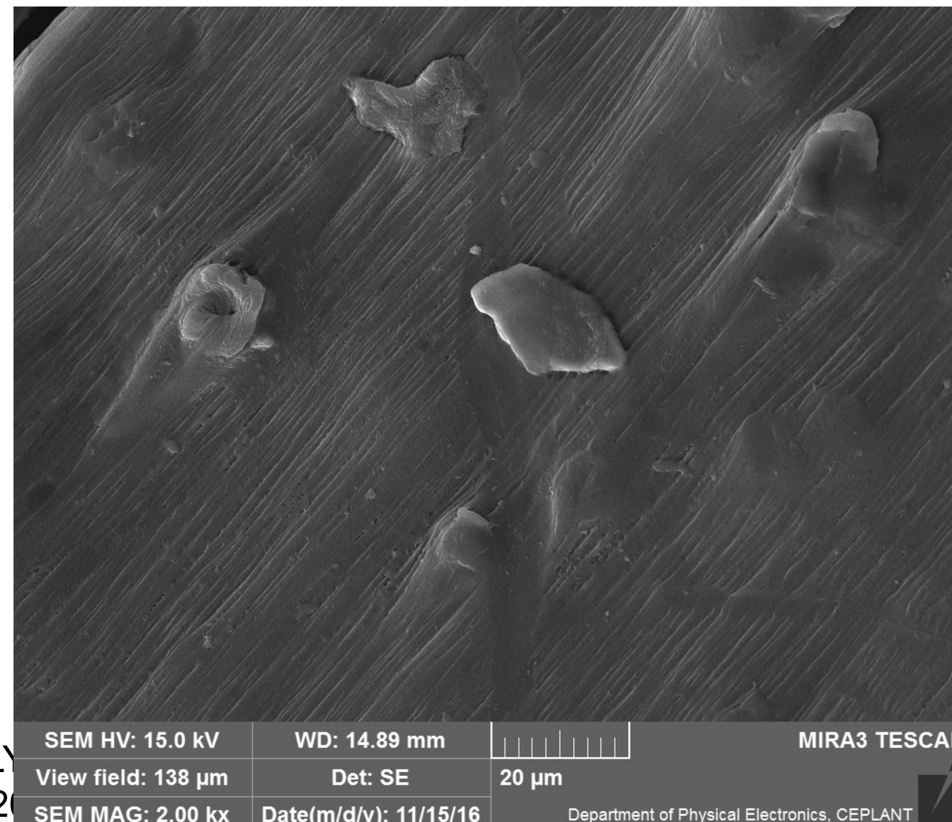
- The Degradation is usually necessary „PUSH AHEAD“ by Thermo oxidation

What was done by me

- BIODEGRADABLE LDPE films (up to 40 % w/w Corn Starch)
- The Inner part of the Shotgun shell
- PP Fibres with Starch

Polypropylene Fibres with Corn Starch 1

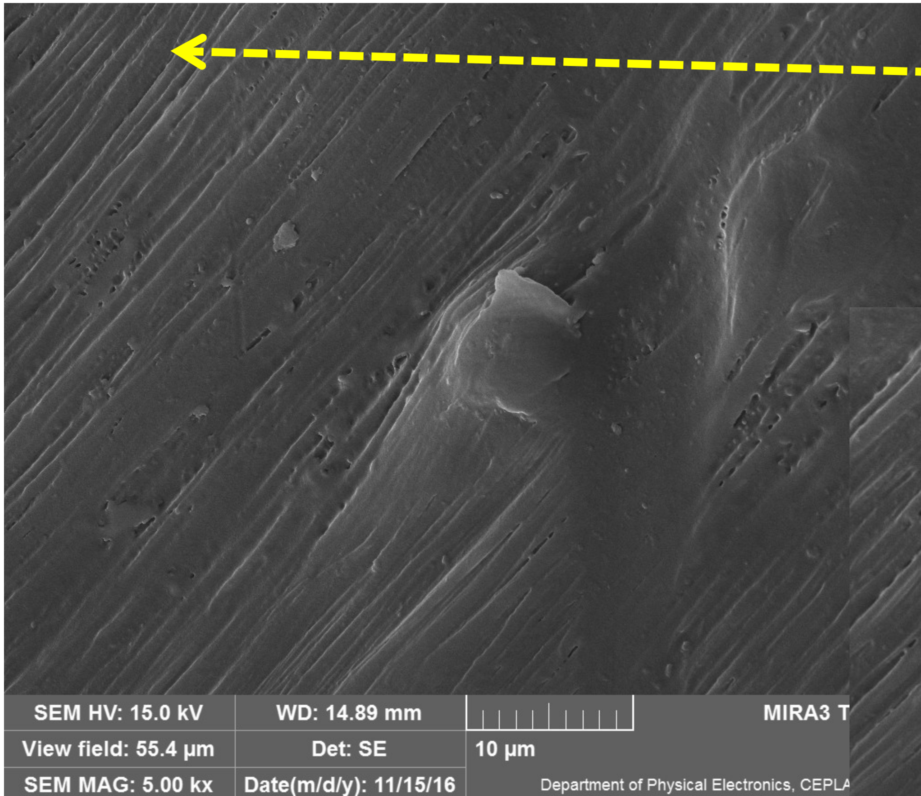


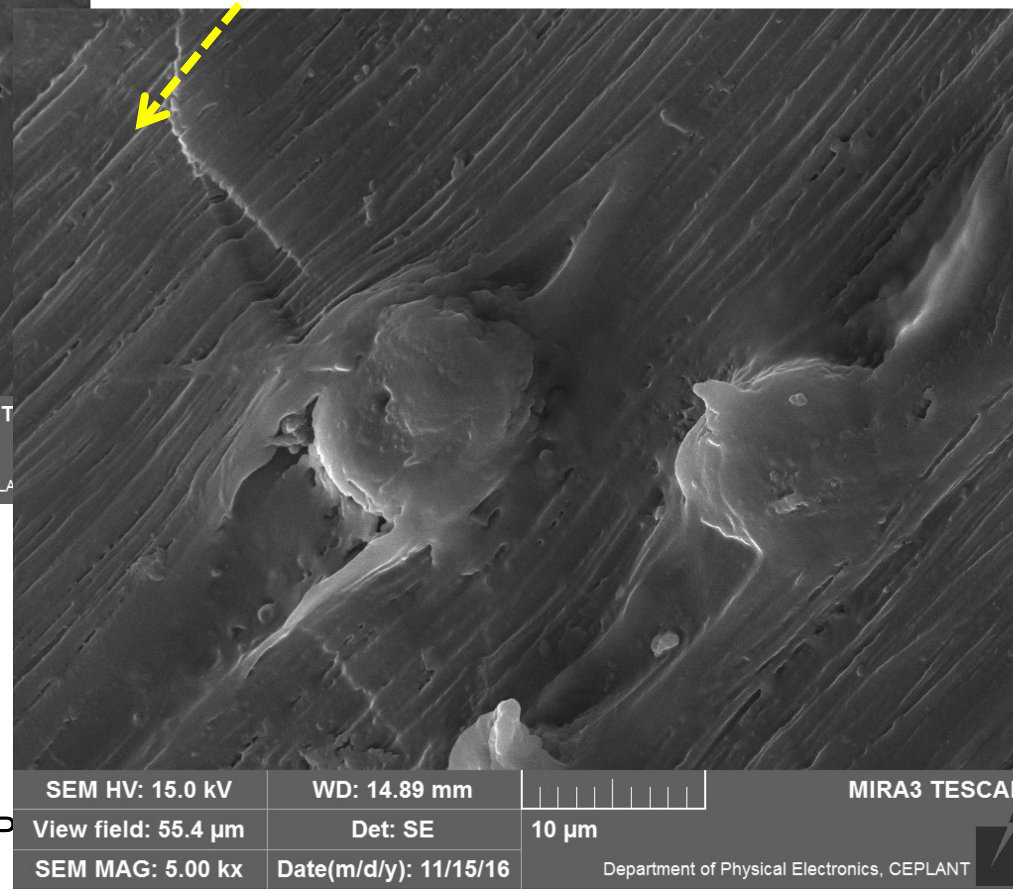


Polypropylene Fibres with Corn Starch 2

FIBRILATION

PP Fibres





THERMOPLASTIC STARCH

- **Processing by Technologies used for the SYNTHETIC THERMOPLASTICS, but very difficult (UP TO NOW)**
- **It is necessary to use so called PLASTICIZERS – usually WATER & GLYCEROL**
- **Products are BIODEGRADABLE**
- **If combined with NATURAL FIBRES (e.g. Flax) > BIODEGRADABLE COMPOSITS**

Ewa Rudnik: Compostable Polymer Materials, ISBN: 978-0-08-045371-2

Journal of Macromolecular Science, Part C ›

Polymer Reviews

Volume 44, 2004 - Issue 3

Original Articles

Biodegradable Multiphase Systems Based on Plasticized Starch: A Review

Luc Avérous

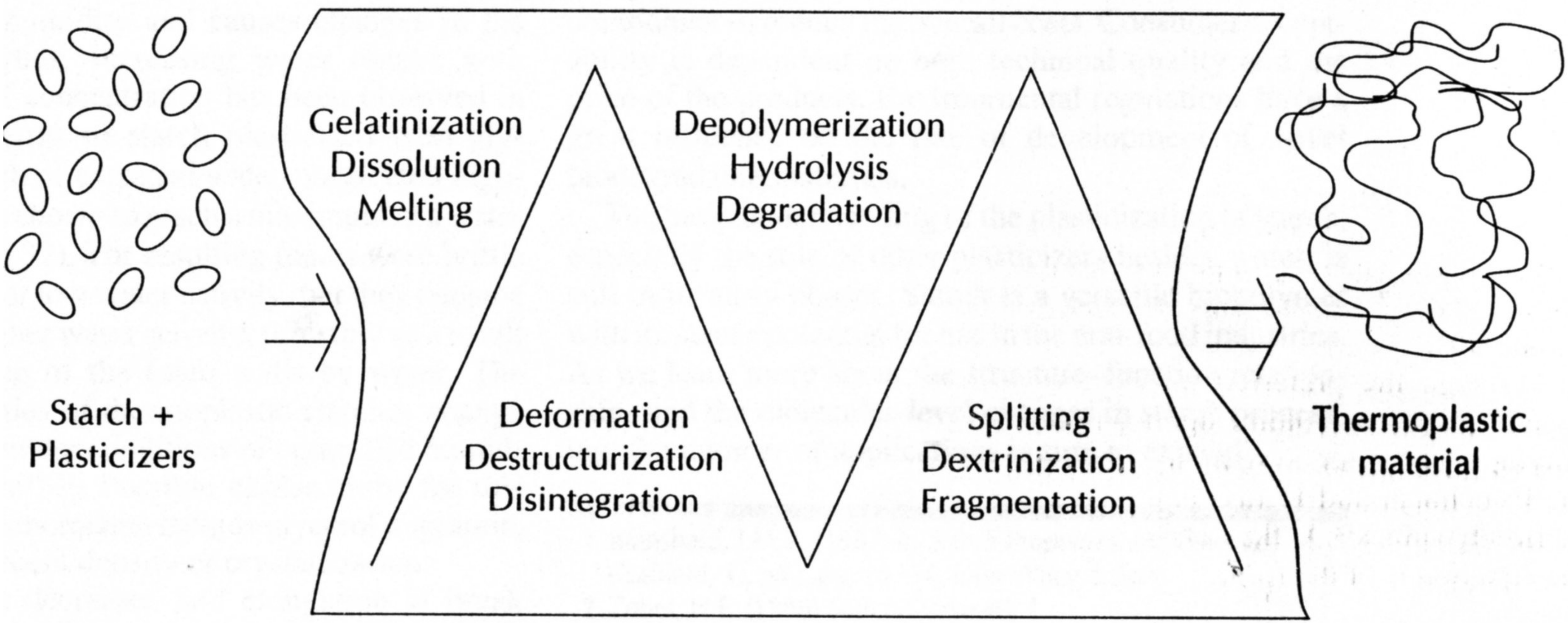
Pages 231-274 | Received 08 Apr 2003, Accepted 12 Feb 2004, Published online: 24 Aug 2007

http://dx.doi.org/10.1081/MC-200029326

Modification of Starch Properties with Plasticizers

K. Poutanen and P. Forssell

PLASTICIZERS – usually WATER & GLYCEROL



AGAR

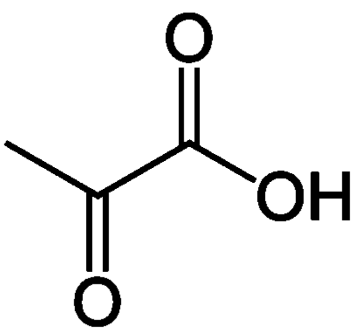
Agar consists of a mixture of agarose and agaropectin.

Agarose, the predominant component of agar, is a linear polymer, made up of the repeating monomeric unit of agarobiose. Agarobiose is a disaccharide made up of D-galactose and 3,6-anhydro-L-galactopyranose. Agaropectin is a heterogeneous mixture of smaller molecules that occur in lesser amounts, and is made up of alternating units of D-galactose and L-galactose heavily modified with acidic side-groups, such as sulfate and pyruvate.

AGAR & Food Industry

- **Clarifying (Fining) of the Wine and Fruit Juice**
- **Thickening of Food**

pyruvic acid



AGAR & Medicine

Bacterial and Mould culture/growth mediu

The other useful POLYSACCHARIDES 1

Plantago ovata, known by many common names including **blond plantain**,[1] **desert Indianwheat**, **blond psyllium**, and **ispaghul**, is a medicinal plant native to Western Asia and Southern Asia. The plant can be found growing wild in the southwestern United States, where it is considered a possibly introduced species.

It is a common source of psyllium, a type of dietary fiber.

Psyllium seed husks are indigestible and are a source of soluble fiber which may be fermented into butyrate – a pharmacologically active short-chain fatty acid – by butyrate-producing bacteria.

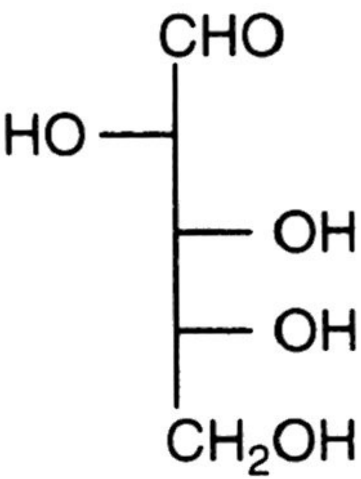
The other useful POLYSACCHARIDES 2A

They are HETEROPLYSACCHARIDES

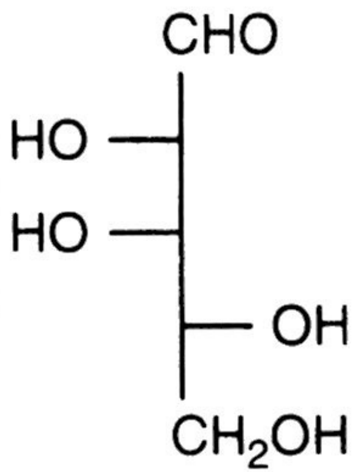
Plant mucilages

HEXOSE

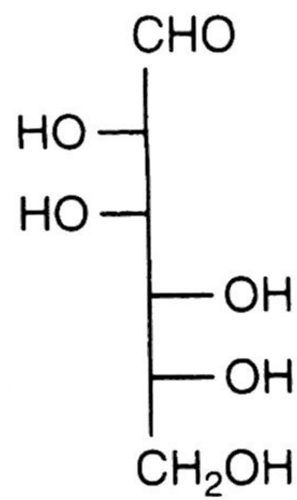
PENTOSE



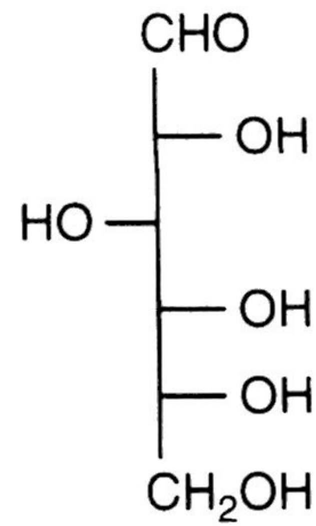
arabinose



lyxose



mannose



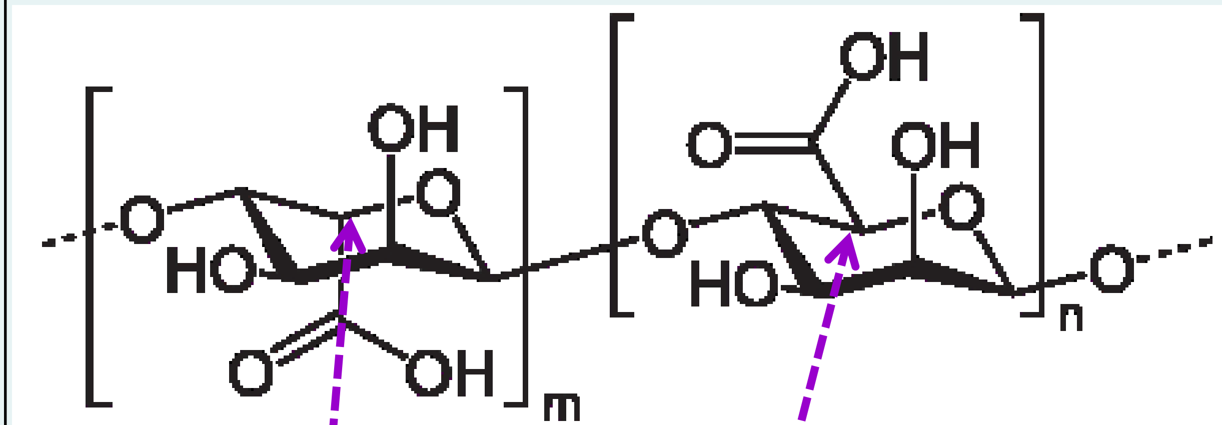
glucose

The other useful POLYSACCHARIDES 2B

Plant mucilages

is made of plant-specific **POLYSACCHARIDES** or long chains of sugar molecules.This polysaccharide secretion of **root exudate** forms a gelatinous substance that sticks to the caps of roots. Root mucilage is known to play a role in forming relationships with soil-dwelling life forms. Just how this root mucilage is secreted is debated, but there is growing evidence that mucilage derives from ruptured cells. As roots penetrate through the soil, many of the cells surrounding the caps of roots are continually shed and replaced. These ruptured or lysed cells release their component parts, which include the polysaccharides that form root mucilage. These polysaccharides come from the Golgi apparatus and plant cell wall, which are rich in plant-specific polysaccharides. Unlike animal cells, plant cells have a cell wall that acts as a barrier surrounding the cell providing strength, which supports plants just like a skeleton.

They are HETEROPLYSACCHARIDES

Building Unit	Structure Unit
L-gulopyranuronic acid	

Molar mass

10,000 – 600,000

ALGINATE

Alginic acid is a linear copolymer with homopolymeric blocks of (1-4)-linked β-D-mannuronate (M) and its C-5 epimer α-L-guluronate (G) residues, respectively, covalently linked together in different sequences or blocks.

Alginate absorbs water quickly, which makes it useful as an additive in dehydrated products such as slimming aids, and in the manufacture of paper and textiles. It is also used for waterproofing and fireproofing fabrics, in the food industry as a thickening agent for drinks, ice cream and cosmetics, and as a gelling agent for jellies.[citation needed]

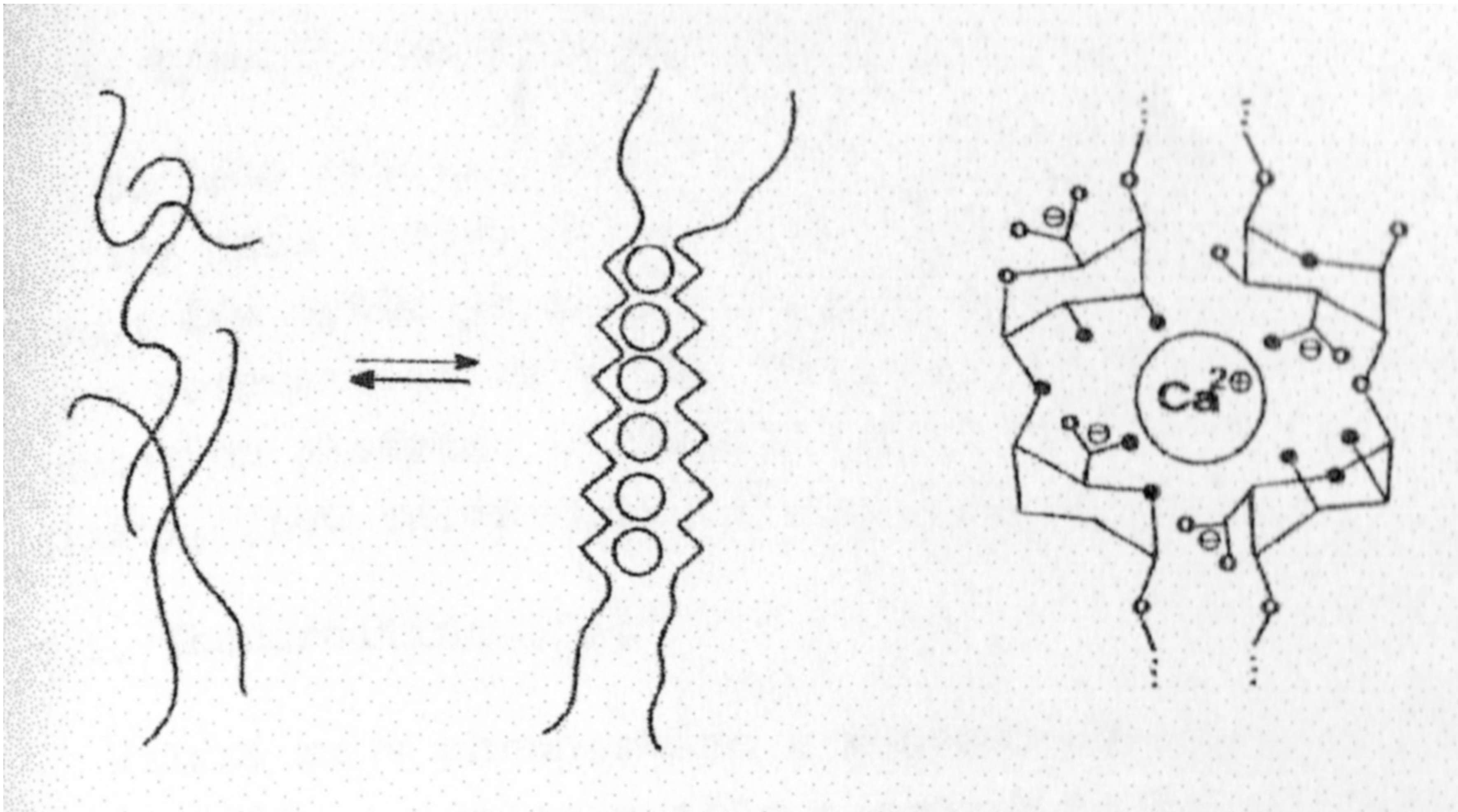
Alginate is used as an ingredient in various pharmaceutical preparations, such as Gaviscon, in which it combines with bicarbonate to inhibit reflux. Sodium alginate is used as an impression-making material in dentistry, prosthetics, lifecasting and for creating positives for small-scale casting.

Sodium alginate is used in reactive dye printing and as a thickener for reactive dyes in textile screen-printing.[citation needed] Alginates do not react with these dyes and wash out easily, unlike starch-based thickeners.

As a material for micro-encapsulation.[7]

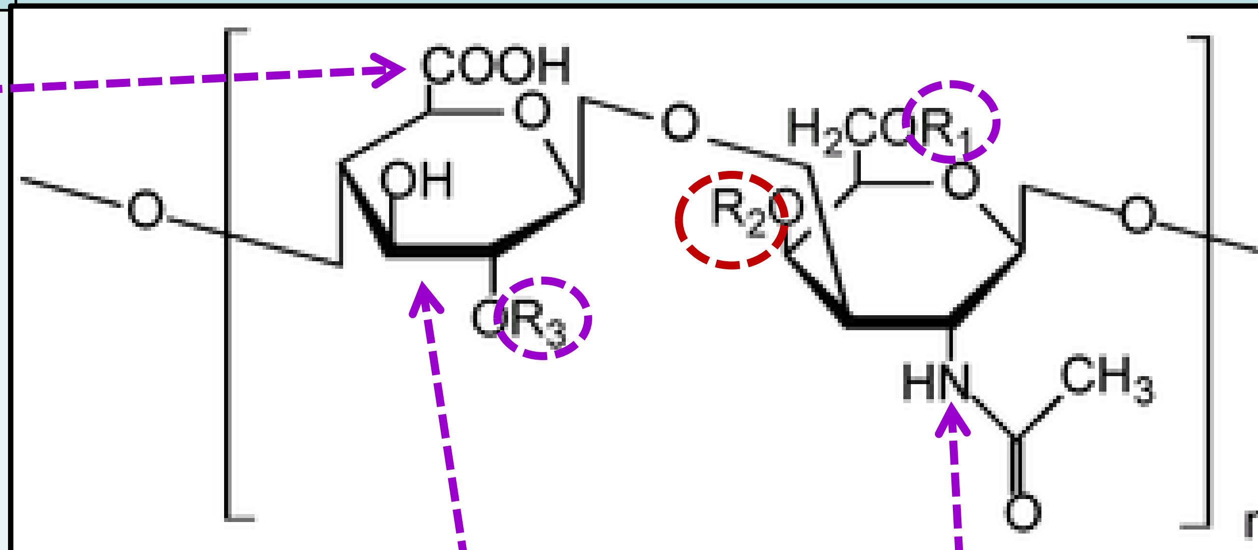
Calcium alginate is used in different types of medical products including skin wound dressings to promote healing[8] and can be removed with less pain than conventional dressings.[

Complex of the Cation Ca^{+2} by Alginate – model „Egg in the Package“



Building Unit	Structure Unit

β–D-glucopyranuric acid



Chondroitin

Chemical structure of one unit in a chondroitin sulfate chain.
Chondroitin-4-sulfate:
R_1 = H; R_2 = SO_3H; R_3 = H. Chondroitin-6-sulfate: R_1 = SO_3H; R_2, R_3 = H.

Chondroitin is a glycosaminoglycan (GAG) composed of a chain of alternating sugars (N-acetylgalactosamine and glucuronic acid). It is usually found attached to proteins as part of a proteoglycan. A chondroitin chain can have over 100 individual sugars, each of which can be sulfated in variable positions and quantities. Chondroitin sulfate is an important structural component of cartilage and provides much of its resistance to compression.[1] Along with glucosamine, chondroitin sulfate has become a widely used dietary supplement for treatment of osteoarthritis.

Chondroitin - Medical use

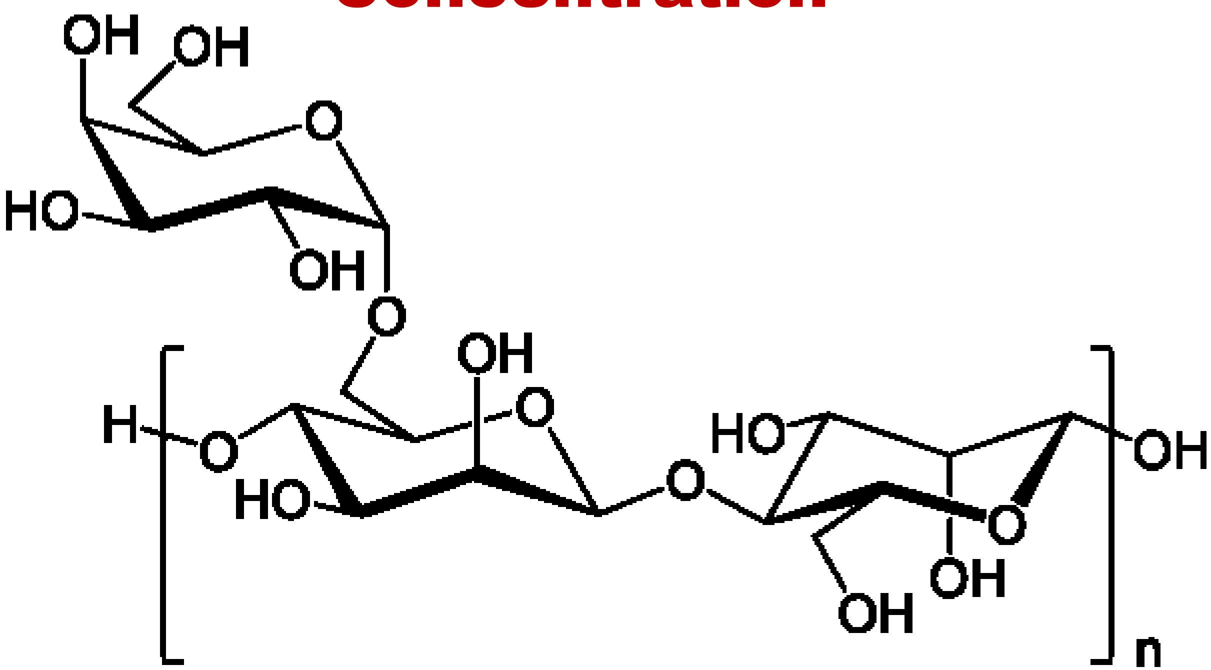
Although chondroitin is used in dietary supplements as an alternative medicine to treat osteoarthritis and also approved and regulated as a symptomatic slow-acting drug for this disease (SYSADOA) in Europe and some other countries, it is technically neither a medicine nor a disease-modifying treatment. See Clinical effects below. It is commonly sold together with glucosamine. Chondroitin and glucosamine are also used in veterinary medicine. Formulated with collagen and wound dressing matrix, one product that uses chondroitin sulfate is the veterinary wound gel Chondroprotec, which is applied over scrapes, burns, and lesions and serves to keep the wound moist and promote healing.

Chondroitin, along with commonly used glucosamine, should not be used to treat patients who have symptomatic osteoarthritis of the knee as evidence shows that these treatments fail to provide relief for that condition.

GUAR GUM - Plant gum

Chemically, **GUAR GUM IS A POLYSACCHARIDE** composed of the sugars galactose and mannose. The backbone is a linear chain of β 1,4-linked mannose residues to which galactose residues are 1,6-linked at every second mannose, forming short sidebranches.

Thickening of Food, because having great influence on the Viscosity Increase, even at very low Concentration



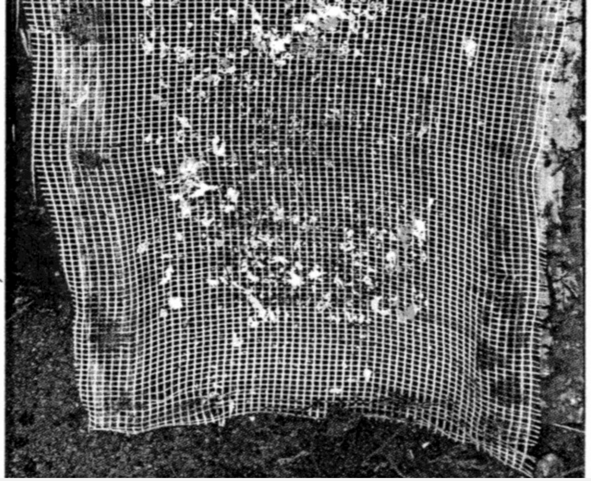
SCIENTIFIC (EXACT) Biodegradability Evaluation of Disposable PLASTIC shopping Bags in Compost

It was done & published by:
Mendel Agriculture and Forestry University in Brno, Faculty of Horticulture

This Article was published in the Czech journal „ODPADY“ (WASTE) last year

„Bio plastics“ shopping Bags tested

Sample	Sample Denomination	Material STATEMENT
1	100 % degradable **shoping Bag KAUFLAND**	HDPE, TDPA – fully degradable plastic Additives
2	**shoping Bag TESCO**	HDPE, PE Pllets + special Additives D_2W
3	Compostable degradable **shoping Bag A**	BIOflex 219 F
4	Compostable degradable **shoping Bag B**	Starch, PCL - polylactone
5	Compostable degradable **shoping Bag C**	Starch, PCL – polycaprolactone, Mater-Bi
6	„BIOBAG“ for dogs Excrements	Starch, PLA
7	Mater-Bi	Bioplastics Mixture, Corn Starch + Additives
8	**shoping Bag COOP**	Oxo-degradable plastic, Fe



Sample 7 (after 12 Weeks)

Almost undestroyed Samples 2, 8 and 1 (after 6 Months)

ODPADY

„Bio plastics" shopping Bags tested

Sample	After 3 Months in the Compost	After 6 Months in the Compost
1	Partly decomposed, approx. 10 %	Partly decomposed, approx. 10 % and Brittle Material
2	Partly decomposed, approx. 10 %	Partly decomposed, approx. 10 % and Brittle Material
3	Partly decomposed, approx. 10 %, some Cracks	Partly decomposed, approx. 50 %
4	Partly decomposed, approx. 30 %	**Decomposed, 100 %, all Materials are Starch based**
5	**Decomposed, 100 %**	
6	**Decomposed, 100 %**	
7	**Decomposed, 100 %**	
8	Partly decomposed, approx. 5 %	Partly decomposed, approx. 10 % and Brittle Material