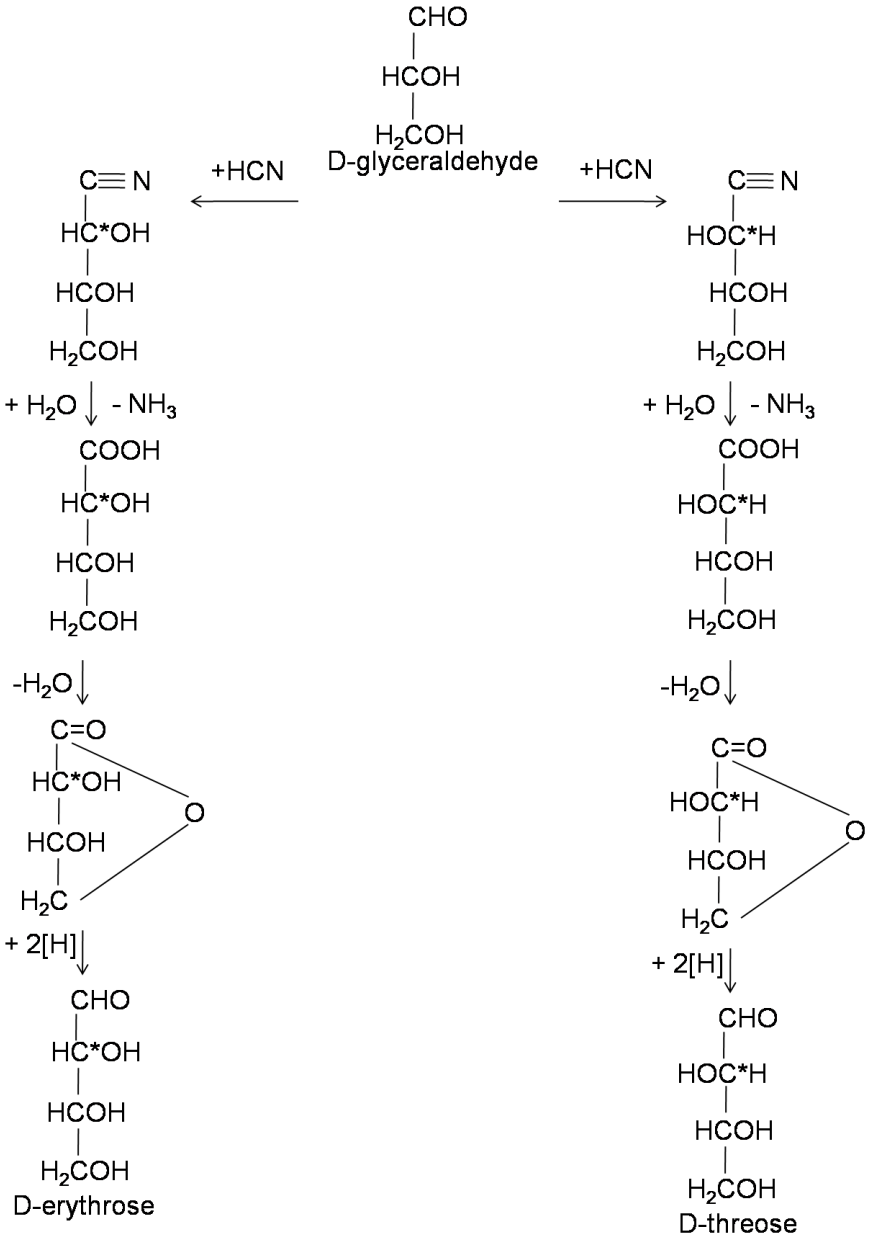
Carbohydrates

CHE 2112



CHE 2112 2022 USE ONLY REFs

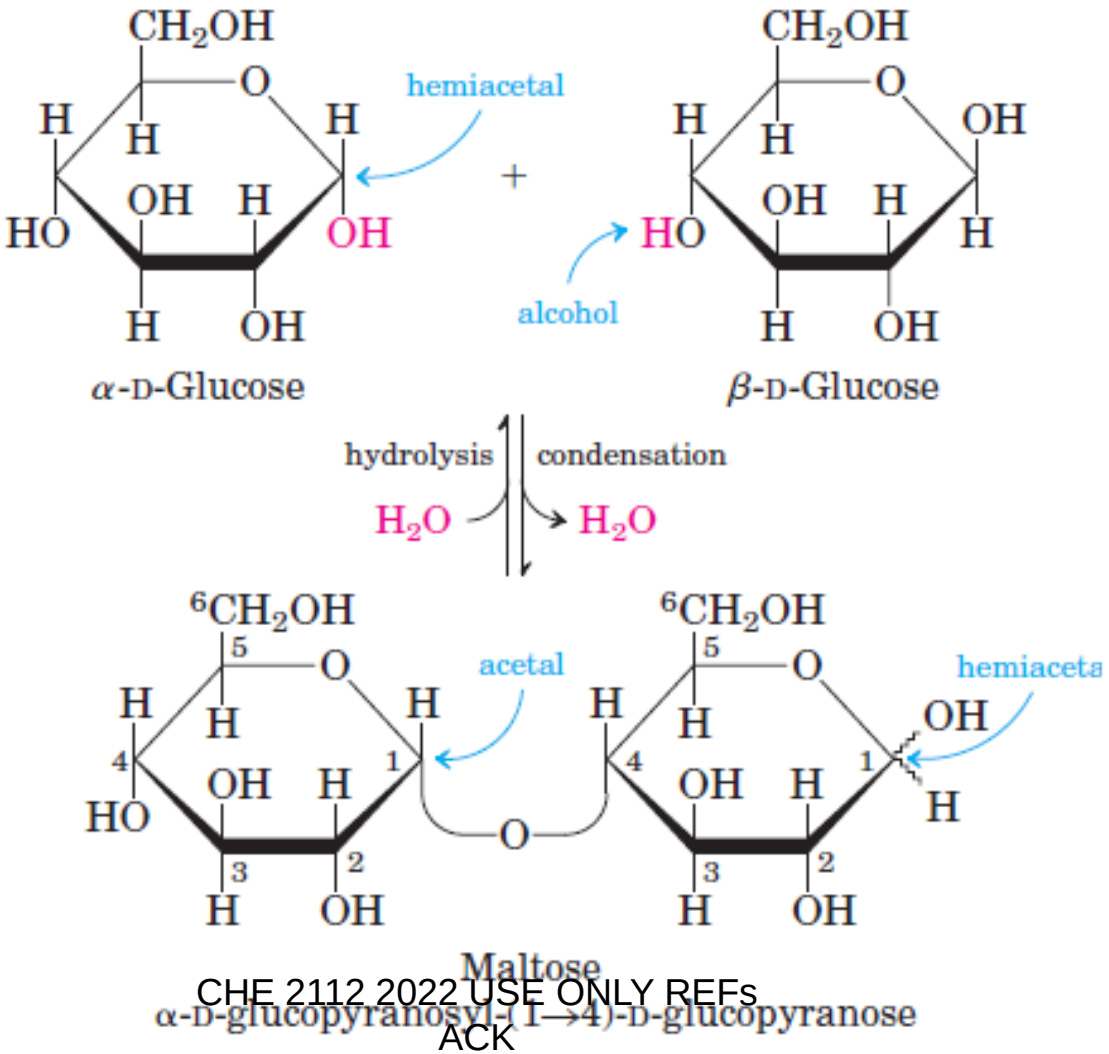
ACK

Disaccharides

- Most common among oligosaccharides
- Sugars made up of 2 monosaccharides joined by a glycosidic linkage.
- Three abundant disaccharides - sucrose, lactose and maltose

Maltose

- Derived from starch, germinating cereals and malt.
- Made up of 2 glucose molecules joined by α-1, 4 glycosidc linkage

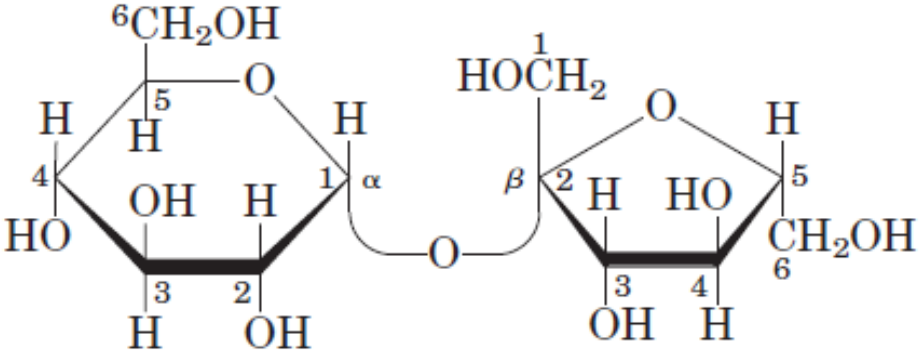


Abequose	Abe
Arabinose	Ara
Fructose	Fru
Fucose	Fuc
Galactose	Gal
Glucose	Glc
Mannose	Man
Rhamnose	Rha
Ribose	Rib
Xylose	Xyl

- Hydrolysed to 2 glucose molecules by maltase found on the outer surface of epithelial cells lining the small intestines.
- It is a reducing sugar

Sucrose

- Found in Cane and beet sugar, sorghum, pineapple and carrot roots
- Made up of α – D-glucose and β –D- fructose
- The two are joined through their anomeric carbon atoms



Sucrose

α-D-glucopyranosyl β-D-fructofuranoside

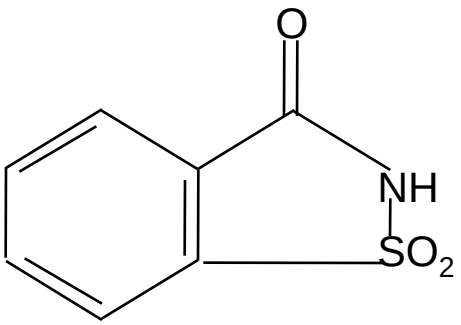
Glc(α1↔2β)Fru

- The aldehyde or ketone group is utilised in the formation of α 1 – 2 glycosidic linkage.
- Absence of anomeric carbon makes sucrose fail to reduce alkaline cupper sulphate, hence it is called a non reducing sugar
- It is hydrolysed to its constituent monosaccharides by sucrase found in the intestinal mucosal cells
- Sucrase is also called invertase because it converts the initial substrate dextrorotatory sucrose to glucose which is dextrorotatory and fructose which is levorotatory

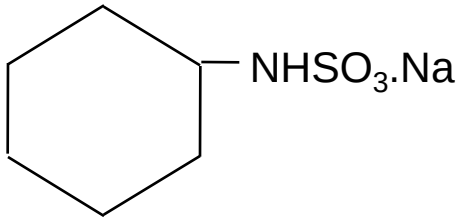
- Sucrase is also called invertase because it converts the initial substrate dextrorotatory sucrose to glucose which is dextrorotatory and fructose which is levorotatory
- Levorotatory fructose predominates and hence changes or inverts the dextrorotatory sucrose to levorotatory.
- Action of sucrase on sucrose results in a mixture of glucose and fructose (or called invert sugar)
- Sweetest of the three common sugars but less so of artificial sweeteners

ARTIFICIAL SWEETENERS

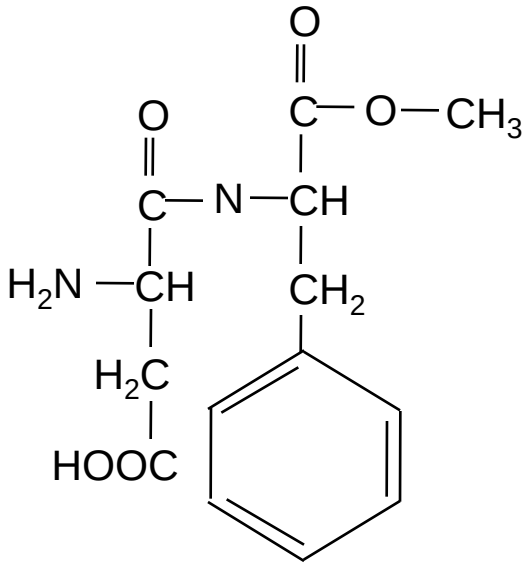
- Are molecules/cpds of different types that stimulate tongue taste buds stimulated by sugars but are of no food value



Sacharin



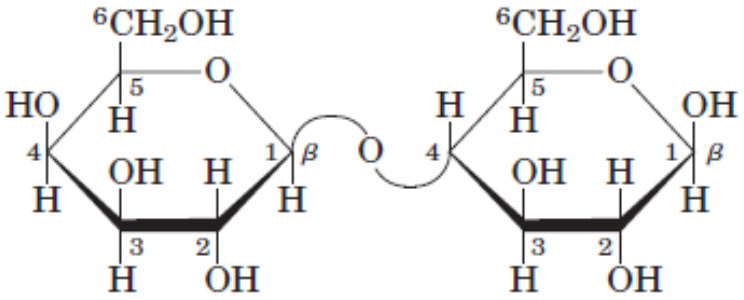
Sucaryl sodium



Aspartame

Sugar/Sweetener	Relative Sweetness
Sugars	
Lactose	0.16
D-Galactose	0.32
Maltose	0.32
D-Xylose	0.40
D-Glucose	0.74
Sucrose	*1.00*
Invert sugar	*1.23*
D-Fructose	1.73
Sweetener	
Sucaryl sodium	30
Aspartame	180
Saccharine	400
Monellin	2000

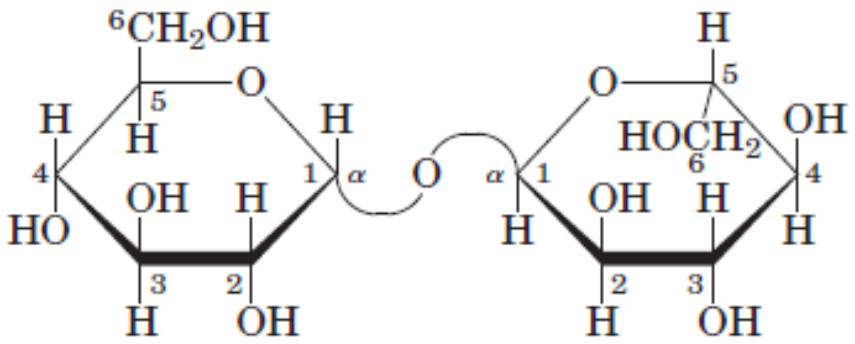
Lactose



Lactose (β form)
β-D-galactopyranosyl-(1→4)-β-D-glucopyranose
Gal(β1→4)Glc

- Found in milk, may occur in urine during pregnancy
- Made up of galactose and glucose joined β -1, 4- glycosidic linkage
- Hydrolysed by lactase found in outer surface of epithelial cells of intestines
- Is a reducing sugar because it has a free anomeric carbon, which would form an aldehyde in a basic solution and is able to reduce alkaline cupper sulphate
- Forms osazones

- Trehalose
- Occurs in yeast, fungi & major component of insect circulating fluid (hemolymph)
- Made up of two α-D-glucose through 1 → 1 glycosidic linkage



Trehalose
α-D-glucopyranosyl α-D-glucopyranoside
Glc(α1↔1α)Glc

- Acid (HCl) hydrolysis yields 2 glucose units
- Non reducing sugar & does not form osazones

Polysaccharides

- Made up of more than 10 monosaccharide (2 – 10 called oligosaccharides).

a. Homopolysaccharides contain only type of monomeric unit, e.g. starch and glycogen.

b. heteropolysaccharides contain two or more different types of monomeric units, e.g. Hyaluronic acid.

Starch

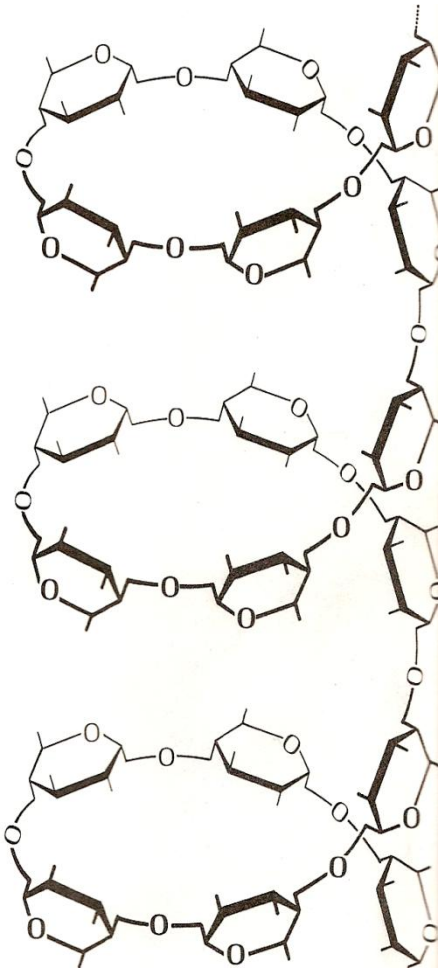
Sources

- Cereals, legumes, potatoes and other vegetables.
- Starch occurs in two types

1**. Amylose** (15 – 20 %)

- Consists of long unbranched chains with all D – glucose units linked through α (1 – 4) glycosidic linkages.
- Chains vary in molecular weights from a few thousands to 500 000.

- Occurs in helical structures which are not truly water soluble but form micelles which are responsible for the blue/purple colour when reacted with iodine.
- Major components of starch can hydrolysed into two different ways

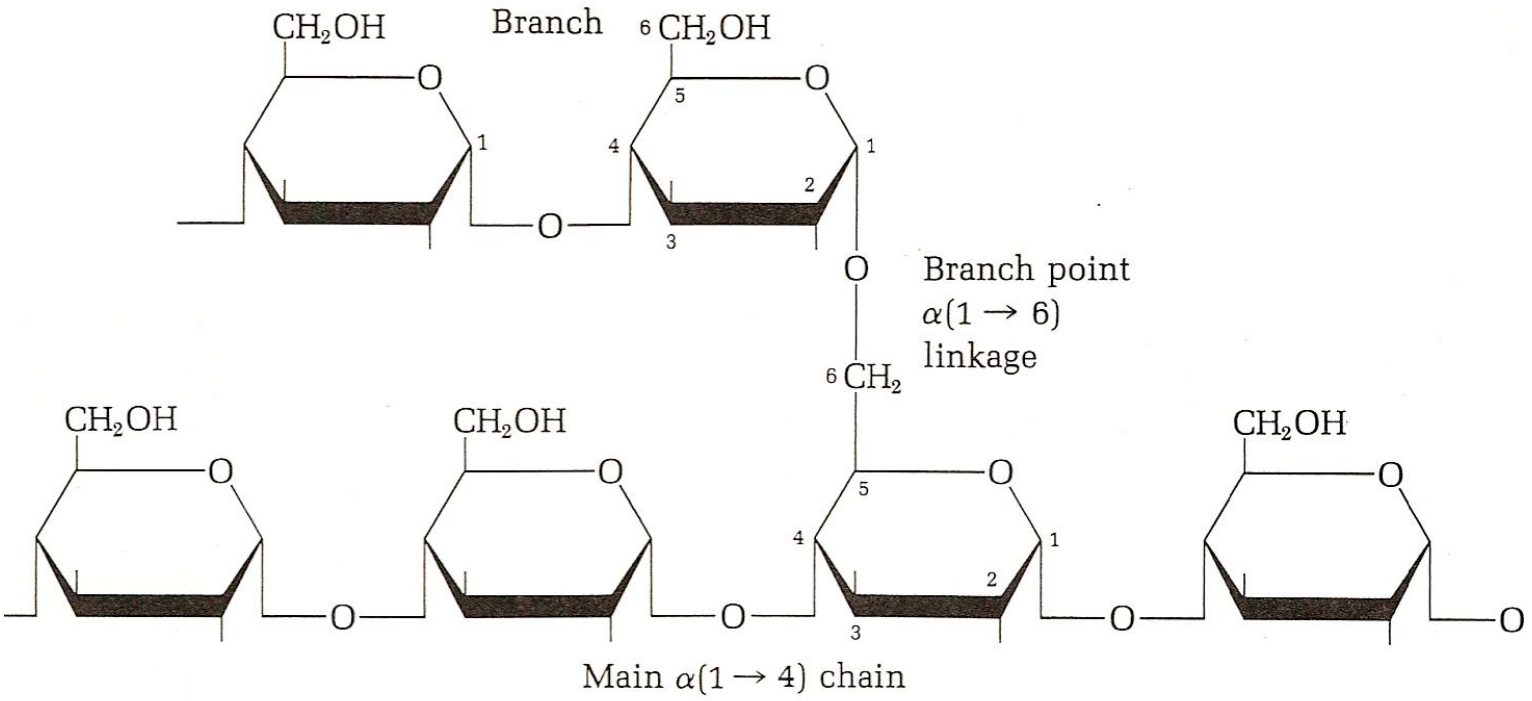


Helical structure of Amylose

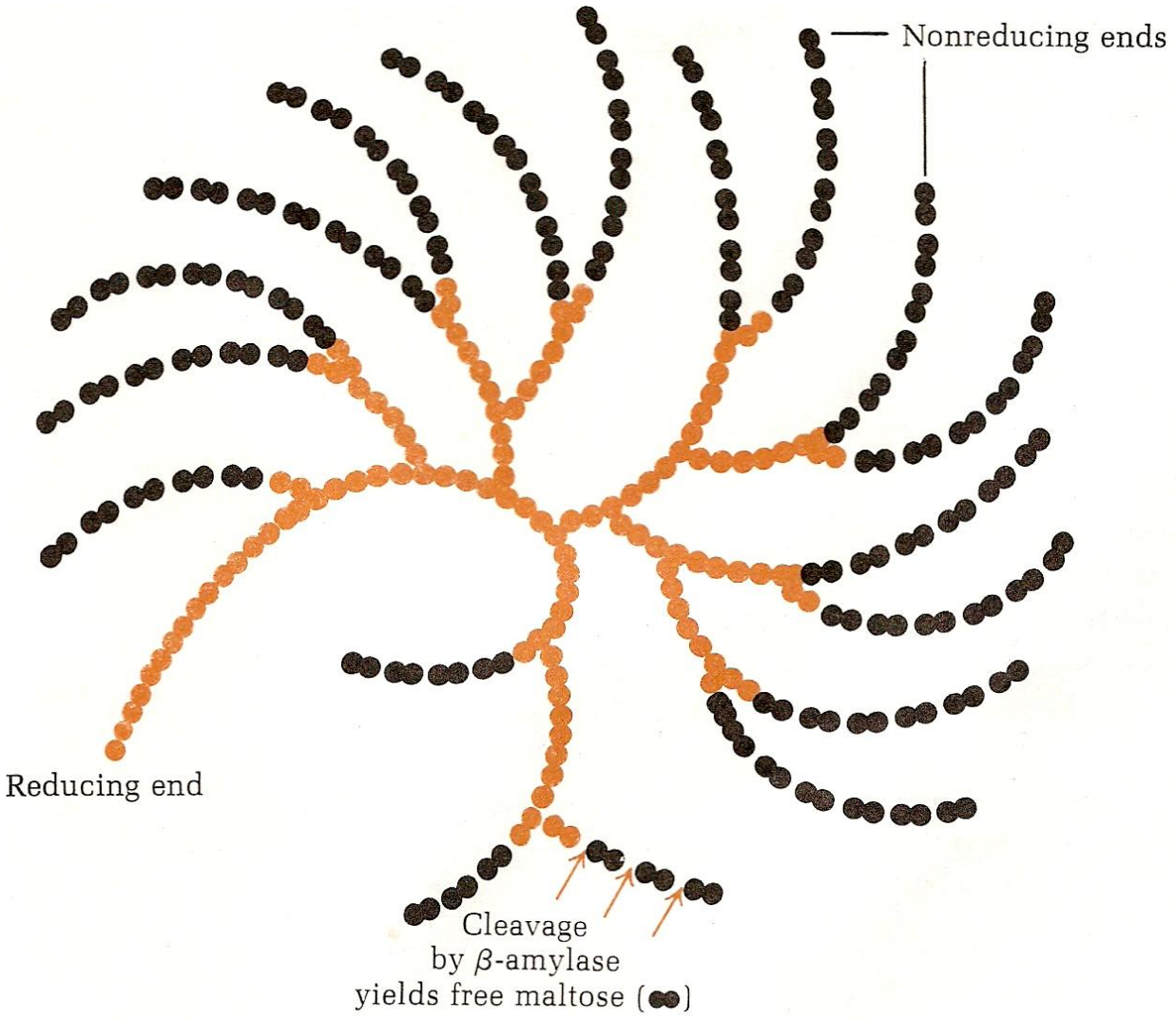
- a. Amylose can hydrolysed by α – amylase [α (1-4)-glucan 4-glucanohydrolase] present in saliva and pancreatic juice and takes part in the hydrolysis of starch in the GIT.
- α – amylase cleaves the α (1-4) linkages at random to yield a mixture of glucose and free maltose only.
- b. Amylose also hydrolysed by β – amylase [α (1-4)-glucan 4-maltohydrolase] which occurs in malt
- It cleave successive maltose from the reducing end and quantitatively.

Amylopectin

- Highly branched
- Branches have an average length of about 24 to 30 glucose residues and this is dependent on species.
- Glucose residues forming the backbone are linked through α (1-4) glycosidic linkages.
- Branch points are through α (1-6) glycosidic linkages


Branch
Branch point
α(1 → 6)
linkage
Main α(1 → 4) chain

- Exhaustive end product resulting from the action of β – amylase on starch is a highly branched core called LIMIT DEXTRINS.
- Called limit dextrin because it represents the limit of action of β – amylase on starch, as β – amylase is unable to hydrolyse α (1-6) glycosidic linkages.
- α (1- 6)-glucosidase [α (1- 6)-glucan 6-glucanohydrolase] is a debranching enzyme that is able to hydrolyse the α (1-6) glycosidic linkages at branch points.
- Therefore, amylopectin can be hydrolysed to maltose and glucose through the combined action of β – amylase and α (1- 6)-glucosidase.



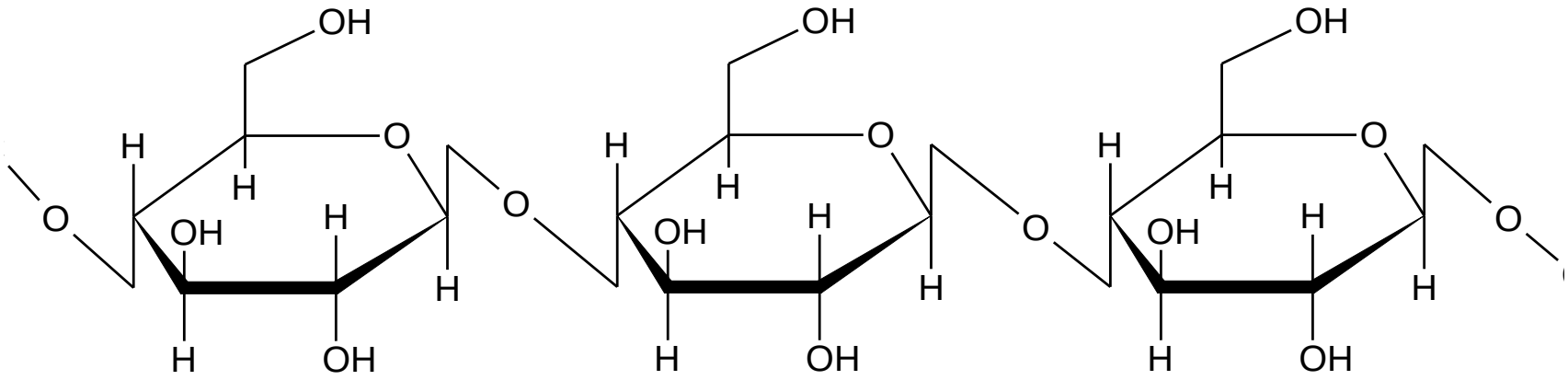
CHE 2112 2022 USE ONLY REFs
ACK

Glycogen

- Stored in animal muscle and liver especially where it may occur up to 70 % of the wet weight.
- Made up of glucose moieties that are linked through α (1-4) glycosidic linkages.
- A compact and highly branched molecule
- Branches occur every 8 to 12 glucose residues.
- Branches increases the solubility of glycogen and create large numbers of terminal residues (sites of action of phosphorylase and synthase, hence increases rate of synthesis and degradation of glycogen
- Branches occur through α (1-6) glycosidic linkages.
- Hydrolysed by α-amylase into glucose
- β – amylase hydrolyses it into maltose and its action result in limit dextrins.
- Gives a red-violet colour with iodine.

Cellulose

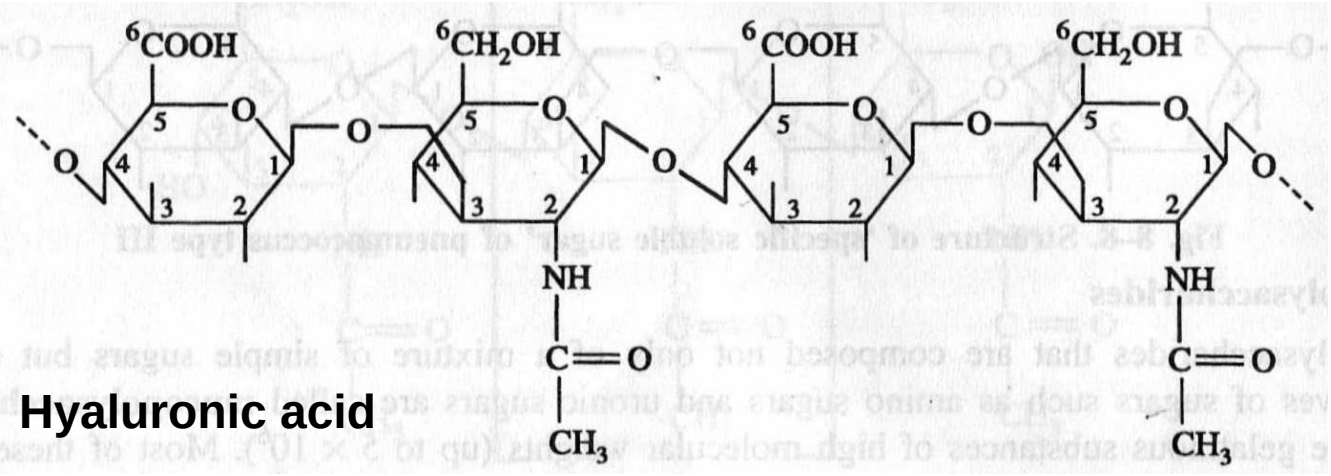
- Most abundant extra cellular polysaccharides
- A linear molecule of β D-glucose which are joined through β (1-4) linkages
- Contains about 1250 – 12500 glucose residues per molecule of cellulose



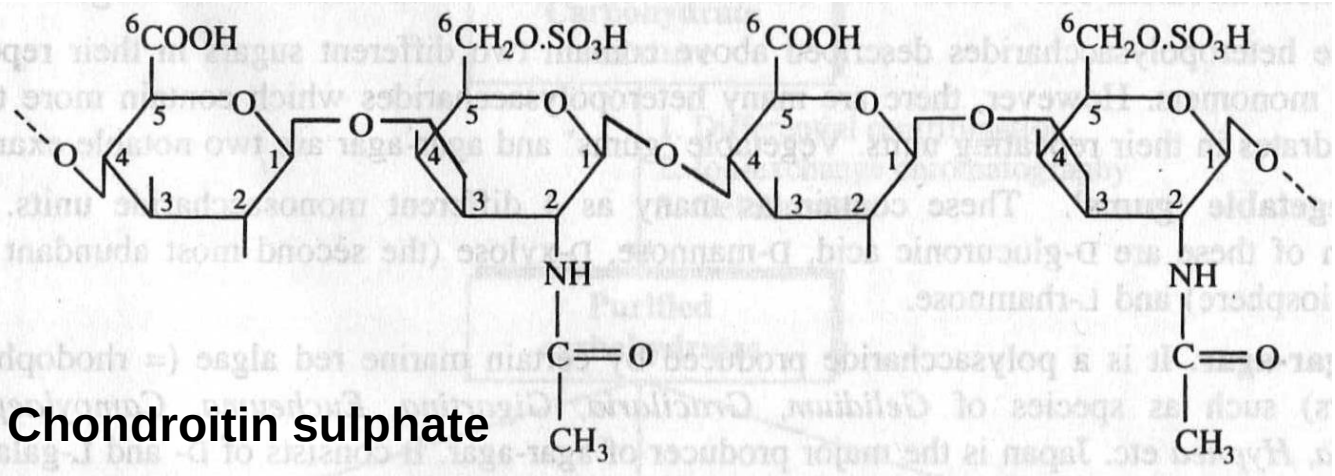
- Cellulose can not be hydrolysed by α – amylase and β – amylase, hence can not be hydrolysed by mammals.
- Ruminants e.g. cows can utilise cellulose for energy generation because the bacteria in their rumen posses cellulase which hydrolyses cellulose to glucose

Heteropolysaccharides

Heteropolysaccharide	**Constituents**	**Linkage between 2 monosaccharide of disaccharide units**	**Linkage between repeating unit**
Hyaluronic acid	D-glucuronic acid and N-Acetyl-D-glucosamine	β (1-3)	β (1-4)
Chondroitin	D-glucuronic acid and N-Acetyl-D-galactosamine	β (1-3)	β (1-4)



Hyaluronic acid



Chondroitin sulphate

Structures and Roles of Some Polysaccharides

Polymer	*Type**	*Repeating unit*†	*Size (number of monosaccharide units)*	*Roles/significance*
Starch				Energy storage: in plants
Amylose	Homo-	(α1→4)Glc, linear	50–5,000	
Amylopectin	Homo-	(α1→4)Glc, with (α1→6)Glc branches every 24–30 residues	Up to 10^6	
Glycogen	Homo-	(α1→4)Glc, with (α1→6)Glc branches every 8–12 residues	Up to 50,000	Energy storage: in bacteria and animal cells
Cellulose	Homo-	(β1→4)Glc	Up to 15,000	Structural: in plants, gives rigidity and strength to cell walls
Chitin	Homo-	(β1→4)GlcNAc	Very large	Structural: in insects, spiders, crustaceans, gives rigidity and strength to exoskeletons
Dextran	Homo-	(α1→6)Glc, with (α1→3) branches	Wide range	Structural: in bacteria, extracellular adhesive
Peptidoglycan	Hetero-; peptides attached	4)Mur2Ac(β1→4) GlcNAc(β1	Very large	Structural: in bacteria, gives rigidity and strength to cell envelope
Agarose	Hetero-	3)D-Gal(β1→4)3,6-anhydro-L-Gal(α1	1,000	Structural: in algae, cell wall material
Hyaluronate (a glycosamino-glycan)	Hetero-; acidic	4)GlcA(β1→3) GlcNAc(β1	Up to 100,000	Structural: in vertebrates, extracellular matrix of skin and connective tissue; viscosity and lubrication in joints