

Carbohydrates

☆ Consist of 1 or more sugars \rightarrow Carbonyl + poly Hydroxyl

☆ They can be classified according to:

1) Number of sugars

Mono, di, oligo, polysaccharide

2) Position of carbonyl

Aldose, ketose
 \rightarrow peripheral \rightarrow within the chain

3) Number of Carbons

Triose, Tetrose, pentose, Hexose, ...

\rightarrow 3C \rightarrow the simplest

Aldose

Ketose

Triose glyceraldehyde dihydroxyacetone

Pentose Ribose, Xylose Xylulose

Hexose
 Mannose 2,3 Fructose \rightarrow sweetest
 Galactose 3,4 Sorbose

Glucose \rightarrow

Essential energy source, blood sugar

more common \rightarrow

☆ Sugars can exist in both linear or ring forms

Rings \rightarrow have ether, they are hemiketals or hemiacetal
 \rightarrow Furanose \rightarrow 5 membered ring, Pyranose \rightarrow 6 membered ring

Isomerism

Isomers \rightarrow same molecular formula but different structure and arrangement

Number of isomer = 2^n \rightarrow number of chiral C

Chiral \rightarrow 4 different groups, No double bonds (The first, last carbons and Carbonyl \rightarrow Achiral)

all of them are non-superimposable

Constitutional isomers } Stereoisomers \rightarrow Enantiomers \rightarrow all chiral carbons are rotated
 different C=O position } different 3D orientation
 (aldose, ketose) } (Right, left)
 \downarrow \downarrow
 down up

Anomers \rightarrow different orientation on the anomeric C
 up \rightarrow β , down \rightarrow α
 C of carbonyl

Diastereomers \rightarrow 1 or more chiral C rotated (not all)
 Not mirror image

Epimer \rightarrow only 1 chiral C is rotated
 C1 \rightarrow aldose, C2 \rightarrow ketose

Modified sugars

1) Oxidation (sugar acids)

\rightarrow of anomeric, last C \rightarrow form COOH

Weak agent \rightarrow anomeric \rightarrow -onic acid

Strong agent \rightarrow both \rightarrow -aric acid

Last C \rightarrow Require enzymes \rightarrow -uronic acid

All monosaccharides can be oxidized

\rightarrow ketose \rightarrow converted into enediol (indirect)

\rightarrow Aldose \rightarrow converted into lactone (indirect)

☆ When Vitamin C is oxidized \rightarrow loses its activity
 causes Scurvy

☆ Benedict's test

$Cu^{+2}, NaOH \rightsquigarrow Cu_2O$ precipitate
detect reducing sugars

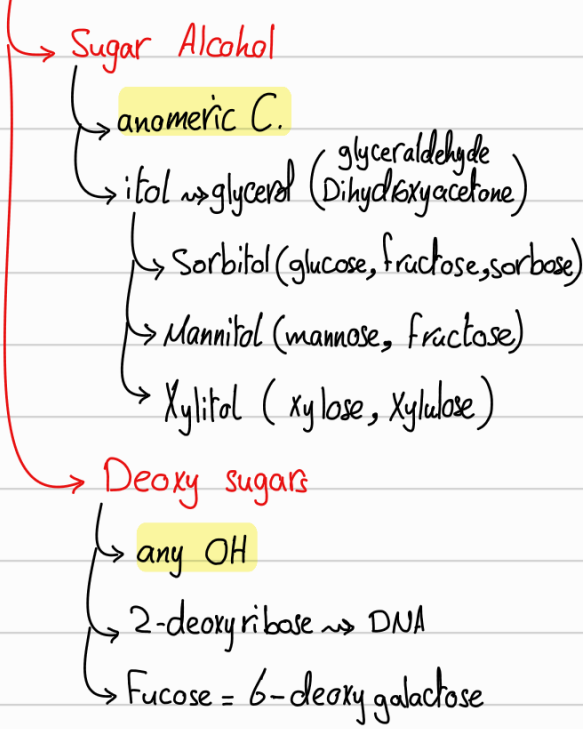
☆ Tollen's test

$Ag(NH_3)_2^+$
detect cyclic Reducing sugars

☆ Blood glucose test

Glucose oxidase

2) Reduction



3) Sugar esters

phosphorylation (add P)
of any C

4) Amino sugars


add NH_2 to any C
except anomeric
☆ It name end -amine
☆ usually followed by acetylation

5) Glycosides

add any group to anomeric
 \rightsquigarrow O-glycoside
 \rightsquigarrow N-glycoside \rightsquigarrow Nucleotide
 \rightsquigarrow C-glycoside \rightsquigarrow Disaccharides

☆ Glycoside can't be converted from Ring to linear

Disaccharides

2 sugars  glycosidic bond
formed by glycosyl transferase

Sucrose

α -Glucose + β -Fructose
1-2
Non-Reducing

Hetero

Lactose

β -Galactose + α -Glucose
1-4
Reducing

Maltose

α -Glucose + α -Glucose
1-4
Reducing

Homo

sucrose \rightsquigarrow artificial sweetener
~~Cl~~ \rightarrow Cl

Lactose = milk sugar
Lactulose \rightsquigarrow isomer of lactose

\rightarrow water absorption from colon
 \rightarrow \uparrow Gut bacteria
 \rightarrow \uparrow short FAs and remove toxic ammonia
 \rightarrow modulate immunity

Lactose intolerance \rightsquigarrow Lactase deficiency \rightsquigarrow Cause bloating and diarrhea

Galactosemia \rightsquigarrow missed galactose metabolizing enzyme \rightsquigarrow swell of brain cells \rightsquigarrow Retardation and cataract

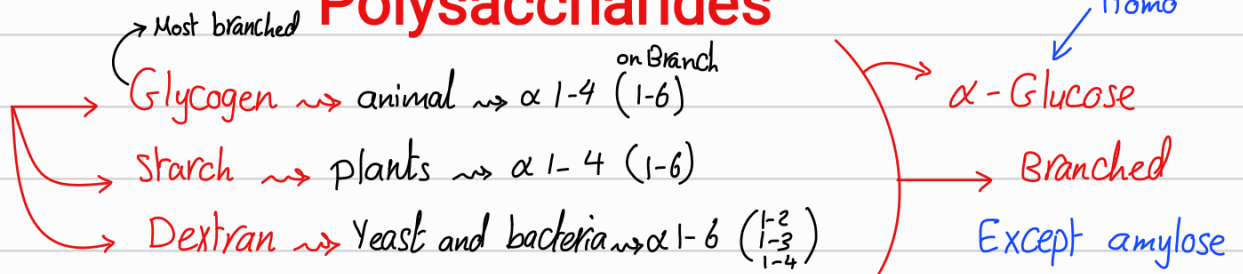
Oligosaccharides

Hetero

Raffinose \rightsquigarrow α -Galactose + α -Glucose + β -Fructose = α -Galactose + Sucrose
 \rightarrow we can't break it \rightsquigarrow we lack α -galactosidase

Polysaccharides

1) Storage



Starch has 2 types: Amylose (unbranched), amylopectin (branched)

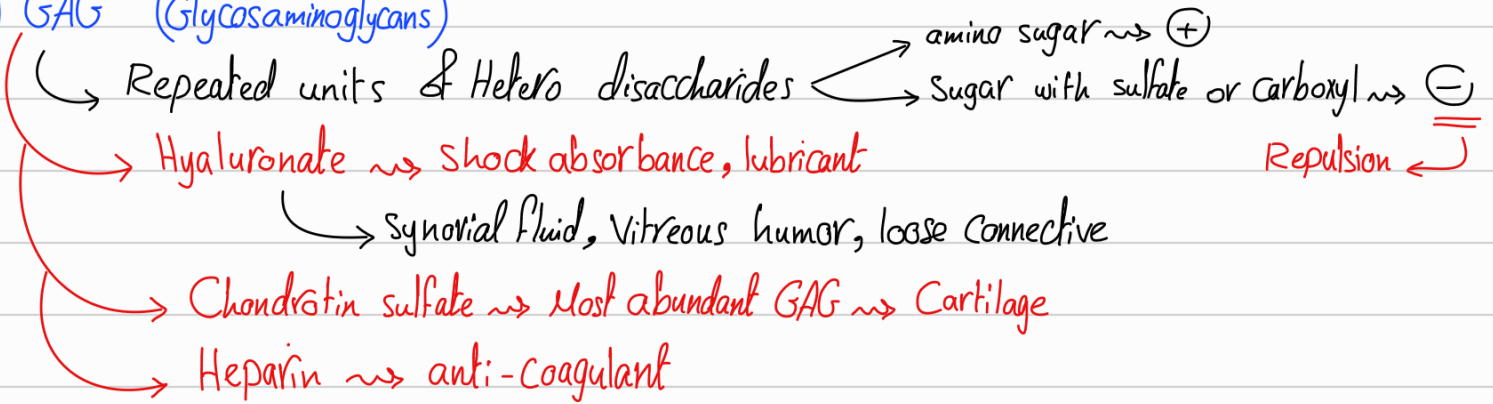
Branching importance \rightarrow \uparrow water soluble + \uparrow access to glucose = \uparrow efficient energy consumption

2) structural:

| Chitin | Cellulose | Pectin |
|--------------------------|------------------------|---------------------------------------|
| N-acety β -glucose | β -glucose | Hetero (α -Galacturonic acid) |
| Animals exoskeleton | Plant | Plant |
| β 1-4 unbranched | β 1-4 unbranched | β 1-4 unbranched |

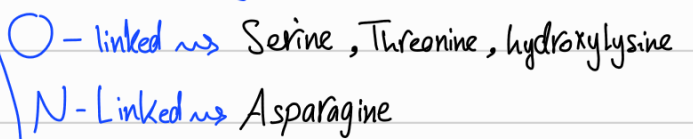
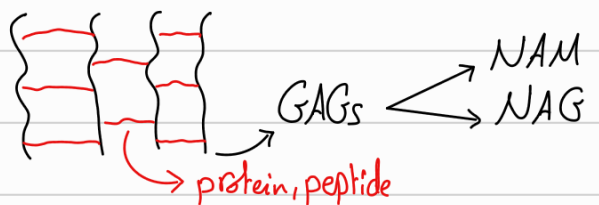
We can Break only α bonds (weaker), but β -bond (stronger, rigid) are not broken in our bodies \rightarrow we don't have β -glycosidase

3) GAG (Glycosaminoglycans)



Proteoglycans & Peptidoglycans

Glycoprotein



Functions: protein folding, targeting, \uparrow half-life
 Signaling and communication

Lubricant, cell adhesion, structural component, stimulate proliferation

Reducing sugars:

Mono \rightarrow all Reducing, Poly \rightarrow all non-Reducing

Di \rightarrow sucrose (Non), Lactose and Maltose (reducing)

Molecular formula:

