Carbohydrates

Summer semester 2023-2024

What are they?

- Carbohydrates are valuable for it function

Carbohydrates are **polyhydroxy aldehydes or ketones.**

Saccharide is another name for a **carbohydrate**

- Saccharide = Carbohydrate
  - the functional group for the sugars either aldehyde or Ketone & they have hydroxyl groups
    - the carboxyl group is the predominant
      - the weakest is the alkane

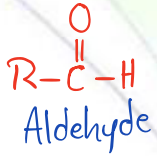
Functions:

↱ it doesn't store energy, but a littel amount of it get stored for long time
↱ it can be degraded easily

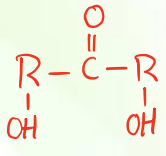
- **Source of energy (glycogen and starch)**
- **Structure (cellulose and chitin)**
  - Cellulose
    Found in tree
  - Chitin
    exoskeleton of animals / insects
    - lobester
- **Building blocks (glycosaminoglycans)** → ex glycoprotein, glycolipids → the sugar Compound has the important function
  - important "found in ECM" in providing Cushion → Shock Absorber
- **Cellular recognition (glycoproteins)**

make larger molecule ← بناء

- هم لتزق الخلية على الخلية الأخرى
- Also if I want to look at the function of the immune system
  it recognize the bacteria by the Sugar group it attached to the surface



Aldehyde

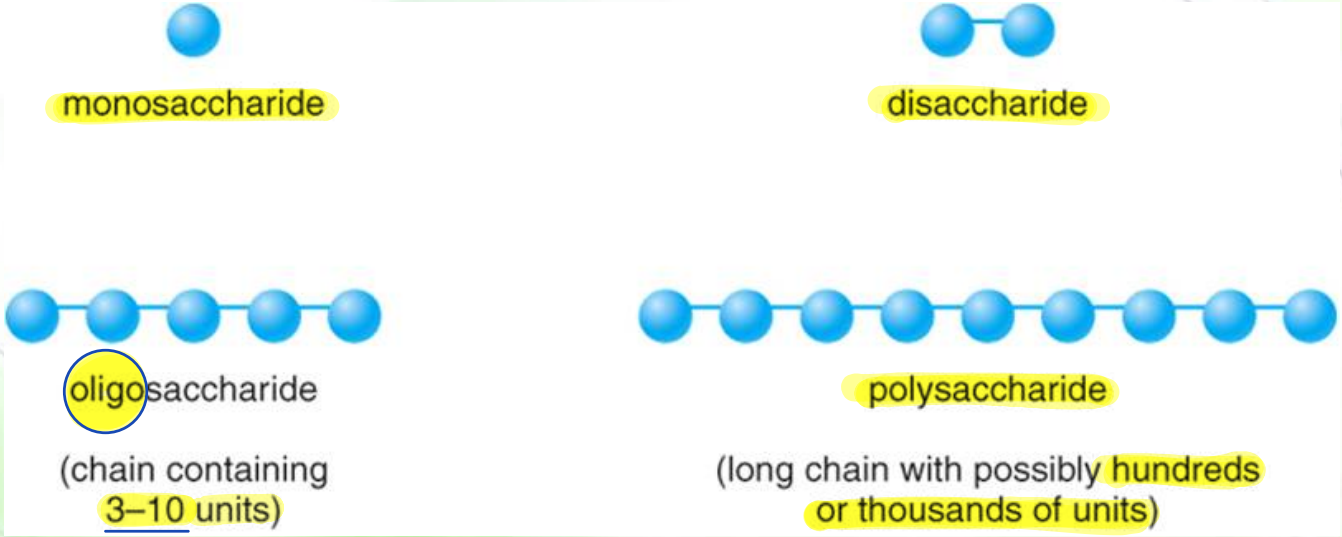


Ketone

Classification I

By the number of sugars that constitute the molecule

Monosaccharides, Disaccharides, Oligosaccharides, Polysaccharides Different classification system "methodology"



Carbohydrates – natural forms

Most carbohydrates are found naturally in bound form rather than as simple sugars.

- **Polysaccharides (starch, cellulose, inulin, gums)**
- **Glycoproteins and proteoglycans (hormones, blood group substances, antibodies)**
  - depends on how much sugar
    - if I have large protein structure & little groups of sugars it called glycoprotein
    - if I have large sugar structure polysaccharide & little group of amino acide – little peptides it called proteoglycan
- **Glycolipids (cerebrosides, gangliosides)**
  - lipids molecule with little sugar molecules
- **Glycosides**
  - Sugar molecule reacted with alcohol molecules
- **Mucopolysaccharides (hyaluronic acid)**
  - Remember Histology:- it's found in Cartilage in the GS → GAGs
- **Nucleic acids (DNA, RNA)**
  - large molecule "EC" out the cell

- Sugar molecule can be a part of a larger structure

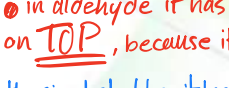
Monosaccharides

- ose prefix refers to sugars
- Sugars can make Stereoisomers
- All sugars are D Sugars (on the right side)

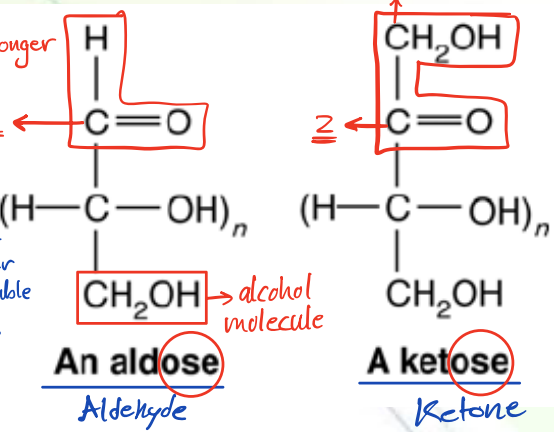
Basic chemical formula: $(CH_2O)_n$

They contain two or more hydroxyl groups.

- in aldehyde it has to be on TOP, because it's stronger
- the simplest aldose it has to be carbons → glyceraldehyde
- Simplest Ketone Dihydroxyacetone

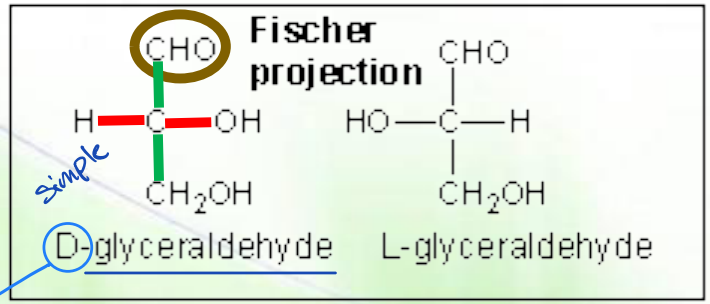


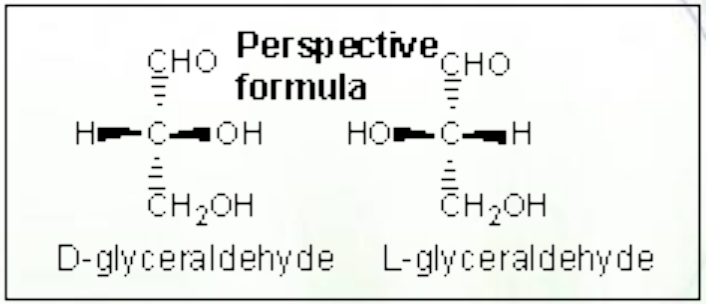
this Ketone can't do isomers since it's achiral, but other Ketone may be able to do Stereoisomers



- in Keton it has to be on TOP also, but carbon no. 2

in 3D ← Fisher projections or perspective structural formulas.





this's right

(L) for left

Forward **Backward**

Top (C1): Most highly oxidized C

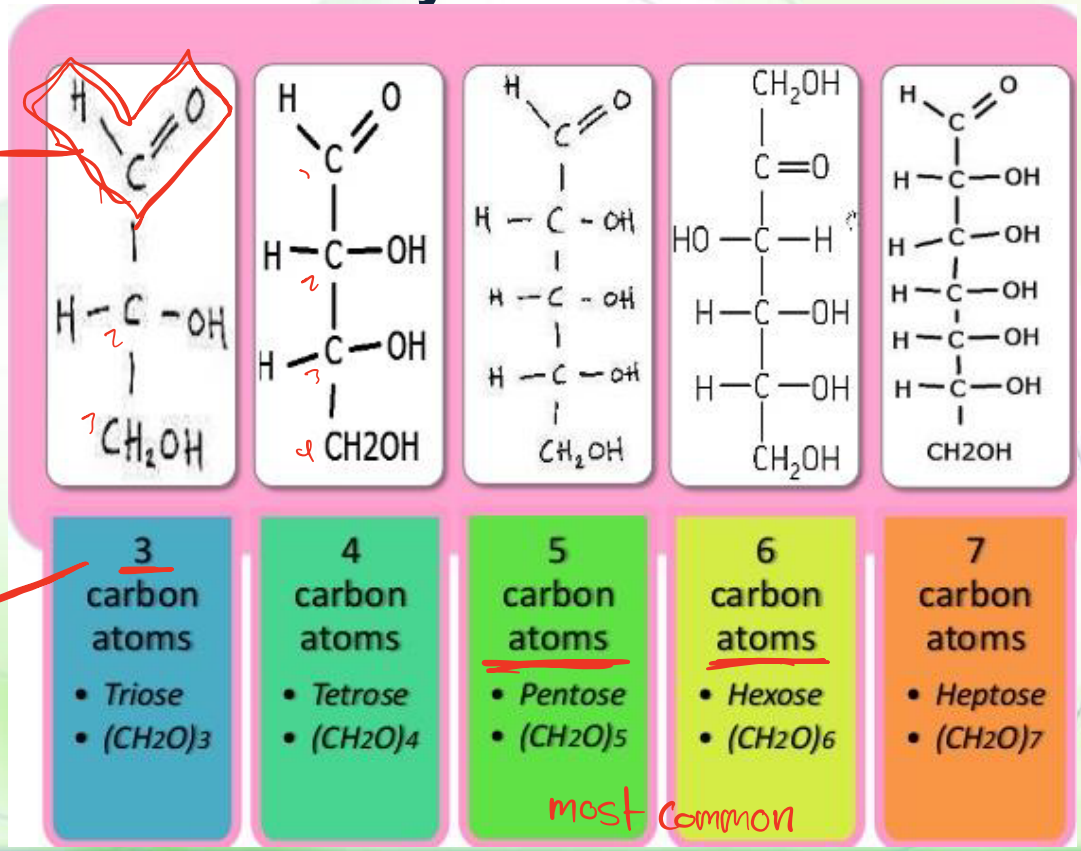
Classification 2

each carbon have OH except carboxyl group

By the number of carbon atoms they contain.

- Triose
- Tetrose
- Pentose
- Hexose
- Heptose
- …

aldehyde on TOP

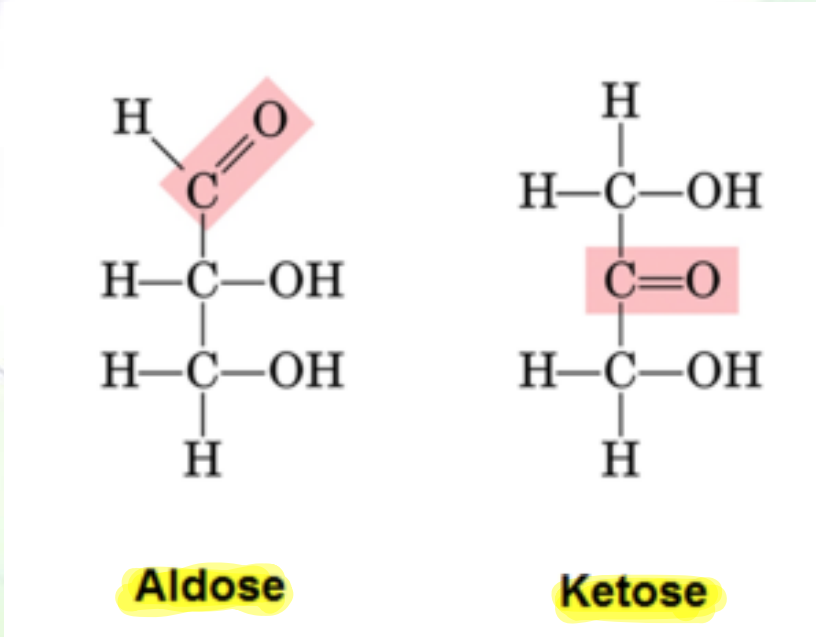


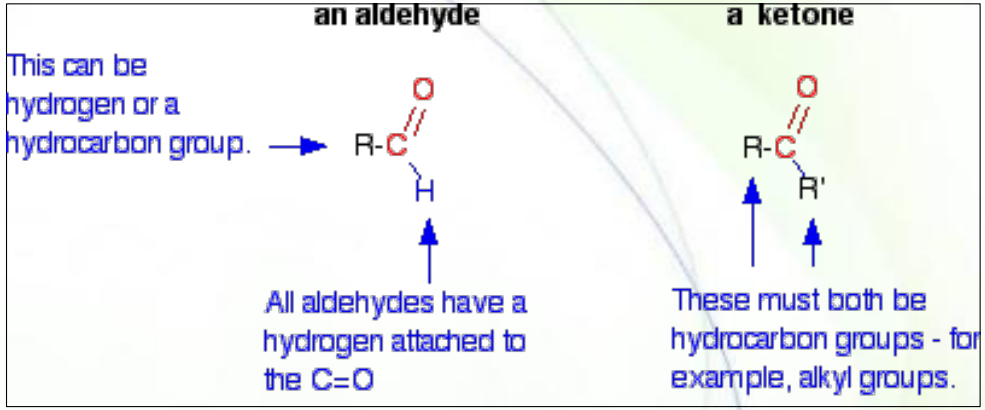
less number in monosaccharide

most common

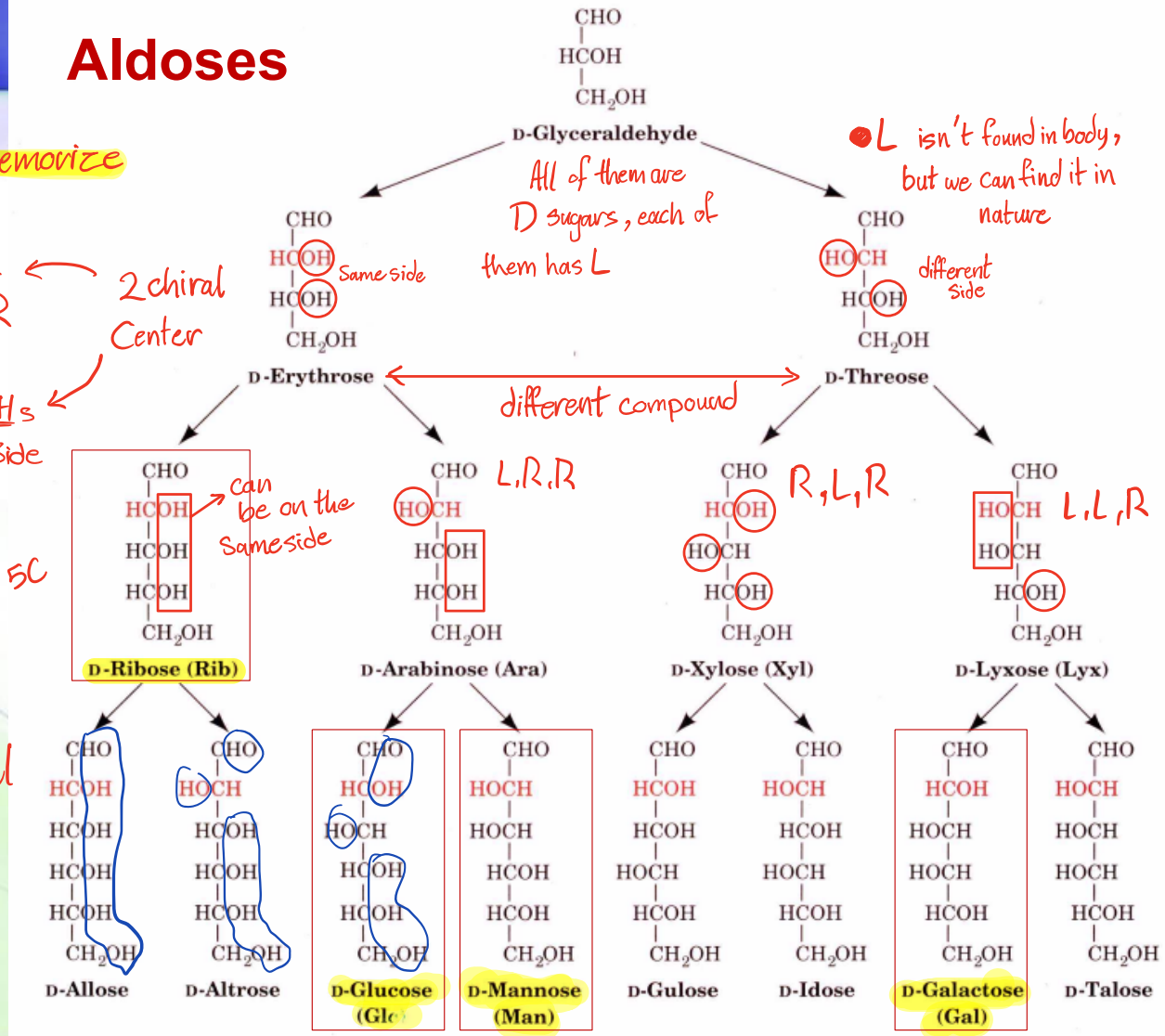
Classification III

By the functional group





Aldoses



- you need to memorize all the red boxes

All of them are D sugars, each of them has L

- L isn't found in body, but we can find it in nature

OH to L
OH to R
← 2 chiral Center

2 OHs on Same Side

Same side

different Side

different compound

5C

can be on the Same side

L,R,R

R,L,R

L,L,R

4 chiral Center

Memorize the ones in boxes.

- more carbo → more chiral center → more opptions "Compound"

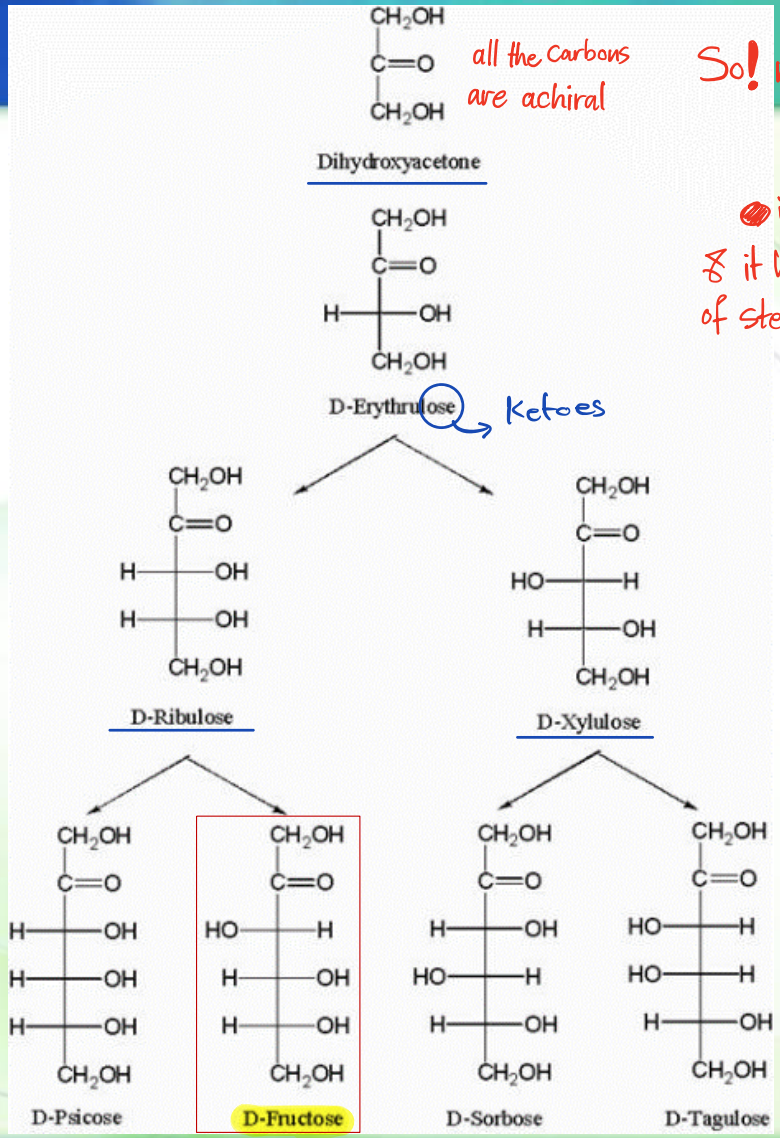
no. C − 2 = chiral Center
↳ on aldoes

Ketoes is different

2^{cc} → chiral center

2^{n}
↳ no. of products

Ketoses



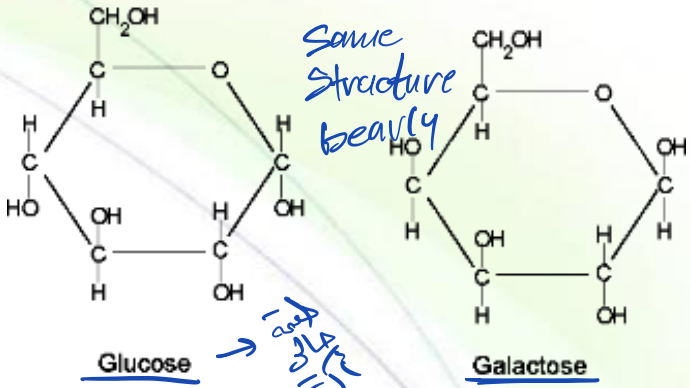
- it's less complex & it has less number of stereoisomers
- Aldoes has more number of molecule

Memorize the ones in boxes.

Common Monosaccharides

Glucose: aldose → Aldohexoses — 6 carbon — Carbonyl → no. 1

- Mild sweet flavor
- Known as blood sugar
- Essential energy source
- Found in every disaccharide and polysaccharide

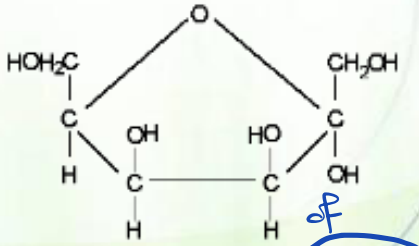


Galactose:

- Hardly tastes sweet & rarely found naturally as a single sugar

Fructose: → Very sweet

- Sweetest sugar, found in fruits and honey
- Added to soft drinks, cereals, desserts

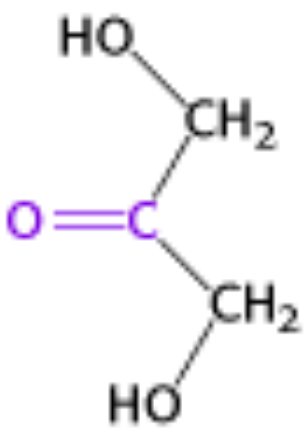


hexose

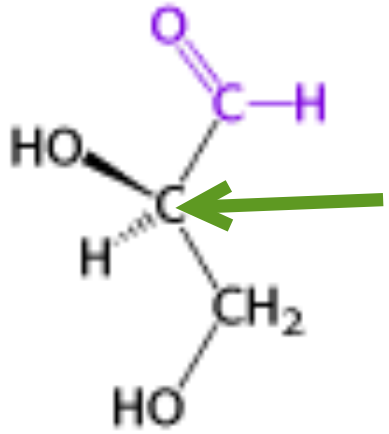
details about the ... don't worrie

Trioses

What is a chiral carbon?



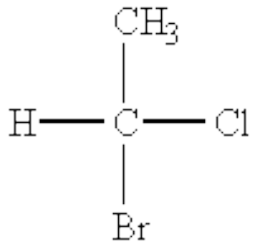
Dihydroxyacetone
(a ketose)



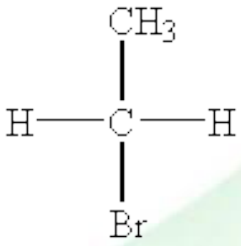
D-Glyceraldehyde
(an aldose)

Chiral carbon

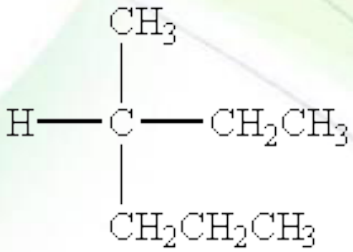
Note what a chiral carbon is…



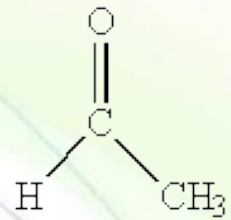
Chiral



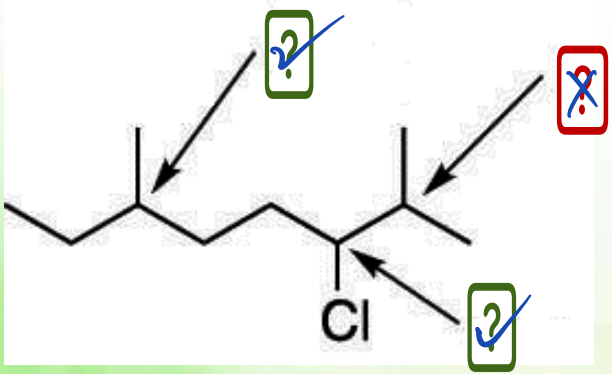
A



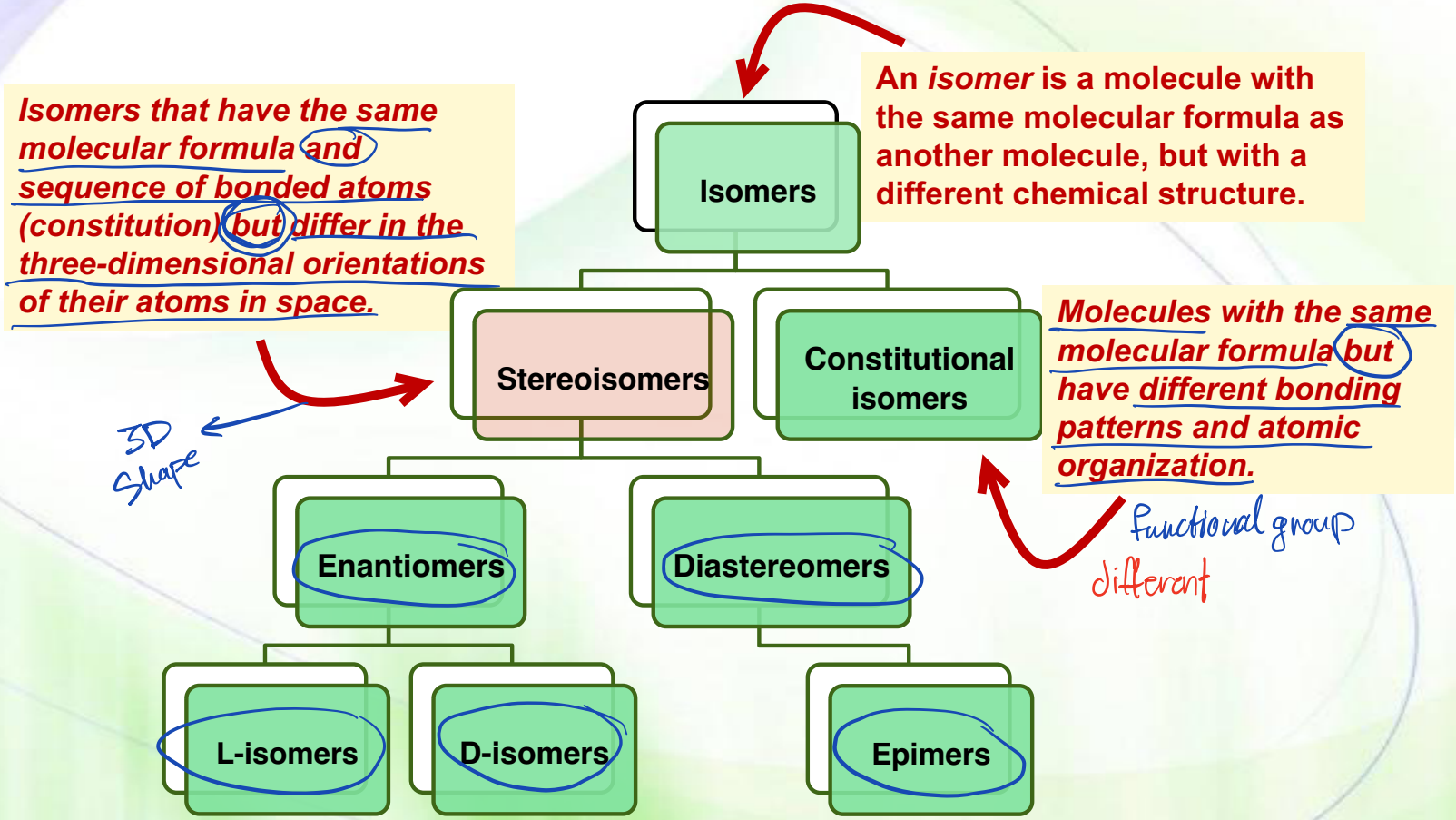
C



A



Isomerism

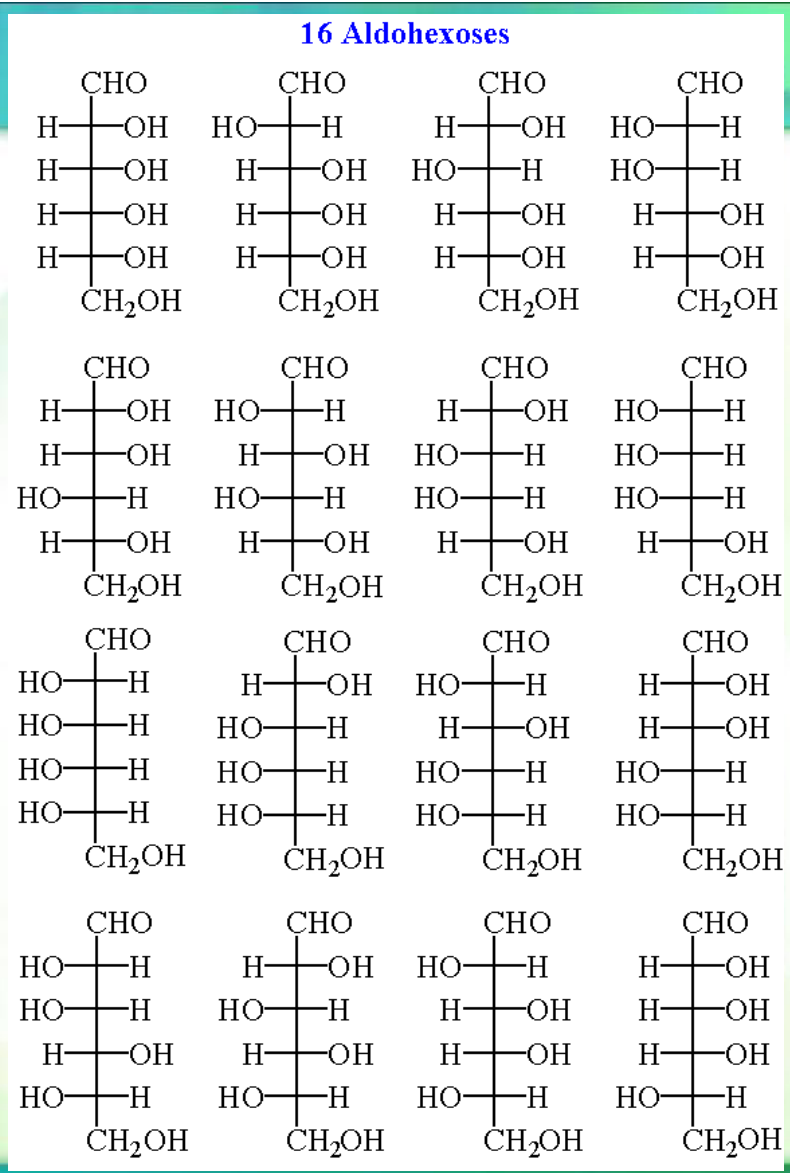

An *isomer* is a molecule with the same molecular formula as another molecule, but with a different chemical structure.
Isomers
Stereoisomers
Constitutional isomers
Isomers that have the same molecular formula and sequence of bonded atoms (constitution) but differ in the three-dimensional orientations of their atoms in space.
3D Shape
Molecules with the same molecular formula but have different bonding patterns and atomic organization.
Functional group different
Enantiomers
Diastereomers
L-isomers
D-isomers
Epimers

Isomers of glucose

2^n (n is the number of chiral carbons in a sugar molecule)

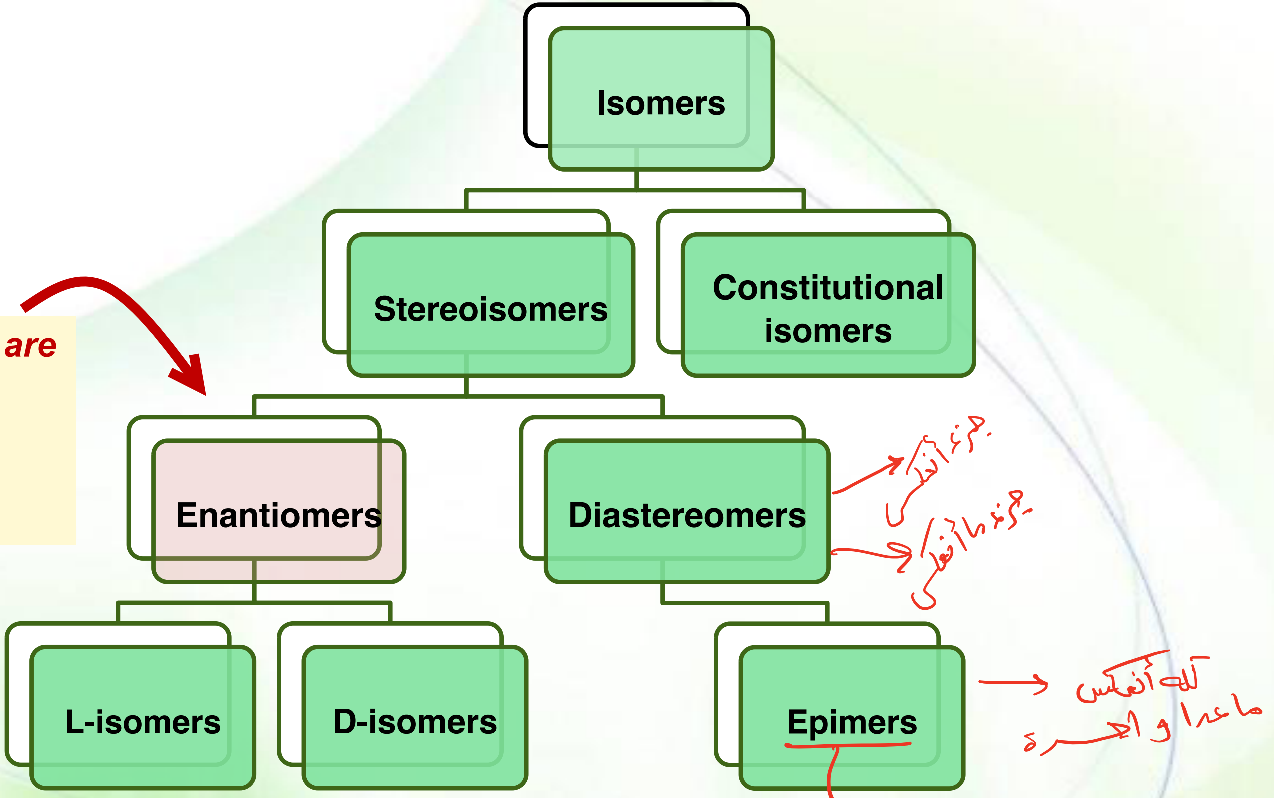
Search for:

Glucose,
Galactose
Mannose



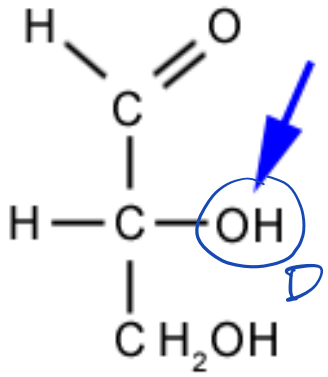
Enantiomers

Two stereoisomers that are mirror images of each other and are non-superimposable (not identical)

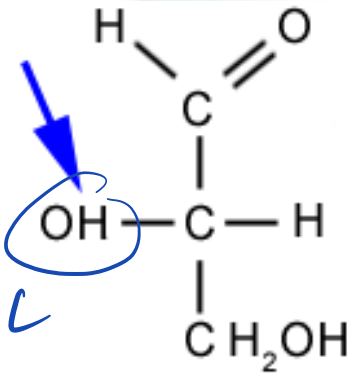


special case
every epimer is diastereomer
but not every diastereomers is epimer

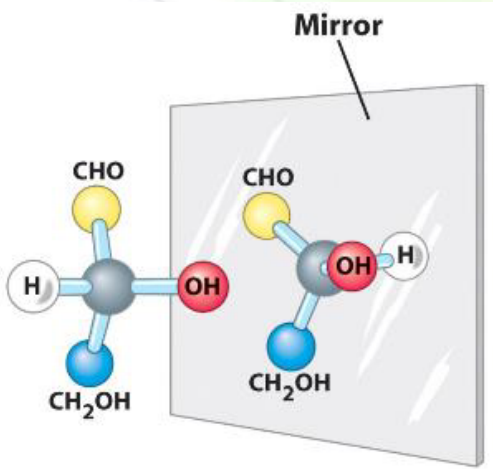
Sugar enantiomers (D- vs. L-)



D-Glyceraldehyde



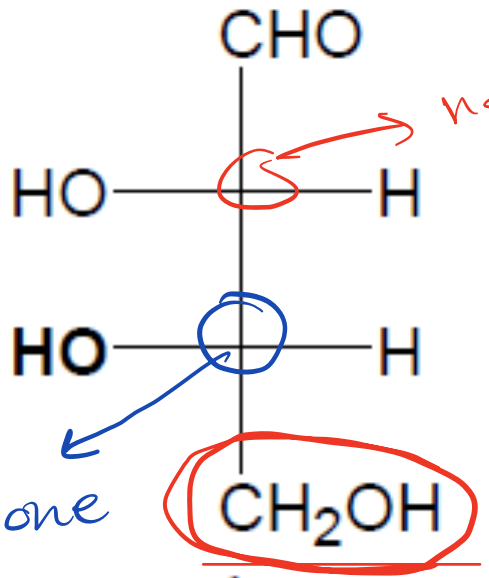
L-Glyceraldehyde



Ball-and-stick models

Which one(s) is a chiral carbon?

Which one to use to determain that it's a D sugar?
the farest chiral center detect the direction

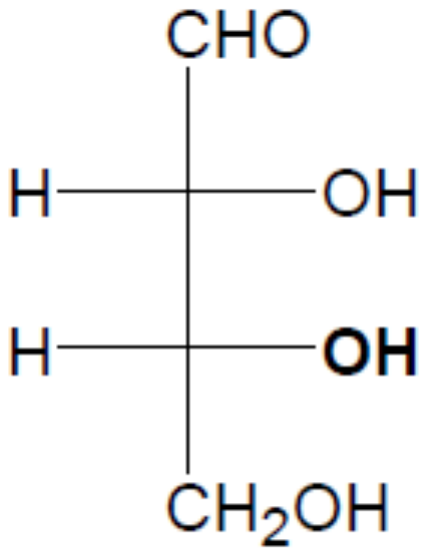


not this

this one

L-erythrose

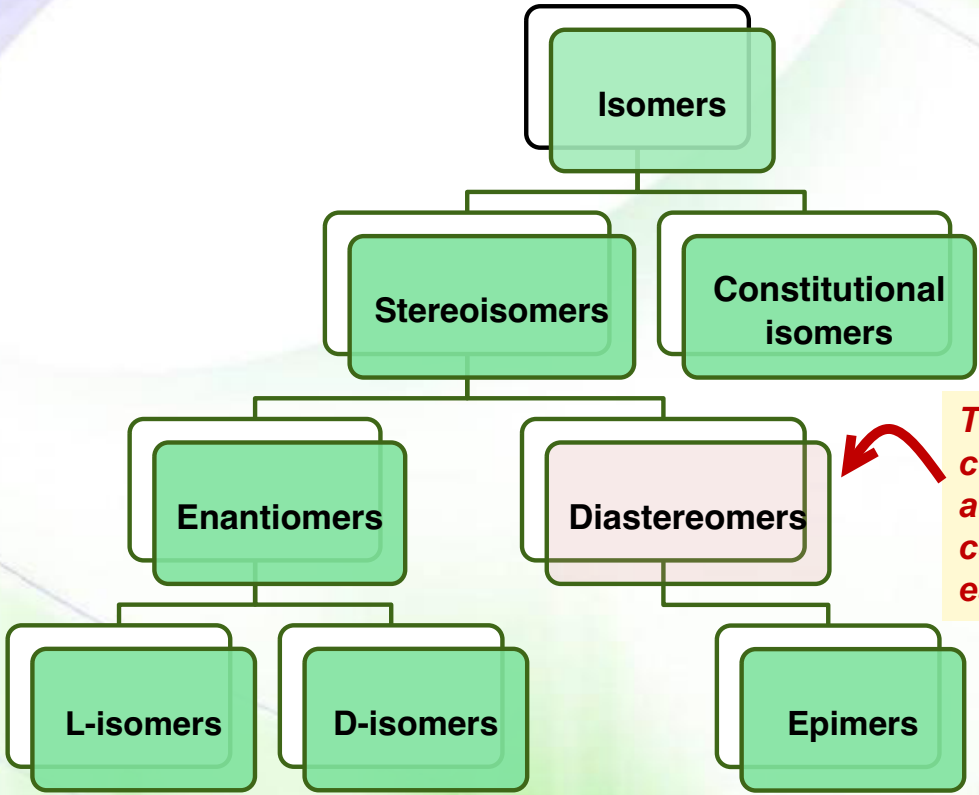
that determain the direction



D-erythrose

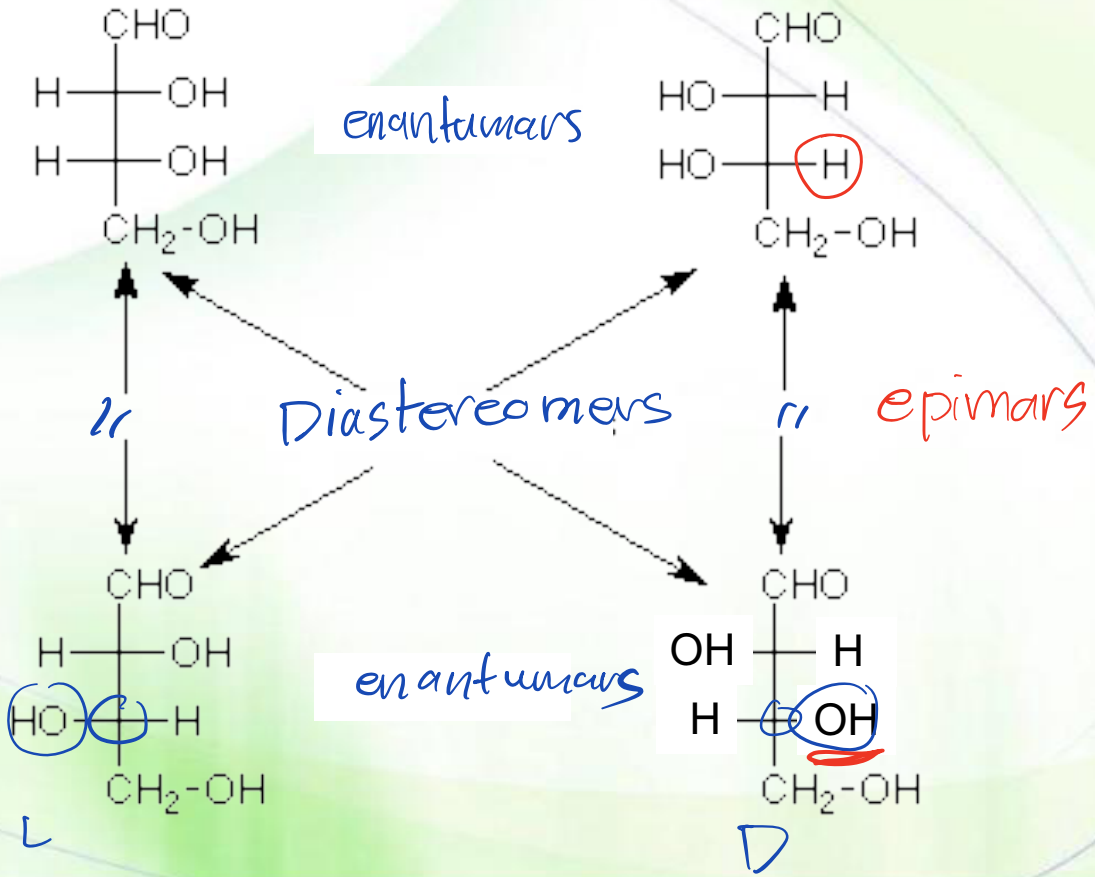
Do not memorize but study them.

Isomerism

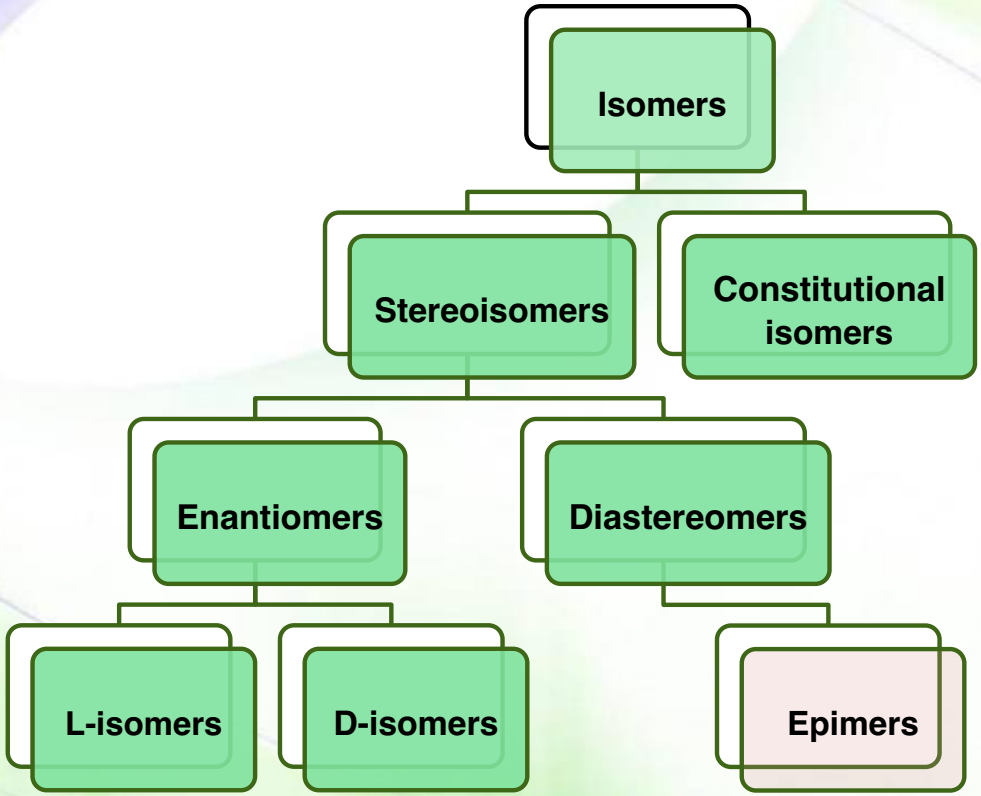


Two or more stereoisomers of a compound having different configurations at one or more (but not all) of the chiral carbons and are not mirror images of each other.

Stereoisomers, but non-mirror images and non-superimposable, then…*diastereomers*



Isomerism

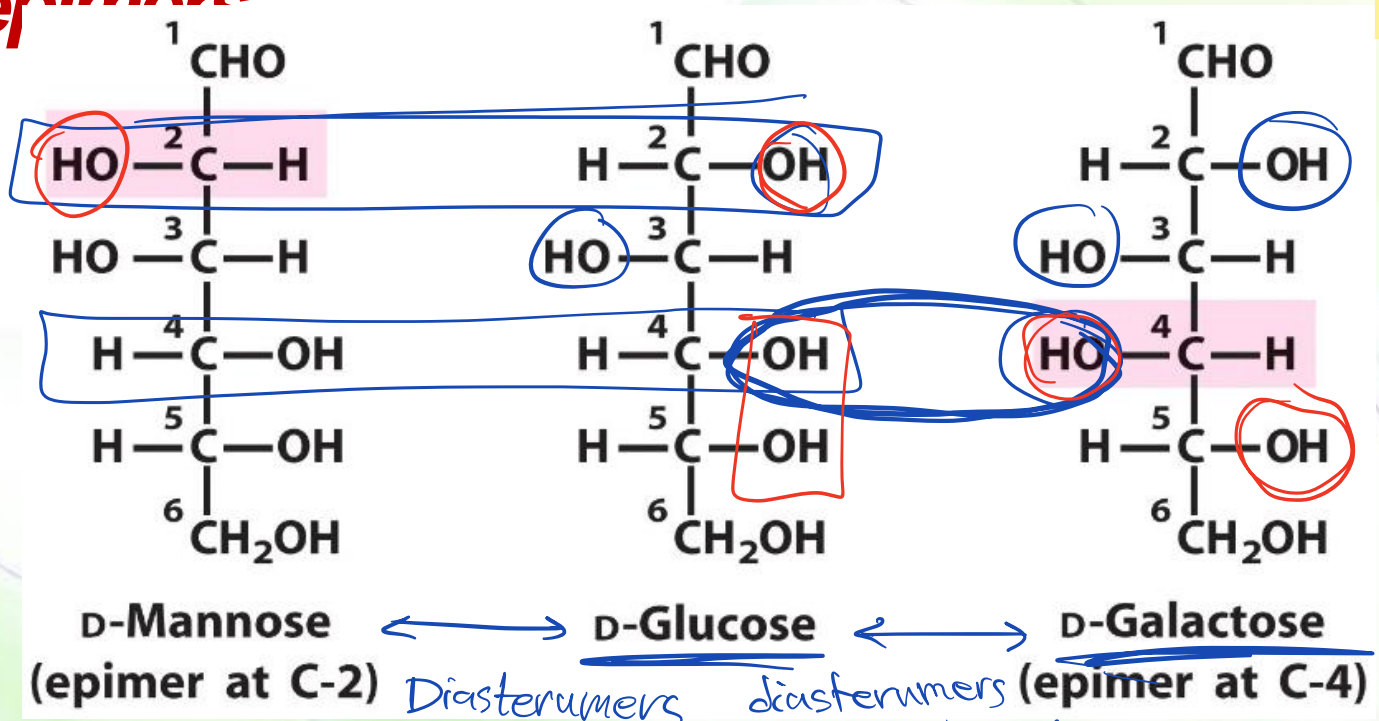


Epimer refers to one of a pair of stereoisomers whereby two isomers differ in configuration at only one chiral carbons.

Diastereomers with different orientation of one chiral carbonm

then… epimers

Memorize and study them.

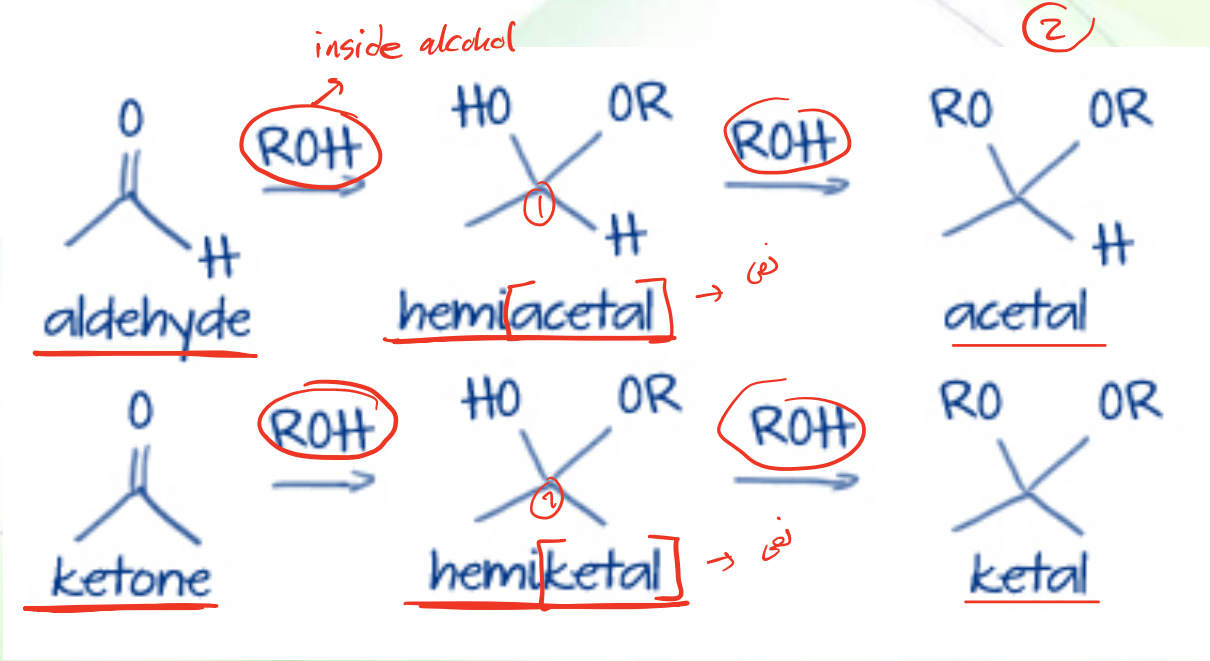


the releation between Mannose & Galactose? Diasterumers ONLY

Is L-glucose an epimer with D-mannose and D-galactose?

Acetal/ketal vs. hemiacetal/hemiketal

Hemiacetal and hemiketal: ether and alcohol on same carbon
Acetal and ketal: two ethers on same carbon

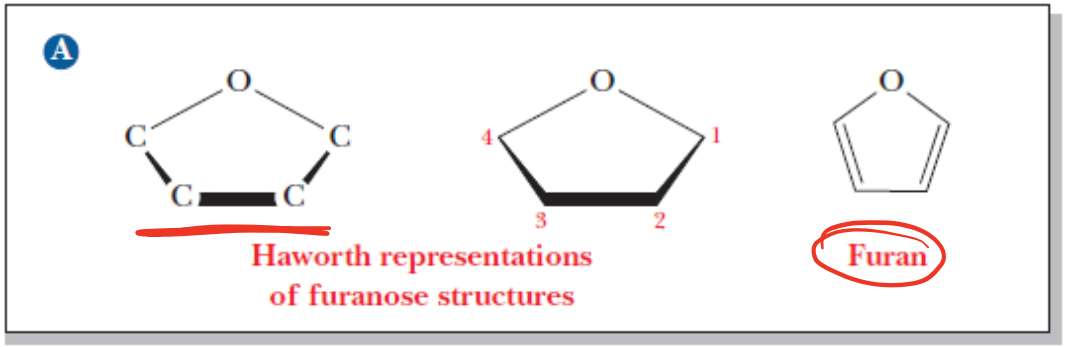


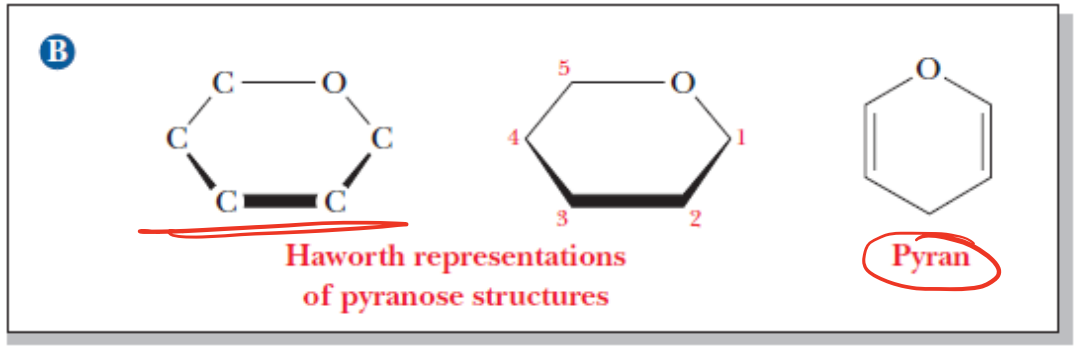
when they do full reaction they will become no. 2

2 OR Groups

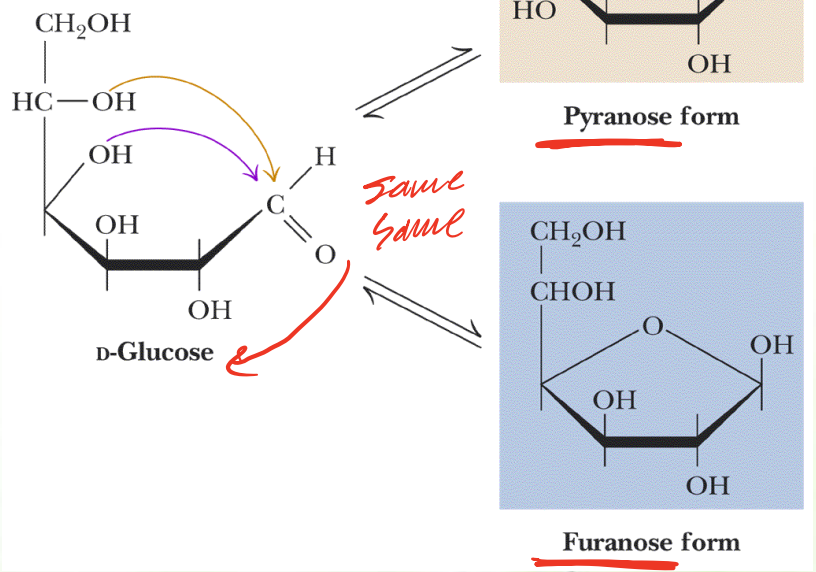
What is the difference between hemiacetal and hemiketal and the difference between acetal and ketal?

Formation of a ring structure



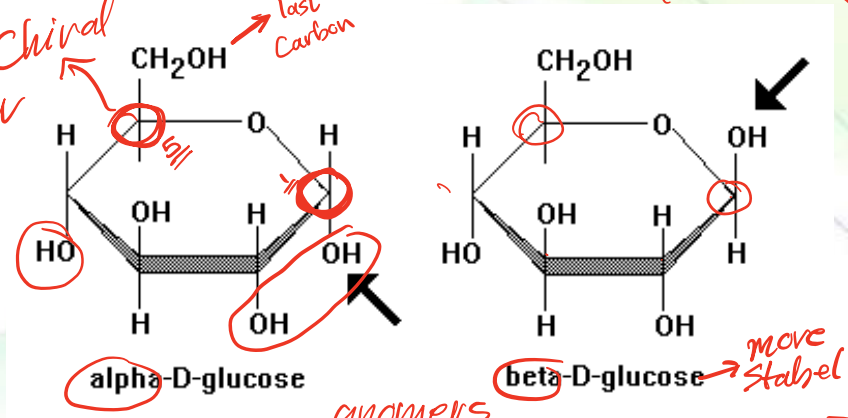


Glocupyranoses
↳ pyran



↓
Fructofuranoses

Anomers



last Chiral Center

last Carbon

Glucouse either D of L only

can be changed by enzyme

on Right go down

& left go up

- Carbonyl reacts with Chiral Center
- ring is more reactive
- the bond is changing but not the places of OH in learner was carbonyl
- must one of the oxygen bondes break down & change to OH

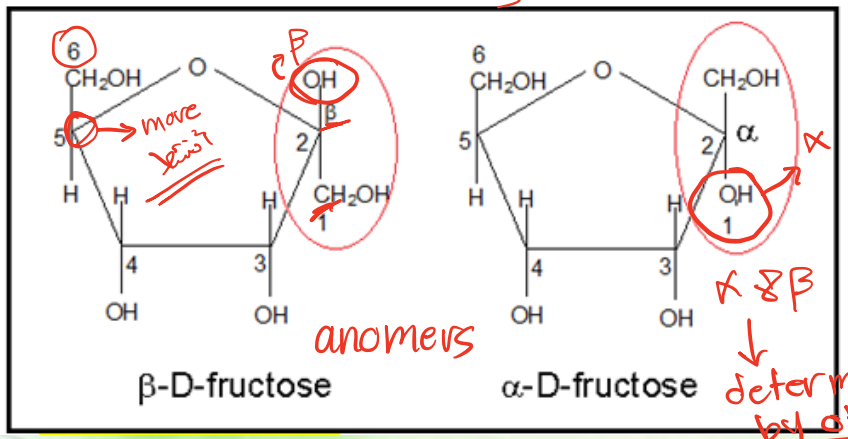
more stabel

anomers → can change From it self

what determain the stability ?

OH up or down & if there's space fro the atomes to move

- in the linear structure every thing on the right goes down & left goes up



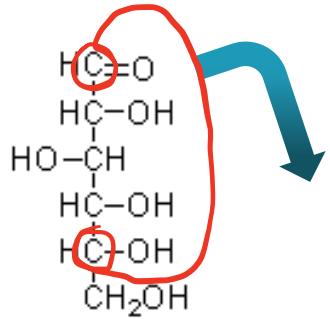
anomers

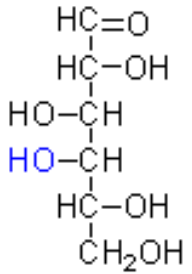
α & β → determain by OH

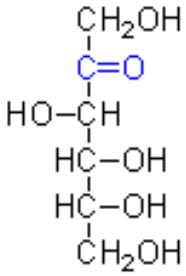
Chain to ring

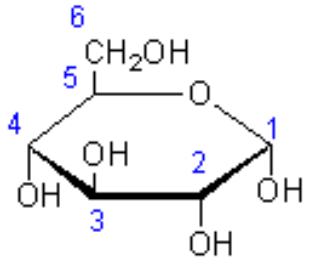
Left-up, right-down

Face the sugar and go down to <u>YOUR</u> right

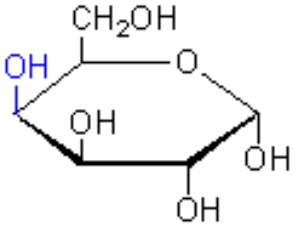




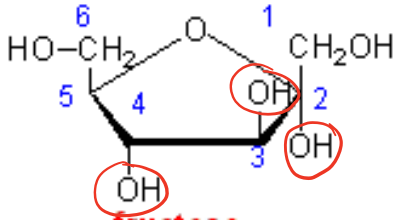




glucose



galactose

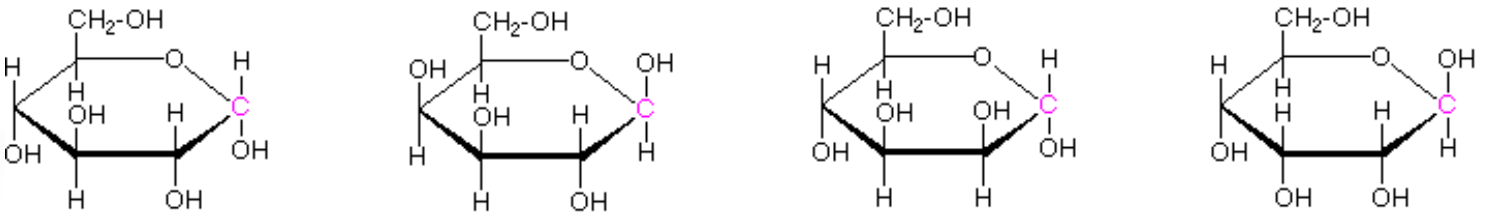


fructose

Cyclic aldohexoses

موضوع التسمية

Examples of Some Pyranose Forms of Hexoses



α-D-glucopyranose β-D-galactopyranose α-D-mannopyranose β-D-allopyranose

anomers → 64% → β
→ 36% → α

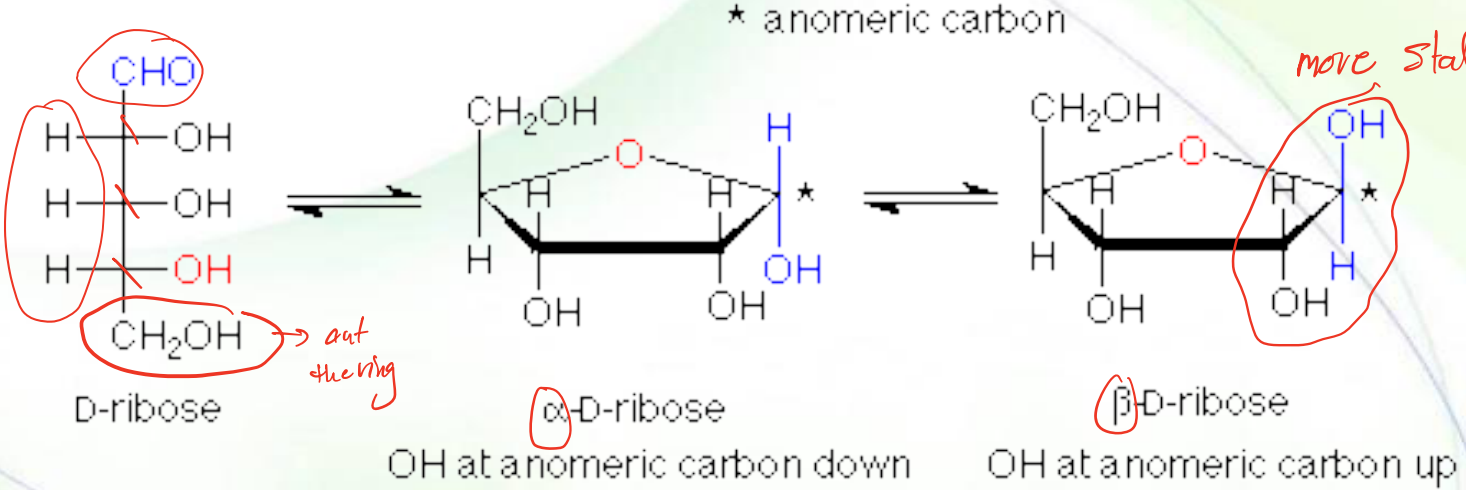
يفتح ويسكر بالتفاعل "reactions"

linear

أجزاء من الثانية

Cyclic ribofuranose

Glucos + Ribos = β is the stable one



RNA , ATP , GDP , cAMP

↳ ribose sugar

- natural obtained sugars

Modified sugars

Sugar acids (oxidation)

OH → 4 → down

- where we can find these modificated sugar?

Glycos Amino Glycan

↳ polysaccharids present in the ECM & they absorb H_2O molecule they bind to H_2O molecule

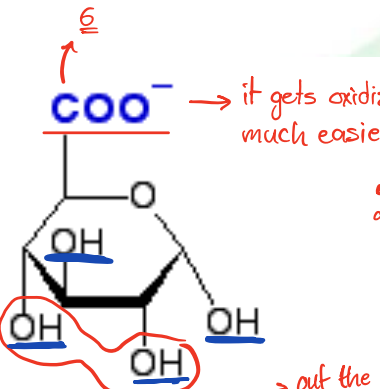
they're side groups, we increased the groups that have high electronegativety

leads to:-
- more polar bonds
- more charged → leads to attract H_2O more
- more hydrogen bonds

which leads to a gell like structure that can handle the shocks "Shock absorber"

Where is it oxidized? What does it form?

- Aldehyde group → oxidized
- Ketone group → can't oxidized
- Alcohol group → oxidized



→ it gets oxidized much easier

- both have different since they are modified

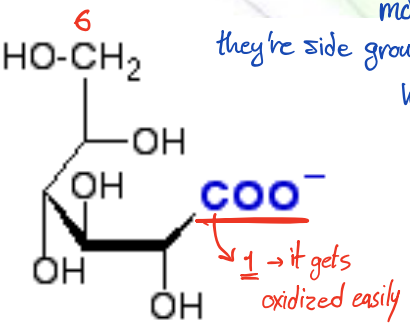
harder to react

to produce it we use enzyme → **α-D-glucuronate**

out the ring

(D-glucuronic acid, **GlcUA**)

from **oxidation of glucose C6 OH**



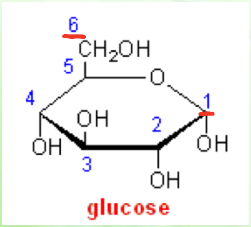
1 → it gets oxidized easily

D-gluconate

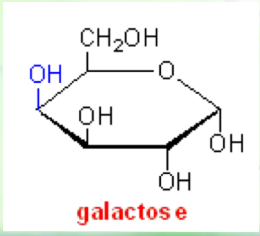
(D-gluconic acid, **GlcA**)

from **oxidation of glucose C1 aldehyde)**

- out side the ring is much easier to do reactions



glucose



galactose

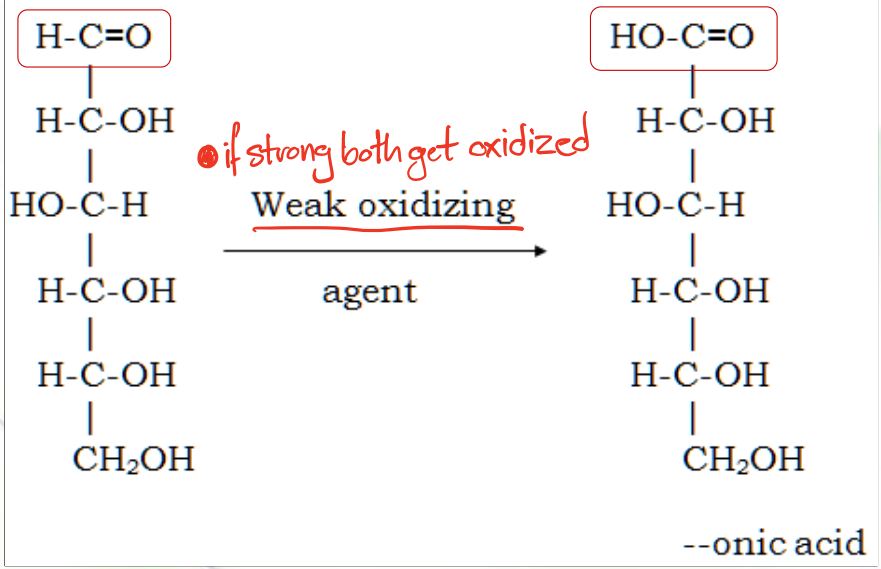
Do not memorize the structure but study it.

1,6 glycose → glycosidic linkage ← it's called

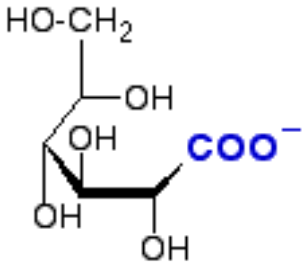
if a bond involves at least 1 anomeric carbon

Gluconate

a. Weak oxidizing agent

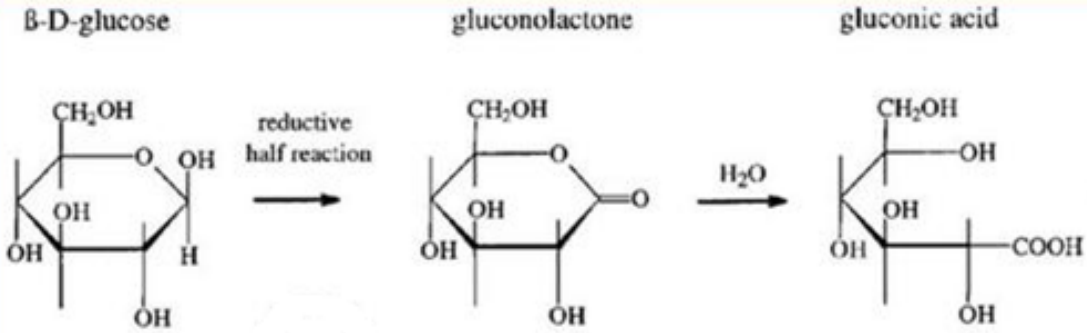


if strong both get oxidized



D-gluconate
(D-gluconic acid, **GlcA**)
from **oxidation of glucose C1 aldehyde)**

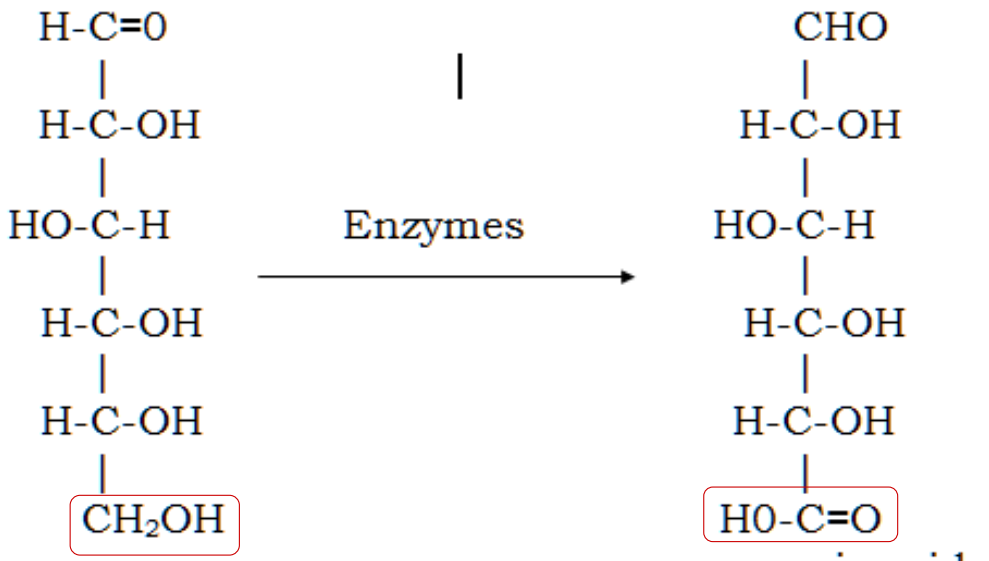
Do not memorize the structure but study it.

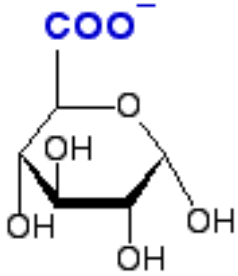


Glucoronate

- using enzym

c. Oxidation of primary alcohol end in biological systems





α-D-glucuronate
(D-glucuronic acid, **GlcUA**)
from **oxidation of glucose C6 OH**

Do not memorize the structure but study it.

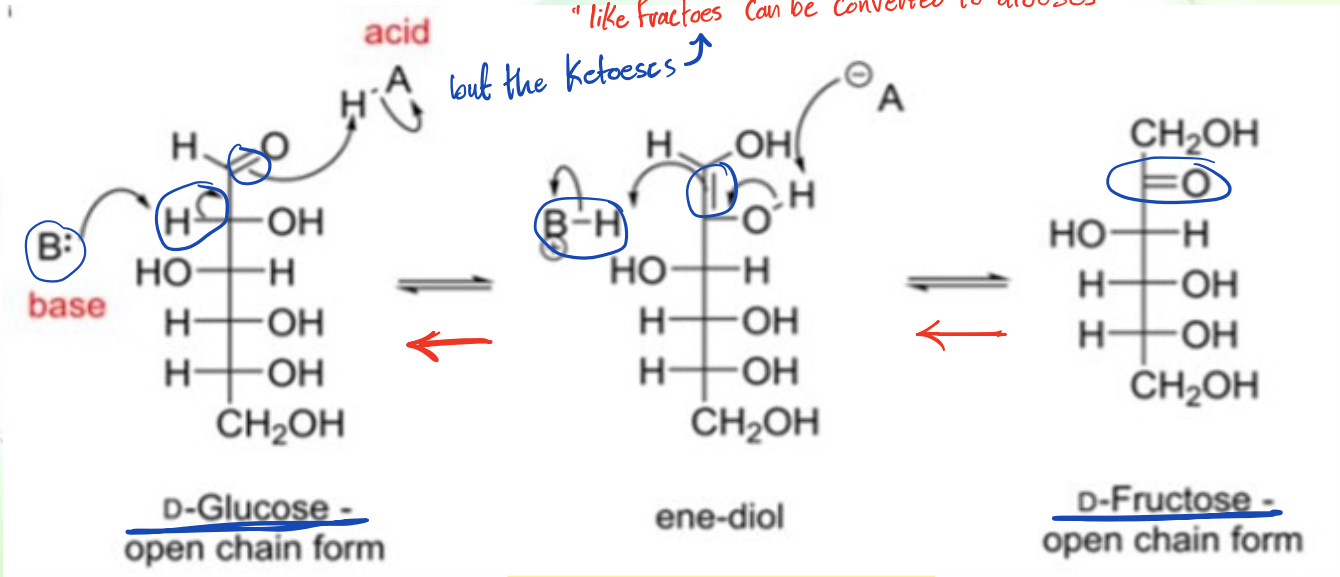
Note

Can't be oxidized

Oxidation of ketoses to carboxylic acids does not occur, but they can be oxidized indirectly.

"like Fractoes" can be converted to aldoses by electron & bond rearrangment process

but the Ketoeses



indirecte oxidization
the become aldoese
then get oxidized
but it's slower & hard

Do not memorize the ene-diol structure but study it.

Sugar alcohols (reduction)

- oxidizing → + reduction they reduce the other reactant "reducing sugar"
- reducing → they act as reducing reagent

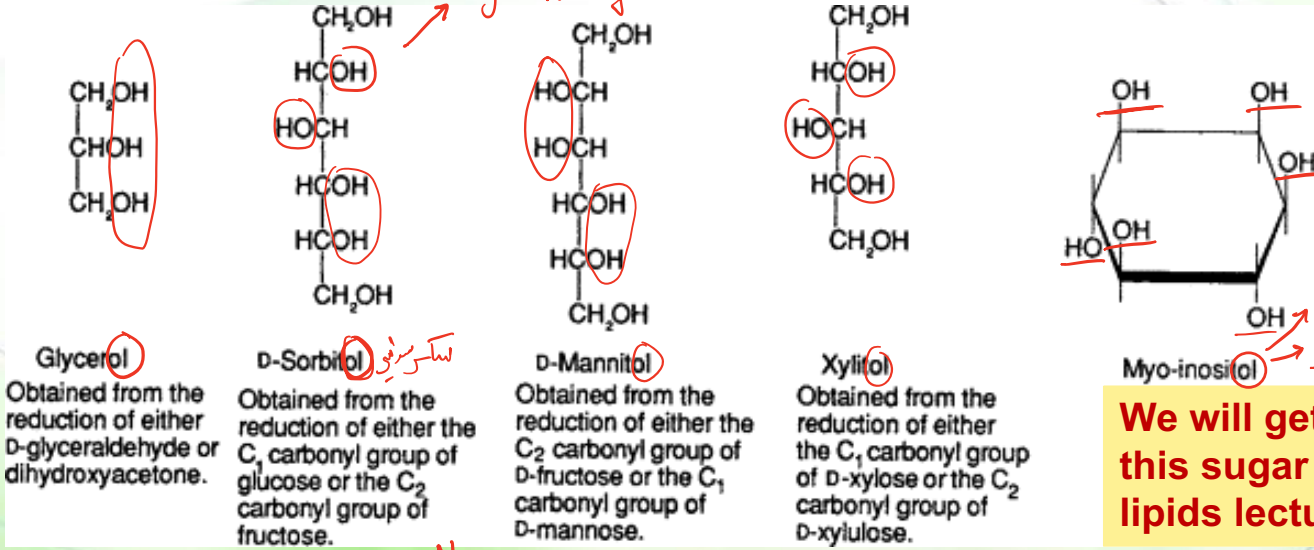
What does it form?

Examples include sorbitol, mannitol, and xylitol, which are used to sweeten food products

first way to reduction

① transform the sugar from Ketone / Aldehyde to alcohol

"reducing the carbonyl Group"



We will get to this sugar in the lipids lecture

it can be produced in the body but in little amount, also the body capture it in the cells if it gets more than the usuall rate

the one that we eat can't be absorbed, because there's no transporter on it surface to get inside the cell

Deoxy sugars (reduced sugars)

One or more hydroxyl groups are replaced by hydrogens.

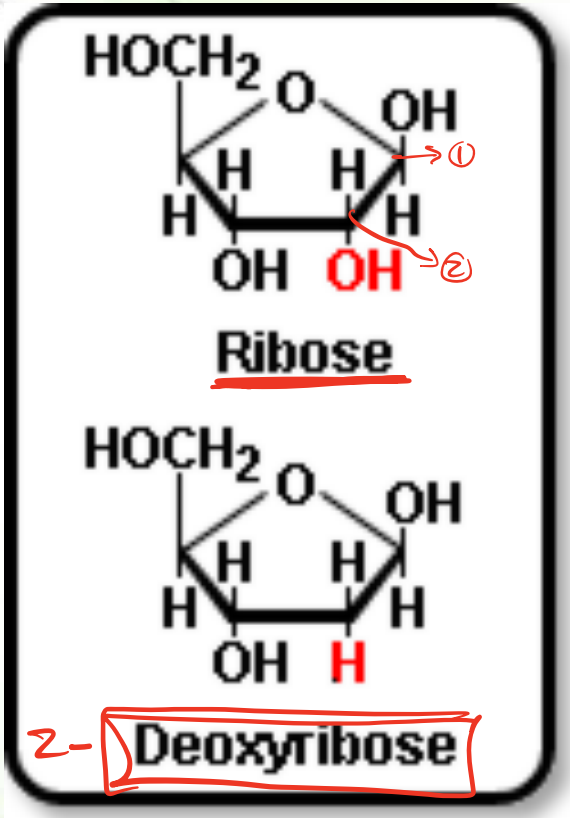
An example is 2-deoxyribose, which is a constituent of DNA.

Second way for reduction "produce reduced sugars"

② it occurs in ribose, where we remove in carbon 2 an oxygen

we will have 2-Deoxyribose sugar

found in nuclie of DNA only



Ribose 8-

Pentose sugar

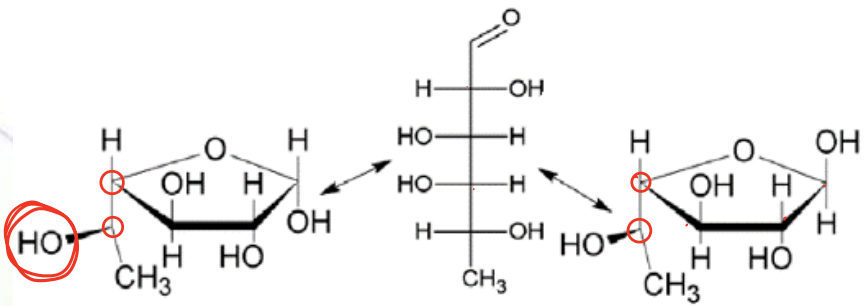
Another deoxy sugar

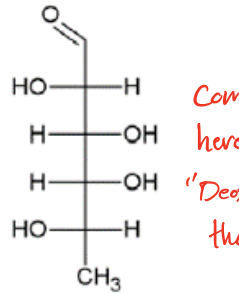
example of blood groups ABO (A, B, AB, O)

blood can be known by the sugar group that's attached to the protein & lipids surface

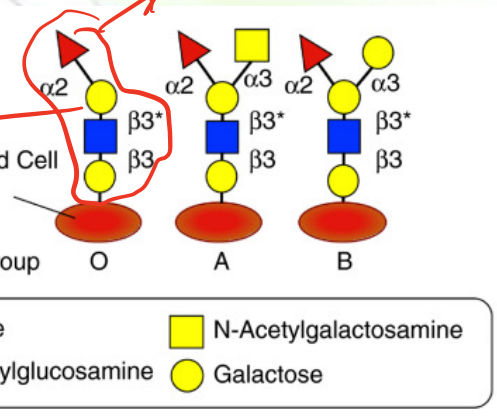
L-fucose (L-6-deoxygalactose)

found in the carbohydrate portions of some glycoproteins





Comes from here "Galactoes" "Deoxy Galactoes" the 6th Carbon



modifide sugar

Do not memorize the structure but study it.

Do not memorize the components except for fucose.

Sugar esters (esterification)

What is the reacting functional group? Where does it react? What are the end products? Where are they used?

phosphester So! $R-\overset{\overset{O}{\|}}{P}-OR'$

$R-\overset{\overset{O}{\|}}{C}-OR'$ → ester group

third way to reduction

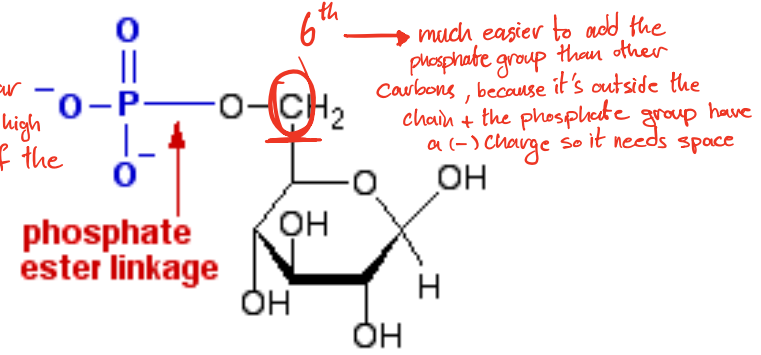
③ esterification

we add phosphates groups drived of phosphoric acid to modified the molecules to form certain functions

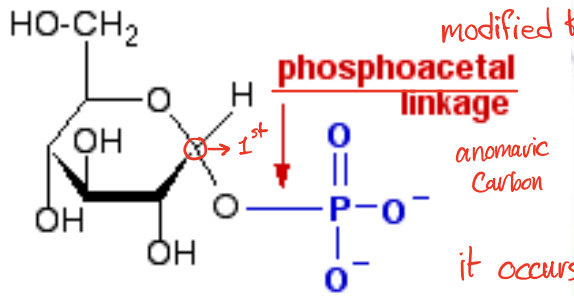
it's produced when we eat a meal & the sugar gets high & the insuline gets high which leads to high uptake of the Sugars in the cells

but what make the glocuose move inside the cells

↑ Conc. blood vs ↓ Conc. cells so gradient move it & the opposite can be happend so! to stop it we use phosphate to trap it inside the cell which makes the transporter unable to identify it & move it



β-D-glucose-6-phosphate
(an ordinary **phosphate ester**)

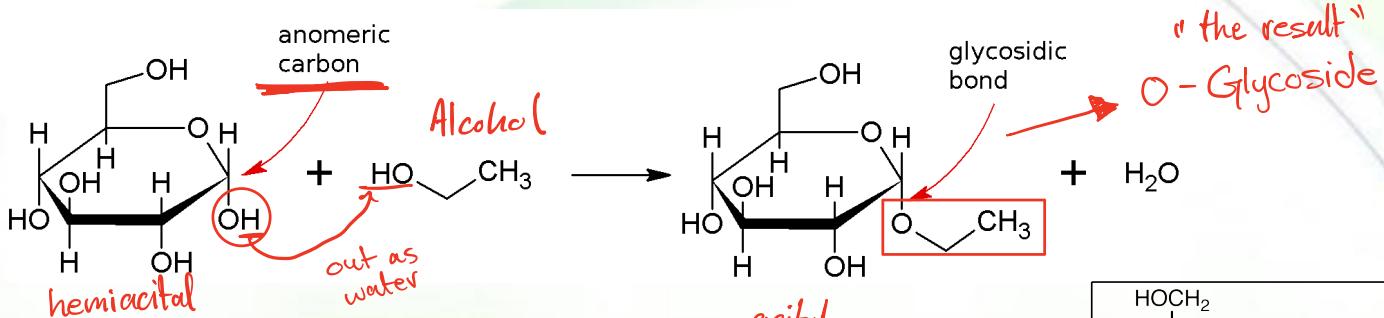


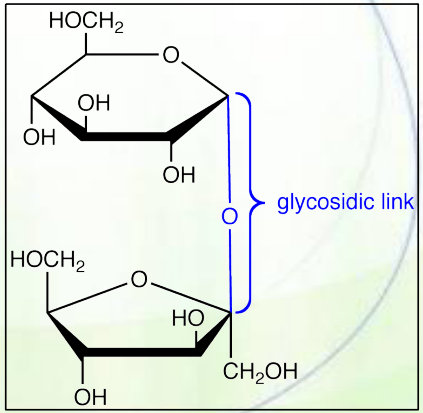
α-D-glucose-1-phosphate
(a **phosphoacetal**)

it occurs in metabolism

O-Glycosides

What is the reacting functional group? Where does it react? What are the end products? Where are they used?



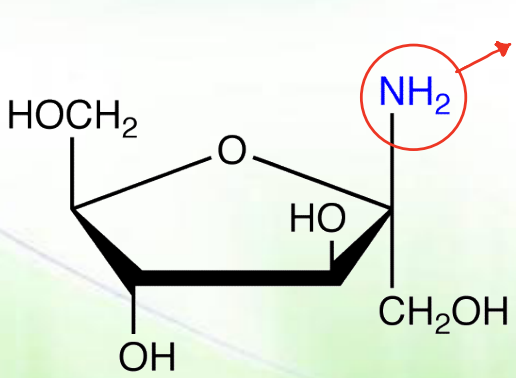


N-Glycosides

sugars that's modified

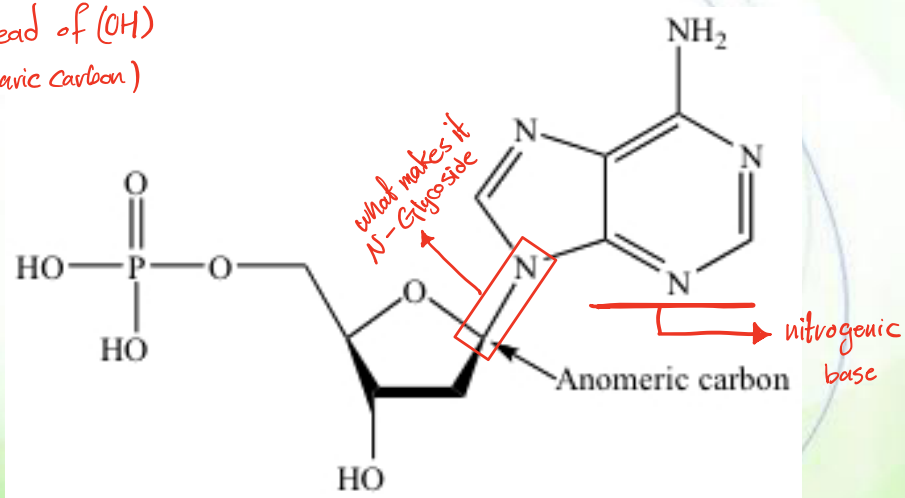
What is the reacting functional group? Where does it react? What are the end products? Where are they used?

Examples: nucleotides (DNA and RNA)



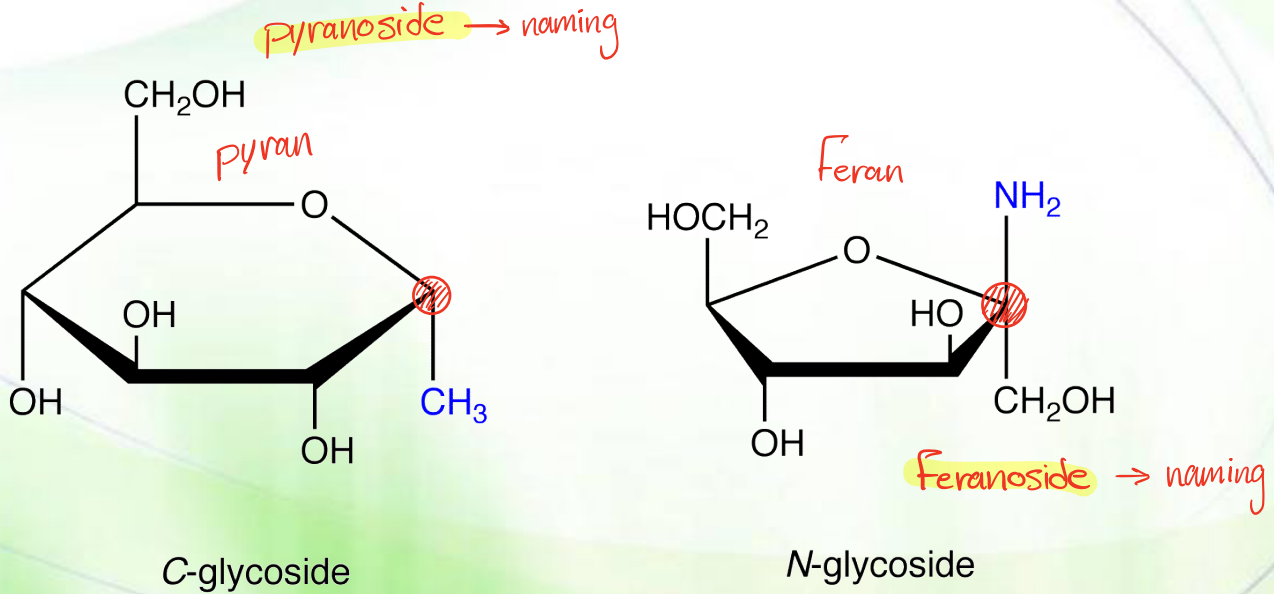
instead of (OH)
(anomeric carbon)

N-glycoside



Note

Glycosides derived from furanoses are called furanosides, and those derived from pyranoses are called pyranosides, regardless if they are N- or O-linkded.

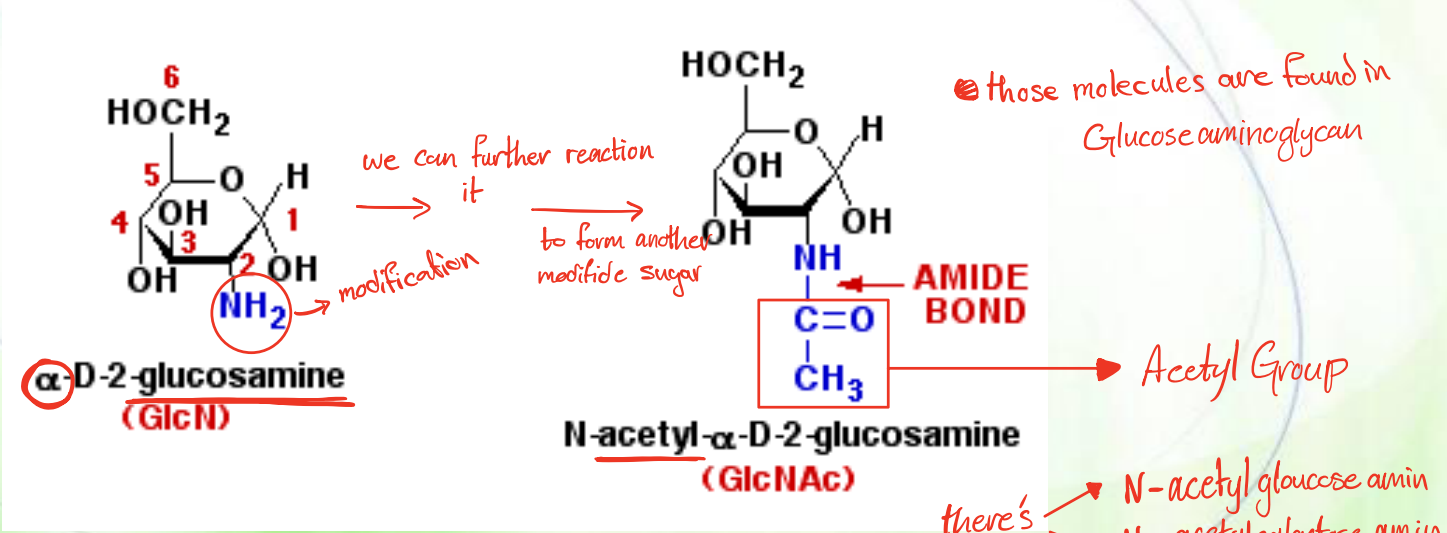


Amino sugars

What is the reacting functional group? Where does it react? What are the end products? Where are they used?

Further modification by acetylation

ex:- the blood groups has amino groups to be able to identify it



Disaccharides

next type of molecule

What are disaccharide? Oligosaccharides? Hetero- vs. homo-?

What is the type of reaction?

not all → the first sugar reacte with it anomaric carbon

most common examples

What is a residue?

Synthesizing enzymes are glycosyltransfer[illegible]

Do they undergo mutarotation?

Are products stable?

- different monosaccharides bonded to form disaccharides

what're the sugars that bonded

what're the sugars atoms that maded the bond

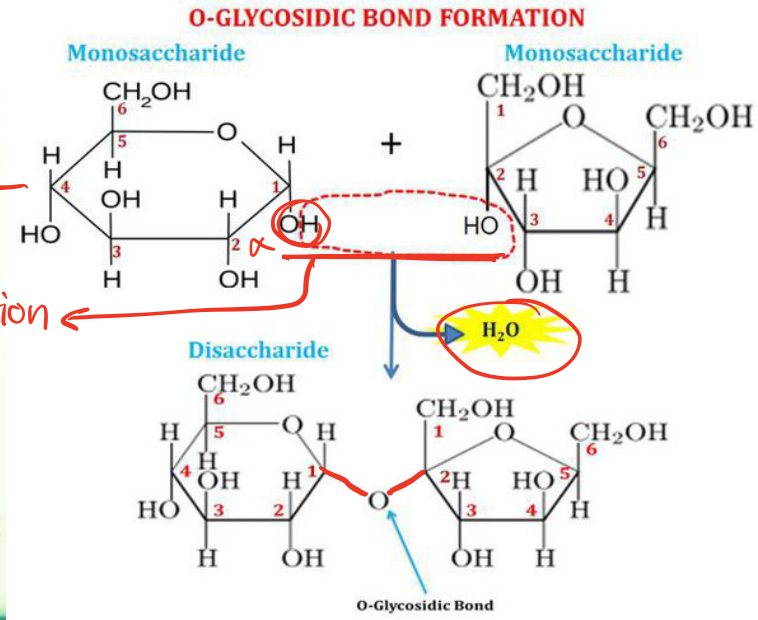
what type of the linkage / the ordering of sugar

this first sugar deside if it's α or β

dehydration

α looks like V

β looks like N



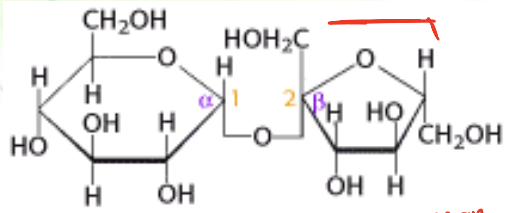
Distinctions of disaccharides

- The 2 specific sugar monomers involved and their stereoconfigurations (D- or L-)
- The carbons involved in the linkage (C-1, C-2, C-4, or C-6)
- The order of the two monomer units, if different (example: galactose followed by glucose)
- The anomeric configuration of the OH group on carbon 1 of each residue (α or β)

Abundant disaccharides

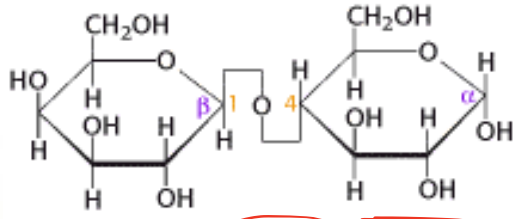
- Configuration
- Designation
- Naming (common vs. systematic)
- Reducing vs. non-reducing

Glucose is most common



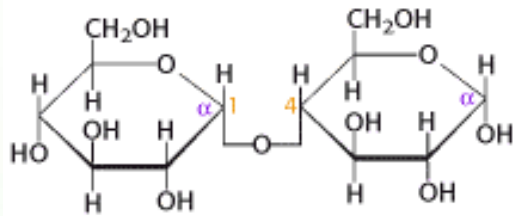
Sucrose → common name

(α-D-Glucopyranosyl-(1→2)-β-D-fructofuranose



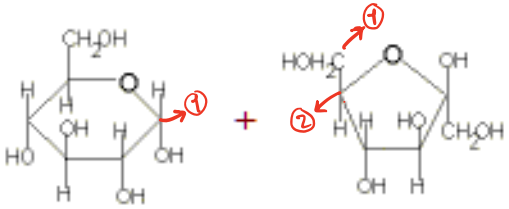
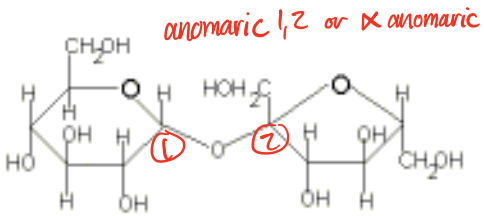
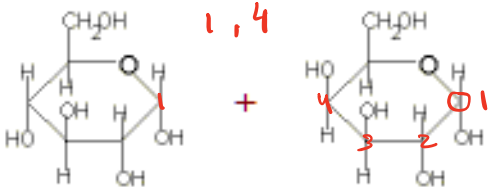
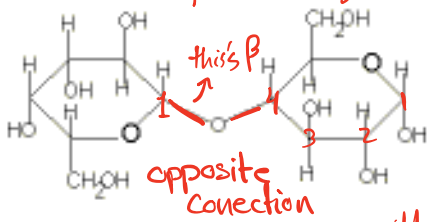
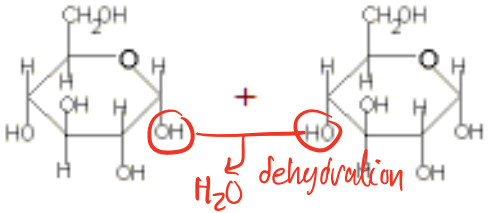
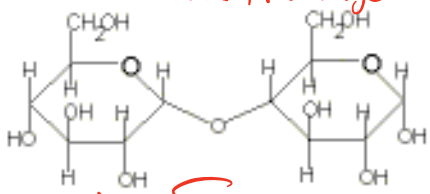
Lactose

(β-D-Galactopyranosyl-(1→4)-α-D-glucopyranose

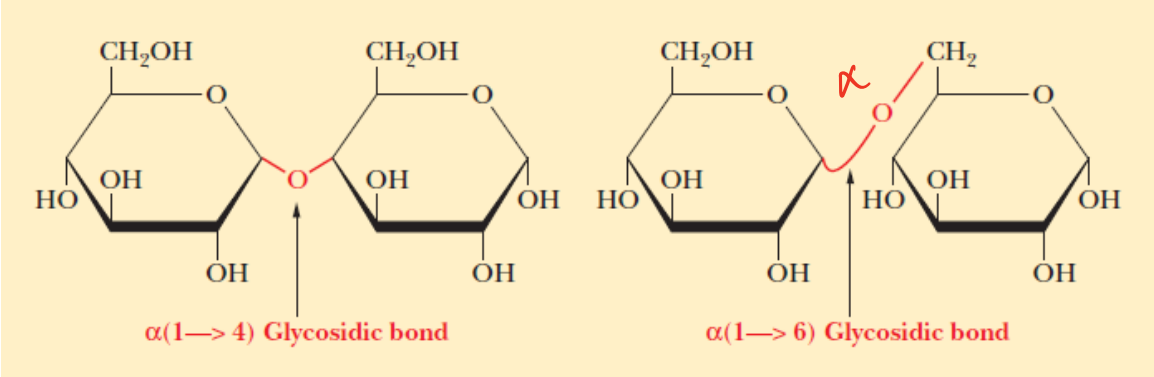


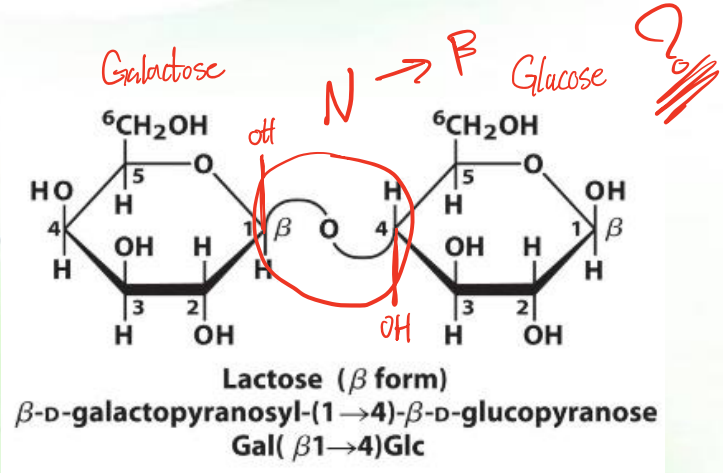
Maltose

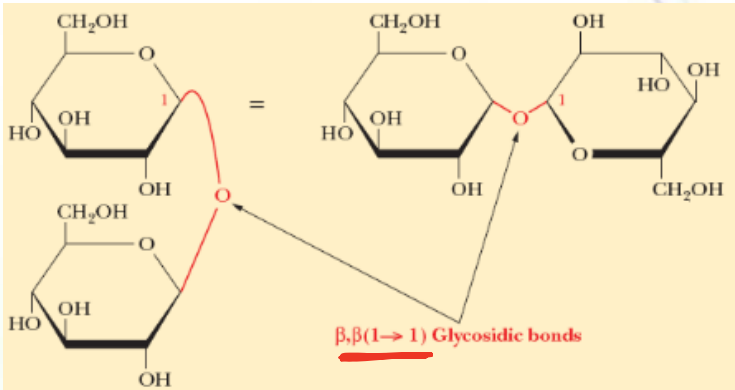
(α-D-Glucopyranosyl-(1→4)-α-D-glucopyranose

Name	Formula	Formed from	Structure
sucrose	$C_{12}H_{22}O_{11}$	glucose + fructose  anomaric + anomaric	---> sucrose + H_2O  anomaric 1,2 or ∝ anomaric سكر الأثرة common table sugar
lactose	$C_{12}H_{22}O_{11}$	glucose + galactose  Galactose first then Glucose	---> lactose + H_2O  β 1,4 linkage opposite conection milk sugar
maltose	$C_{12}H_{22}O_{11}$	glucose + glucose  H_2O dehydration	---> maltose + H_2O  ∝ 1,4 linkage سكر الشعير mold sugar

Different forms of disaccharides



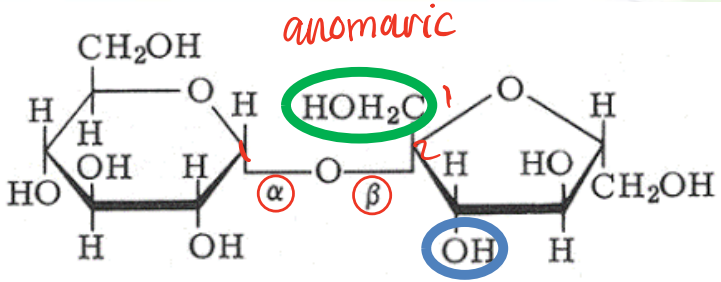


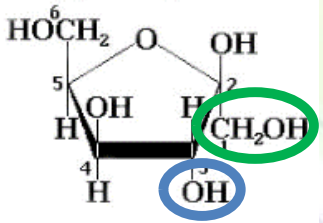


.A disaccharide of β-D-glucose

Sucrose

Sucrose come intermediate in sweetness

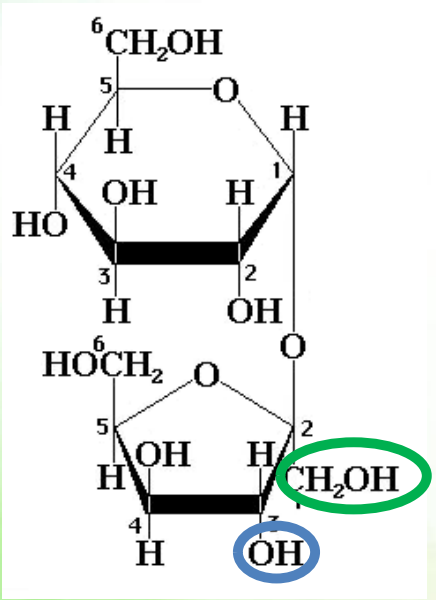




α, 1-2

anomaric C 1-2

- Fructose → highest in sweetness
- Sucrose
- Glucose



This is extra

Lactulose

- the low activity of the enzyme in the body won't be able to digest the lactose fully

- babies rely on milk to get nutrients, so they have enzyme that's called lactaze that digests lactose keeps increasing till it reach 1 month high

It is formed by the isomerization of lactose.

It has health benefits:

because if it was digested it will become glucose + fructose which's much easier to the body to absorb & since the lactose enzyme activity is low there won't be a good absorption for the products, so lactose will stay in the intestens & will disturb the osmotic pressure. this will result in water moving to the intestins & deloted it. Also the remaind lactose in the intestins will be the food of the flora "in the intestins" not fully but still will get neutrated from it to release $CO_2(g)$ & $CH_4(g)$ → side product

- **It is used in treating constipation.**
- **It promotes the growth of health-promoting gut bacteria.**
- **It modulates the immune system.**

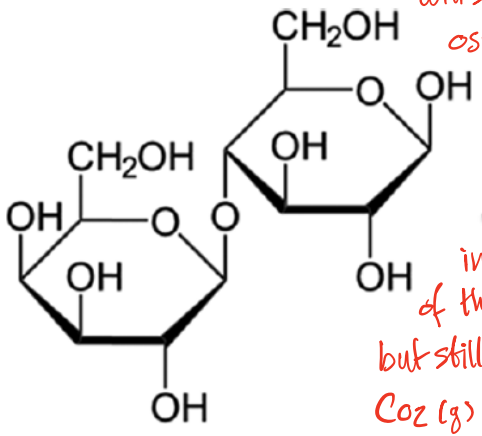
Do not memorize the structure but study it.

5-7 years it keeps decreasing till it reach adult's enzyme activity " when it reach 7y "

lactaze which's enzyme for lactose

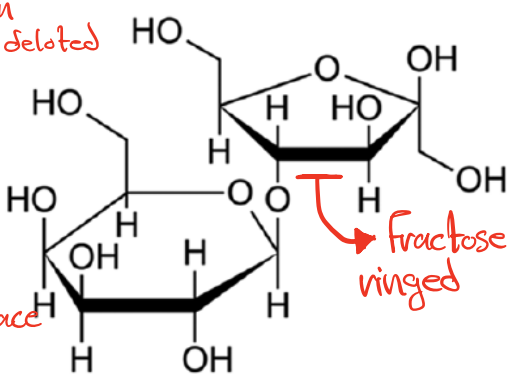
9g of lactose "1 glass of milk"

↳ 1L of water is lost from the body



Lactose

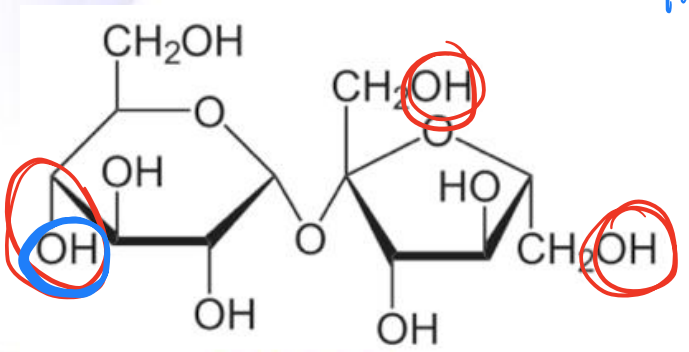
Isomerization



Fructose ringed

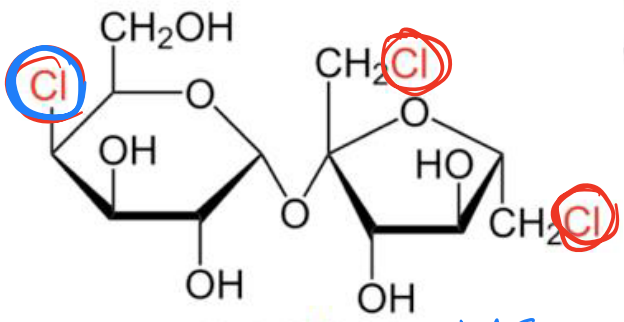
isomers of lactose ← **Lactulose**

Sucralose (artificial sweetener)



sucrose

the OH changed to Cl



sucralose 10X Sweetnes than Sucrose

Vit D:-

we can have it by getting it synthesized from the sun

& if we want it from milk we would need 10L to just get the wanted amount

News > WebMD Health News

Sucralose Damages DNA, Linked to Leaky Gut: Study

Lisa O'Mary
June 01, 2023

Sucralose, a Common Artificial Sweetener, May Increase Cancer Risk

WebMD

* read

Milk problems

not genetic — starts when hitting puberty

it's just a digestion problem that's caused by the reduced amount of lactase enzyme → it doesn't consider as a disease it's the normal thing that people have after they get 7yo

Lactose Intolerance: A deficiency of the enzyme lactase in the intestinal villi allows lactase of intestinal bacteria to digest it producing hydrogen gas, carbon dioxide, and organic acids and leading to digestive problems (bloating and diarrhea).

when we have a pilled up of compounds it will try to have another track to reduce it

But when it enters the cell it will be a problem

monosaccharide — if we absorb it or digest it, it's fine

the simplification of galactose function :-
- Mainly: GAGs, Sugars of glyco (protein / lipids) etc..
- Not Mainly: Store energy

Because of the enzyme deficiency we will have a pilled up galactose which we can't use it

like Sorbitol's idea it problem that the don't act like the transporter it will be reduct to Surface alcohol = galactitol

Galactosemia: **Missing** a galactose-metabolizing **enzyme** can result in galactosemia where **nonmetabolized galactose** accumulates within cells and is converted to the hydroxy-sugar galactitol, which cannot escape cells. Water is drawn into cells and the swelling causes cell damage, particula… the brain, resulting in severe and irreversible retardation. It also causes cataract.

Genetic Disease

- One of it's problems:- increasing the osmotic pressure & they stay inside the cell

mostly the neurons get effected so bad, because they can't be generated again

it's ireversable WE CANNOT FIX IT

have to be transperant

due to cellular deth we will still have some of the dead cells & they're not transperant so they apper in the optical

(the optical cells of the eyes)

موية بيضاء

Raffinose

3-10 → don't reach 100

● plants that makes flowting

What are oligosaccharides?

Example: raffinose → So many ex of green plants

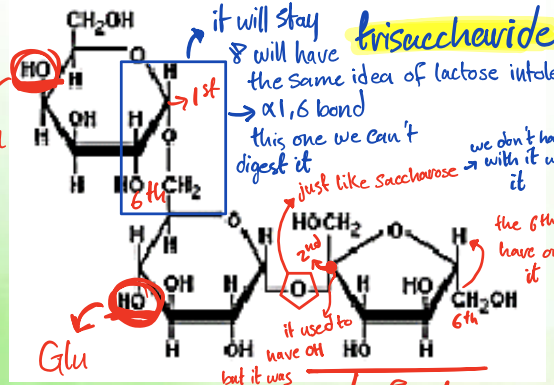
It is found in beans and vegetables like cabbage, brussels, sprouts, broccoli, and asparagus.

if there's a lot of inflamations in the intestence it might leads to colon cancer

Raffinose trisaccharide

Humans lack the alpha-galactosidase enzyme that is needed to break down raffinose, but intestinal bacteria can ferment it into hydrogen, methane, and other gases.

Gala



Homework

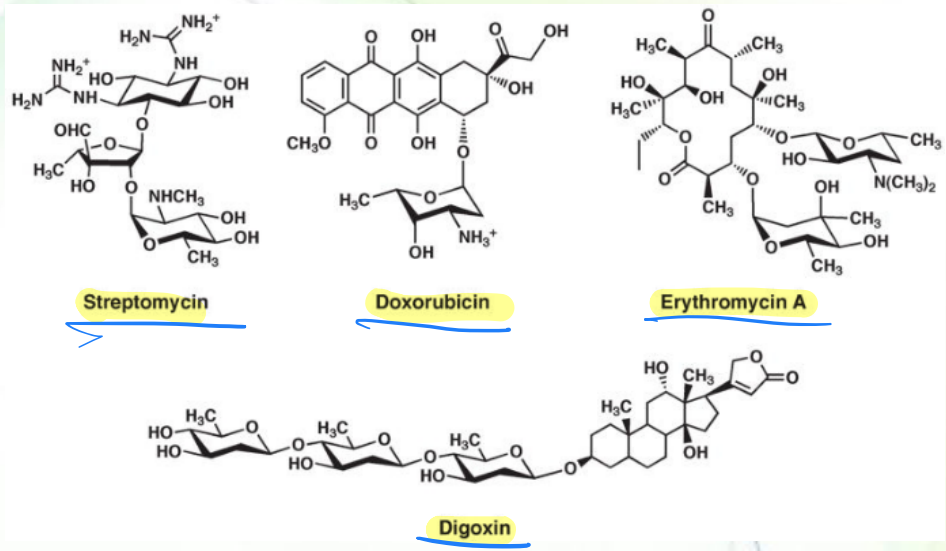
1. Recognize the monosaccharides that make up raffinose.
2. What is the monosaccharide that is attached to *what* disaccharide?

Oligosaccharides as drugs

- Some medications have a sugar like structure

- Streptomycin and erythromycin (antibiotics)
- Doxorubicin (cancer chemotherapy)
- Digoxin (cardiovascular disease)

Just know the ex not the structure



Do not memorize or study the structures.

Polysaccharides

they're very complaccated

What are polysaccharides?

Homopolysaccharide (homoglycan) vs. **hetero**polysaccharides

Same type

different type of monomers

Features of polysaccharides:

what's it unit
" " the linkage in between
is there any branches
what's the perpose of → branching
→ polysaccharide

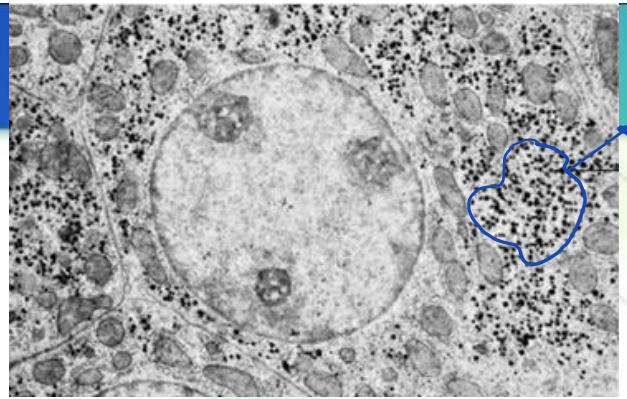
- **Monosaccharides**
- **Length**
- **Branching**
- **Purpose:**
  - **Storage (glycogen, starch, dextran)**
    - the storage of monosaccharide
    - it can't be stored like mono it has to be in poly form
      - in every living being
    - plount
      - we can store it like Glycolipids
    - highly branched
    - bacteria
  - **Structural (cellulose, pectin, chitin)**
    - they have mechanical function
    - Jelling Agent
    - exoskeleton creatures

Glycogen

- looks like starch in structure so they called it

Animal Starch

homopolysaccharide



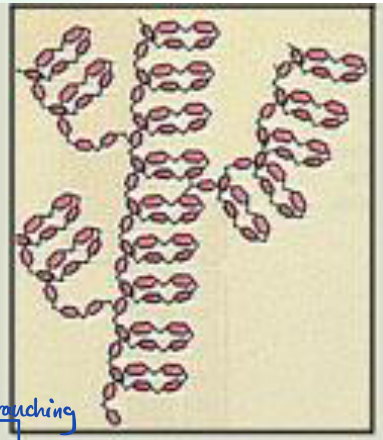
all cells can store glycogen but the largest storage are in liver & muscels . Also they don't last long "less than 24h"

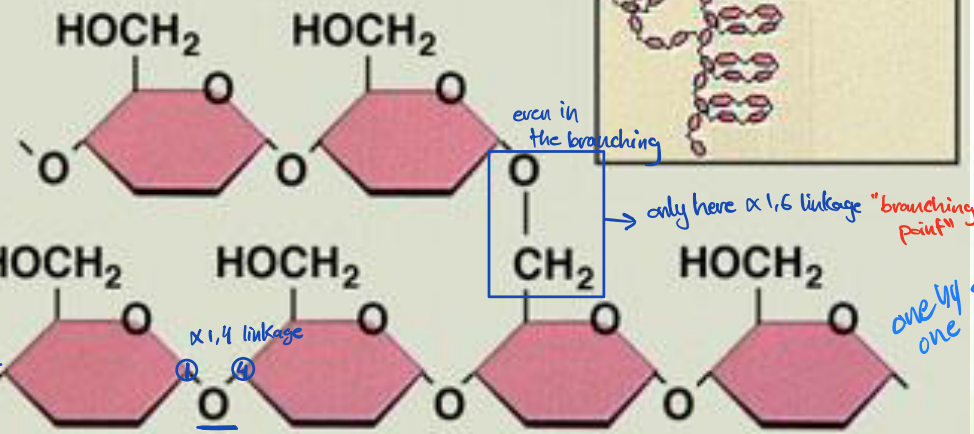
when we eat a lot amount of sugar & this sugar increase the layer of sugar resulting in more uptake

Storage form of Glucose

highly branched

Glycogen



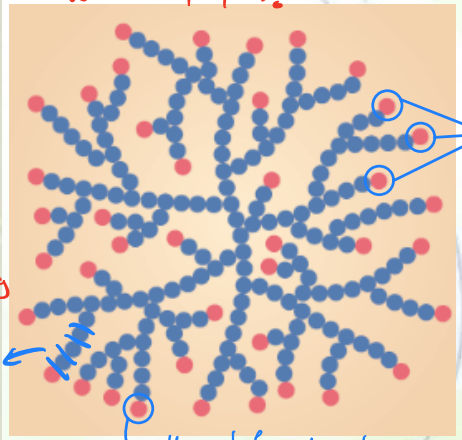


Memorize

branches occure almost at every 10

it branches for 13 layers

what's it porpous? increase the area to have fast degradation



each one of them when the degradation of glycogen apperse each of them will bind to enzyme

one by one

the end of any branch

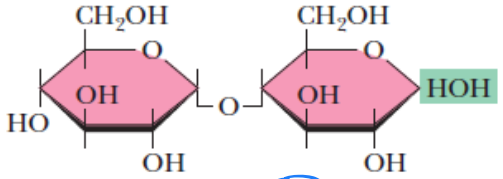
Quick Sources of Glucose

Starch

Can be found in potato, Corn, rice

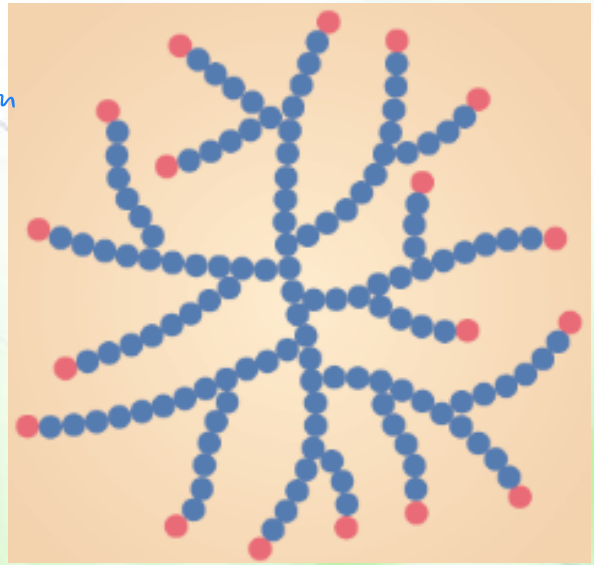
Which organisms' Forms: mixture of

- amylose (10-20%) minor
- amylopectin (80-90%) major → structure of the starch



Maltose (glucose-α-1,4-glucose)

made from Glucose



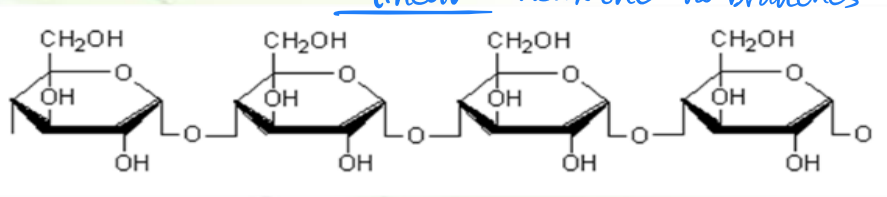
they're connected by α1,4 linkages

every 25 will start to branch → Amylopectine

less complecated than glycogen

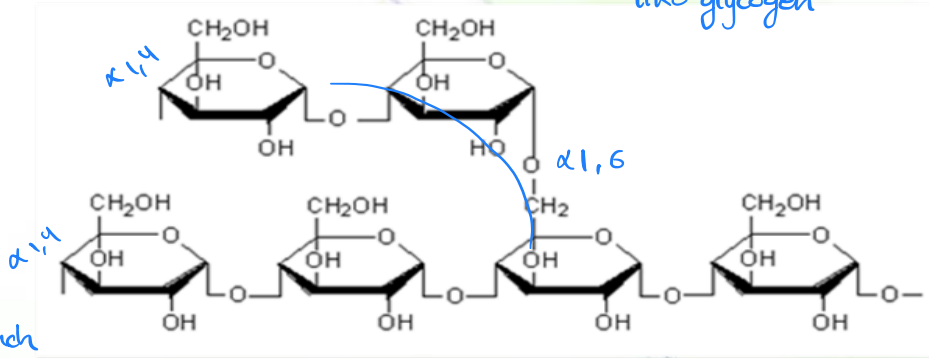
the porpose of branch also "Solubility" increase solubility

linear helix one no branches



Amylose Structure

like glycogen



Amylopection Structure

Memorize

Glycogen vs. amylopectin

Both are made from the same monomer and both are branched.

Glycogen exists in animals and amylopectin in plants.

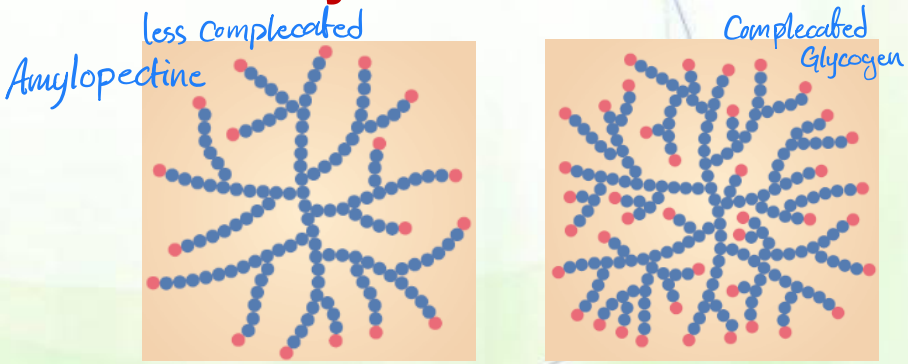
Glycogen is more highly branched.

Branch points occur about every 10 residues in glycogen and about every 25 residues in amylopectin.

Why is branching important?

It makes it more water-soluble and does not crystallize.

Easy access to glucose residues.

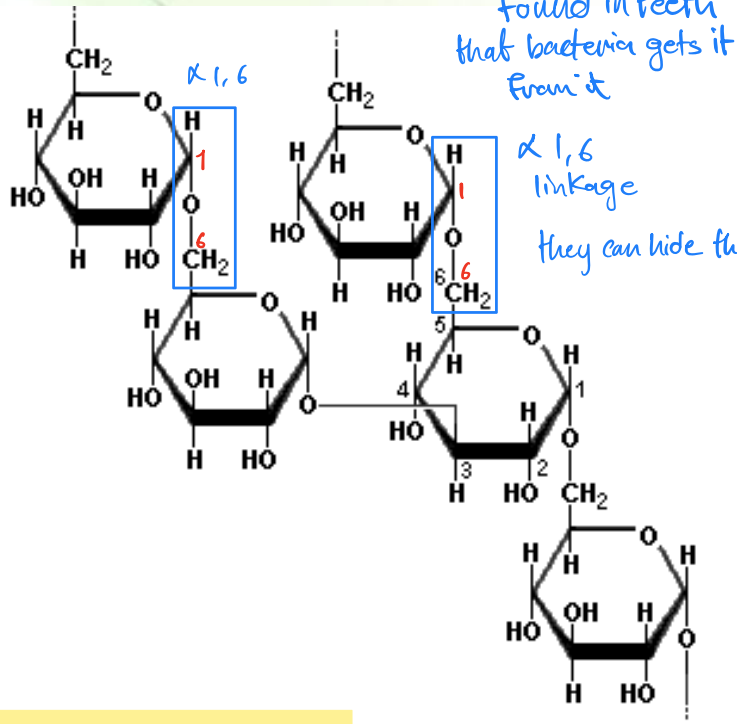


Dextran

highly branched

- A storage polysaccharide
- Yeast and bacteria
- (1-6)-D-glucose with branched chains
- Branches: 1-2, 1-3, or 1-4

highly branched homopolysaccharide made of glucose



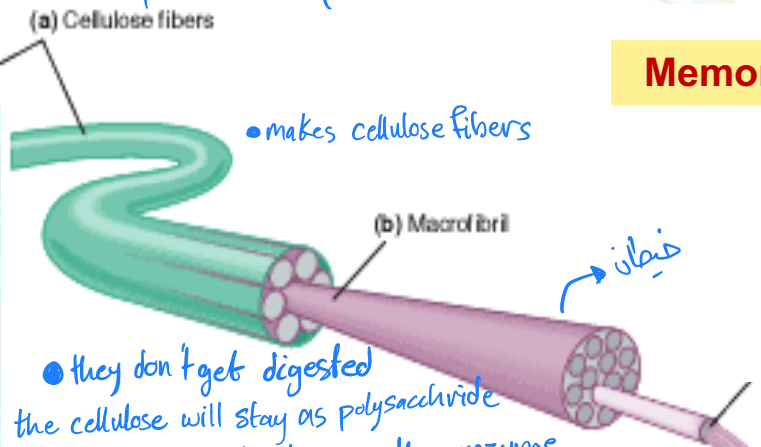
found in teeth that bacteria gets it nourishment from it

they can hide themselves

Do not memorize or study the structures.

Cellulose

present in plants



- makes cellulose fibers
- they don't get digested

the cellulose will stay as polysaccharide because we don't have the enzyme Cellulase

يوجد في الحيوانات التي تأكل النبات

make the things less solid in the body

get bundled → they form large number of hydrogen bond to build better strength

we can get it from plants

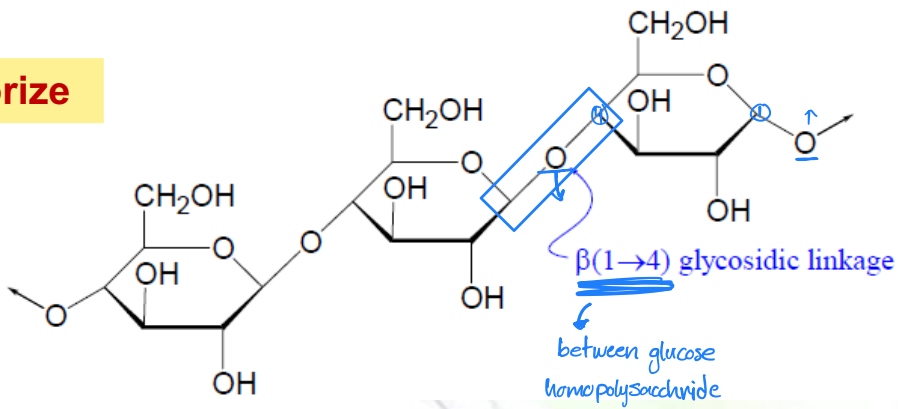
ألياف

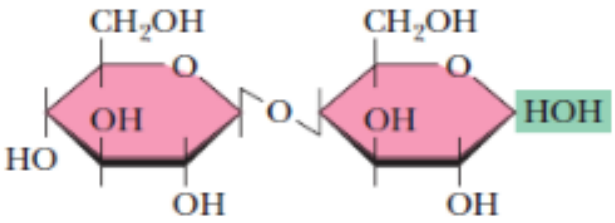
تراكمه يؤدي إلى زيادة عملية الإفراغ في الأمعاء

they drage H2O molecules & form hydrogen bonds they size up, & they give the feeling of fullness

زي الخيطان تبعت شبكة الصياد بتعمل كل السوء والكوليسترول

Memorize





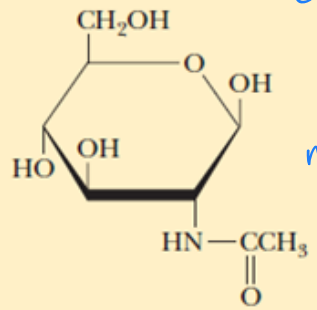
Chitin

What is the precursor?
Where does it exist?

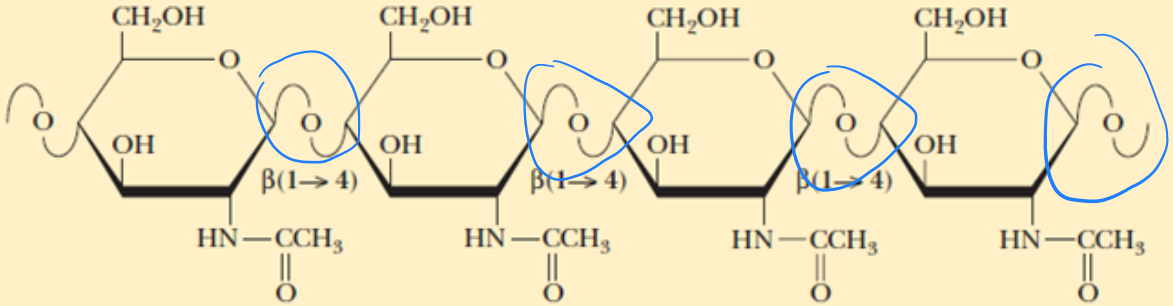
homopolysaccharide

Can add more groups which make it much stronger

made from modified sugar



N-Acetyl-β-D-glucosamine



Do not memorize or study the structures.

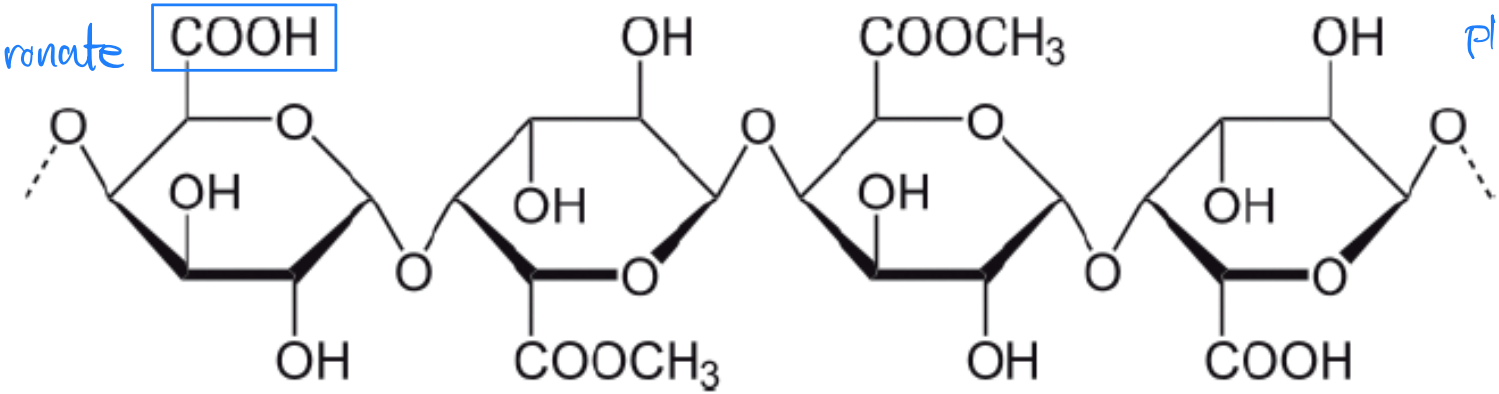
Pectin

What is the precursor?

Where does it exist?

heteropolysaccharide

galactoronate



Galacto ester

uses in food production

plant jell made of pectin

Do not memorize or study the structures.

Are polysaccharides reducing?

A sample that contains only a few molecules of a large polysaccharide, each molecule with a single reducing end, might well produce a negative test because there are not enough reducing ends to detect.

Sacarose → can't be reduced
the bond between glucose & fructouse
bind the anomaric carbons toghather
there's no more anomaric carbon
free to be oxidized

Glycosaminoglycans

heteropolysaccharide repeated disaccharide unit

protein

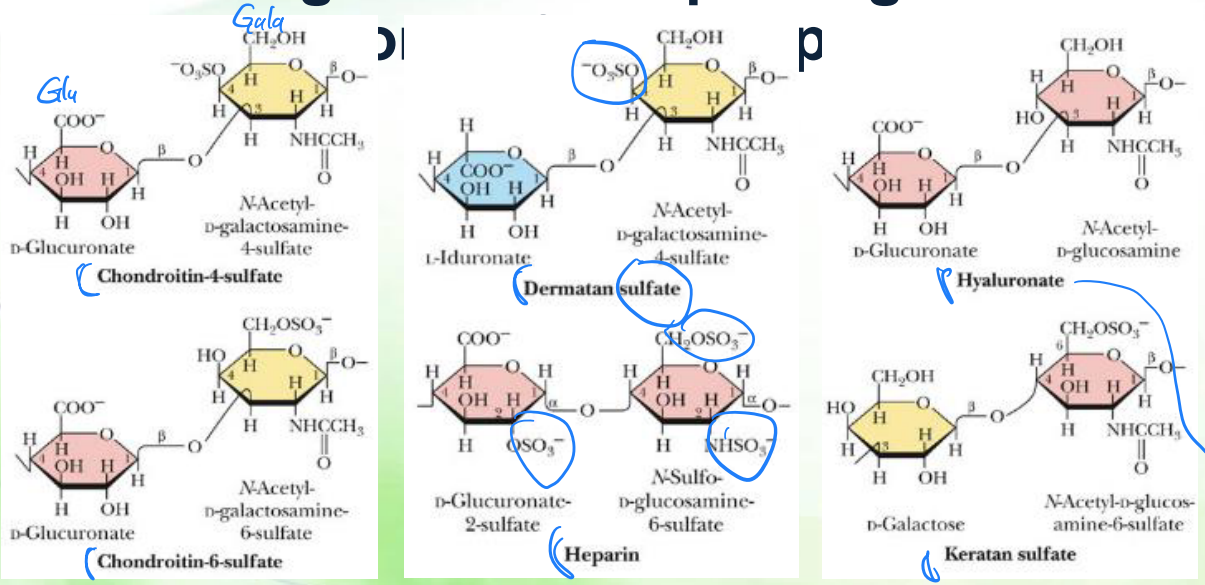
amination
oxidation
Sulfation

What are they? Where are they located?

Derivatives of an amino sugar, either glucosamine or galactosamine

At least one of the sugars in the repeating unit has a negatively charged o p

it main is
Glucose / Galactouse



more polarity = more H_2O
make a Jell structure in ECM

extra cushining effect
CT → made from ECM

Do not memorize or study the structures.

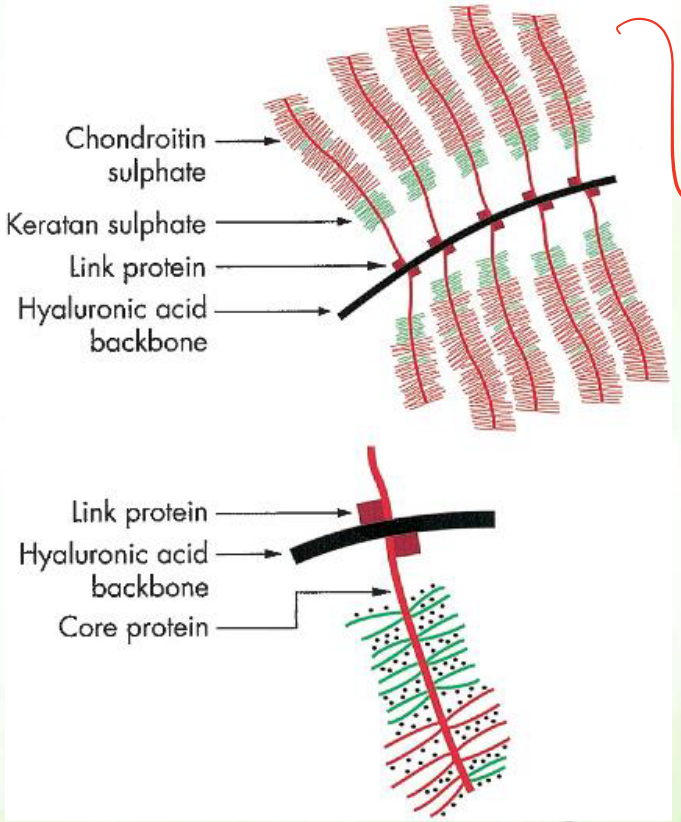
hyloronic acid

Localization and function of GAG

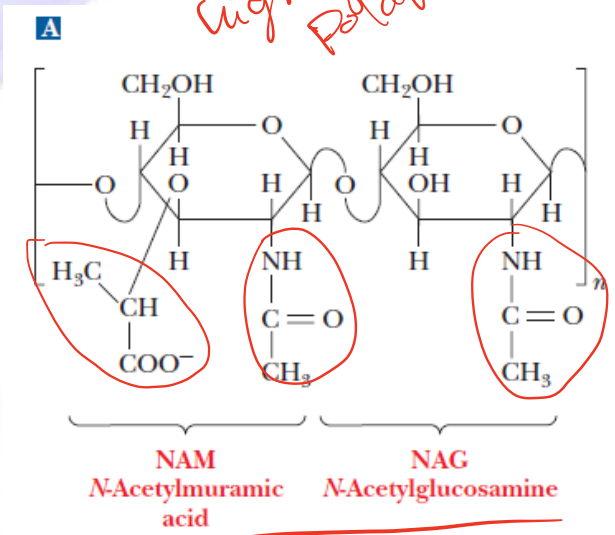
GAG	Localization	Comments
Hyaluronate	synovial fluid, **vitreous humor, ECM of loose connective tissue**	**the lubricant fluid , shock absorbing** As many as 25,000 disaccharide units
Chondroitin sulfate	**cartilage**, bone, heart valves	**most abundant GAG**
Heparan sulfate	basement membranes, components of cell surfaces	contains higher acetylated glucosamine than heparin
Heparin	component of intracellular granules of mast cells lining the arteries of the lungs, liver and skin	**A natural anticoagulant**
Dermatan sulfate	skin, blood vessels, heart valves	
Keratan sulfate	cornea, bone, cartilage aggregated with chondroitin	Only one not having uronic acid

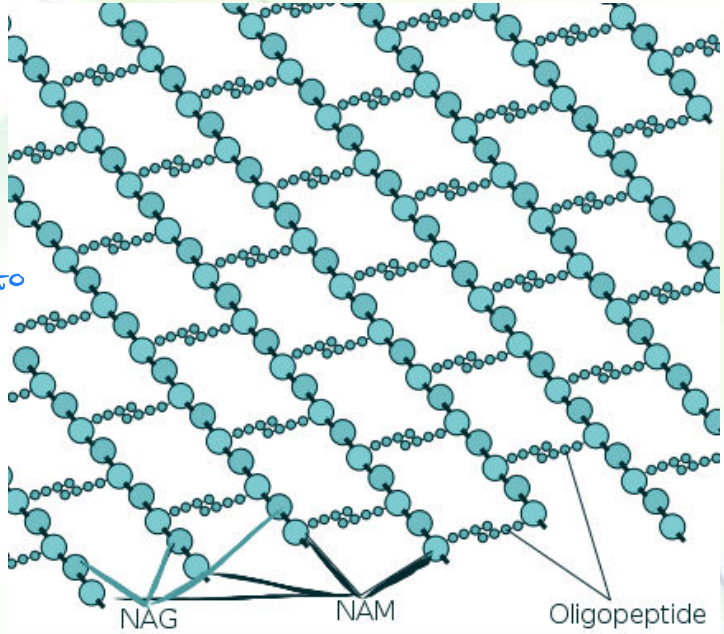
Proteoglycans

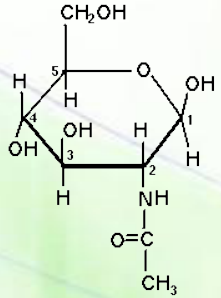
- Lubricants
- Structural components in connective tissue
- Mediate adhesion of cells to the extracellular matrix
- Bind factors that stimulate cell proliferation

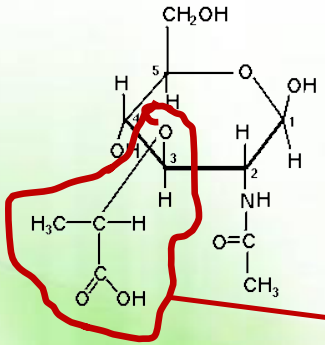


Bacterial cell wall





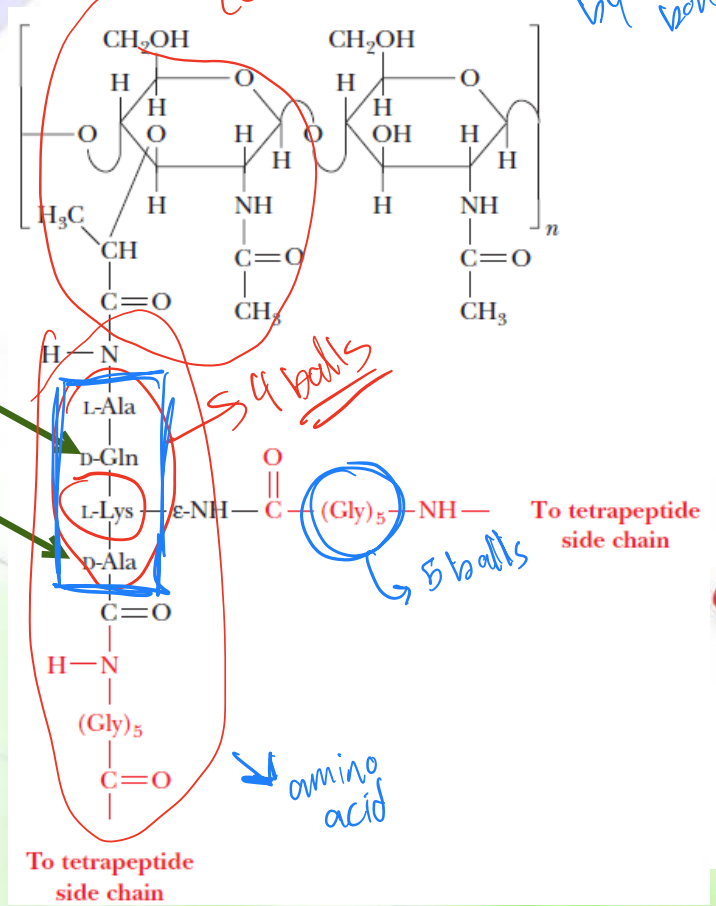

N-acetylglucosamine (NAG)

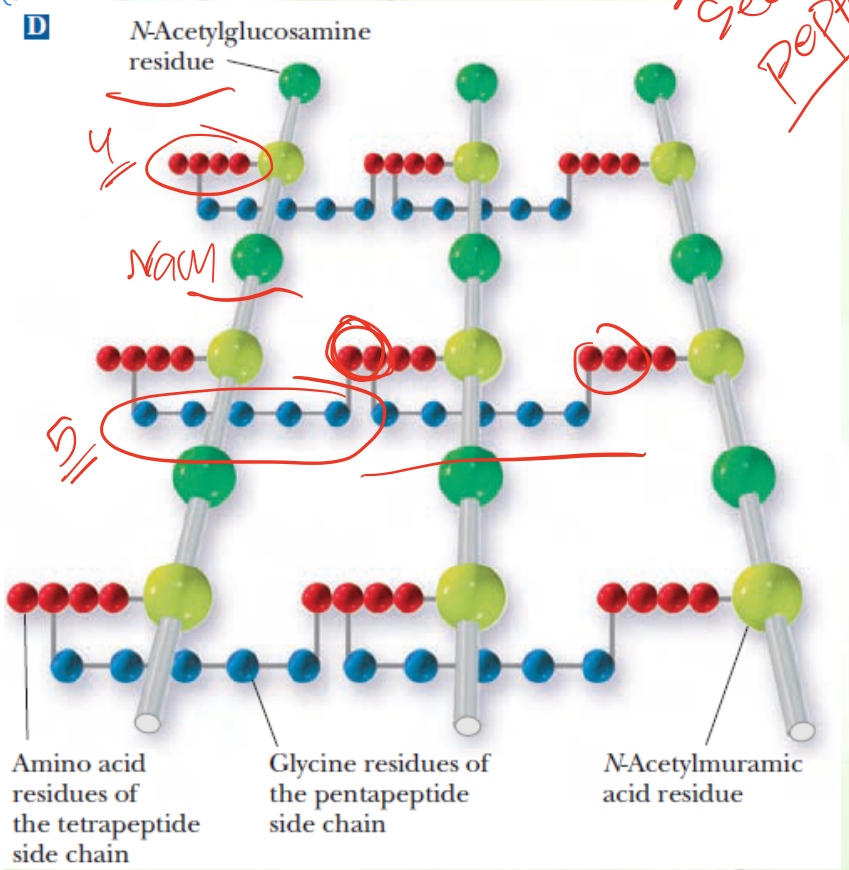

N-acetylmuramic acid (NAM)

Lactic acid

Do not memorize or study the structures.

Peptidoglycan





Glycoproteins

- The carbohydrates of glycoproteins are linked to the protein component through either O-glycosidic or N-glycosidic bonds
  - The N-glycosidic linkage is through the amide group of asparagine (Asn, N)
  - The O-glycosidic linkage is to the hydroxyl group of serine (Ser, S), threonine (Thr, T) or hydroxylysine (hLys)

Do not memorize or study the structures.

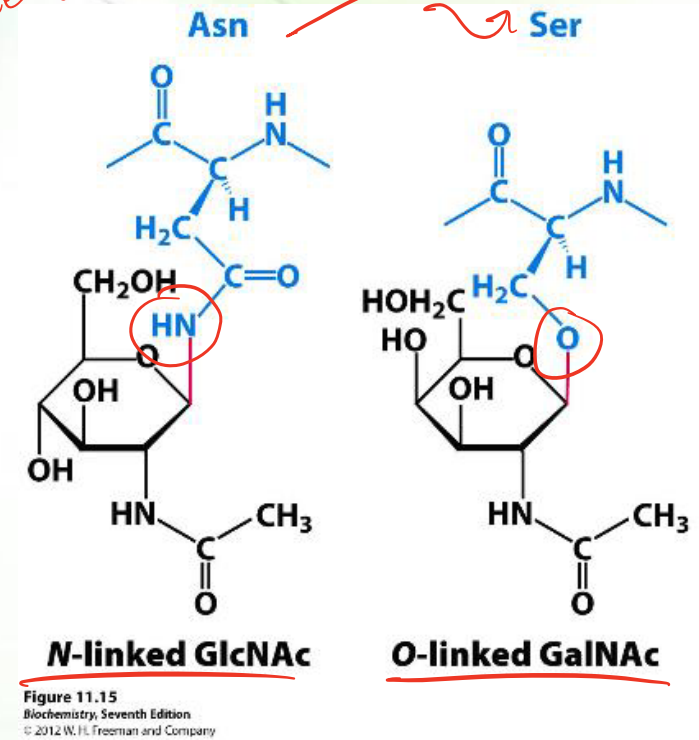


Figure 11.15
Biochemistry, Seventh Edition
© 2012 W. H. Freeman and Company

Significance of protein-linked sugars

recognition
↳ but not all of them

Soluble proteins as well as membrane proteins

Purpose:

- **Protein folding** ✓
- **Protein targeting** ✓
- **prolonging protein half-life** ✓ →  help to avoid degradating
- **Cell-cell communication** ✓
- **Signaling** ✓

Blood typing and glycoproteins

ABO system

Three different structures:

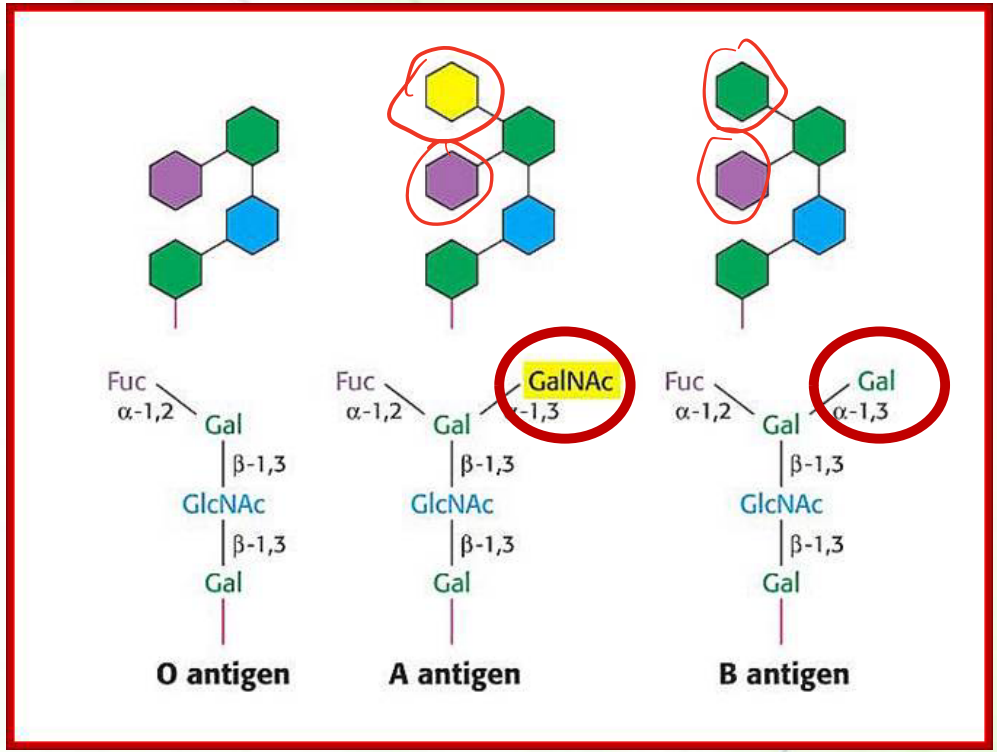
A, B, and O

The difference:

N-acetylgalactosamine (for A)

Galactose (for B)

None (for O)



Sialic acid

more talk in lipids → bacterial cell wall

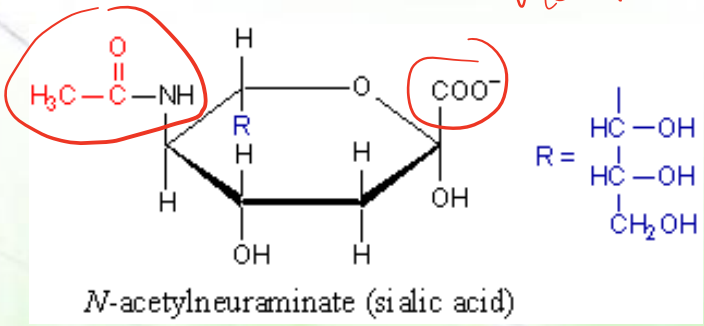
amino sugar → glycolipids

N-acetylneuraminate

Precursor: the amino sugar, neuraminic acid

Location: a terminal residue of oligosaccharide chains of glycoproteins and glycolipids.

modified



N-acetylneuraminate (sialic acid)

Do not memorize or study the structures.