Carbohydrates

Summer semester 2023-2024

لا إله إلا أنت سبحانك إني كنت من الظالمين.
رب إني لما أنزلت إلي من خير فقير.
اللهم صل على سيدنا محمد

What are they?

- Carbohydrates are polyhydroxy aldehydes or ketones.
- Saccharide is another name for a carbohydrate

- Functions:
  - Source of energy (glycogen and starch)
  - Structure (cellulose and chitin)
  - Building blocks (glycosaminoglycans)
  - Cellular recognition (glycoproteins)

* Functional group here : Aldehyde or ketone + OH^- group.

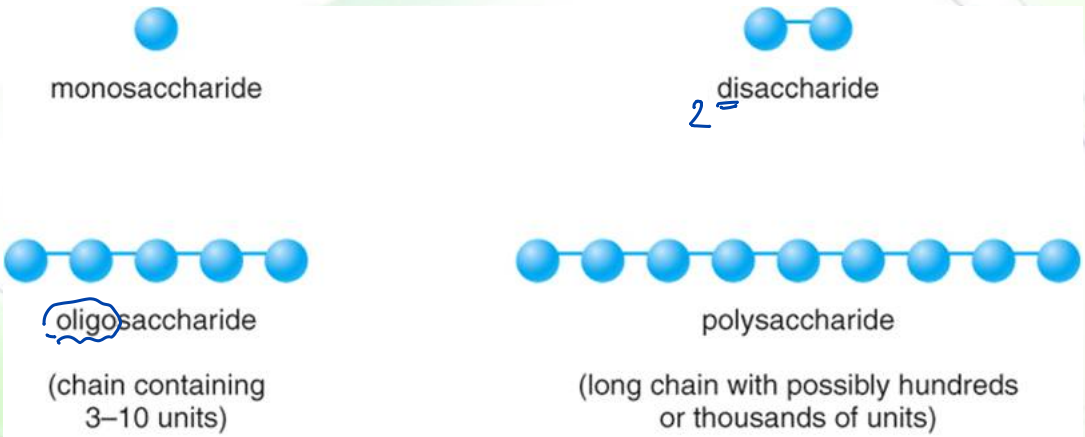
* ترتيب قوة ال functional group :
1) keton.
2) Aldehyde.
3) OH^-.

دعم زي بالنبات

Can make larger structure

Classification I

- By the number of sugars that constitute the molecule
  - Monosaccharides, Disaccharides, Oligosaccharides, Polysaccharides

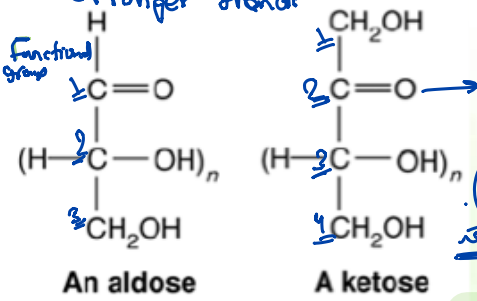


Carbohydrates – natural forms

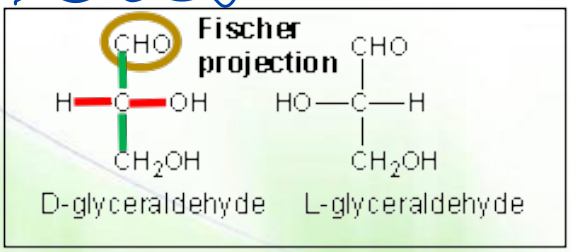
- Most carbohydrates are found naturally in bound form rather than as simple sugars.
  - Polysaccharides (starch, cellulose, inulin, gums)
  - Glycoproteins and proteoglycans (hormones, blood group substances, antibodies)
  - Glycolipids (cerebrosides, gangliosides)
  - Glycosides
  - Mucopolysaccharides (hyaluronic acid)
  - Nucleic acids (DNA, RNA)

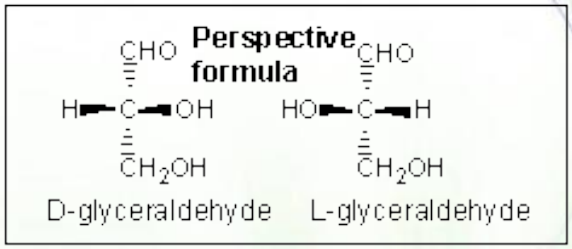
Monosaccharides

- Basic chemical formula: $(CH_2O)_n$
- They contain two or more hydroxyl groups.



Fisher projections or perspective structural formulas.





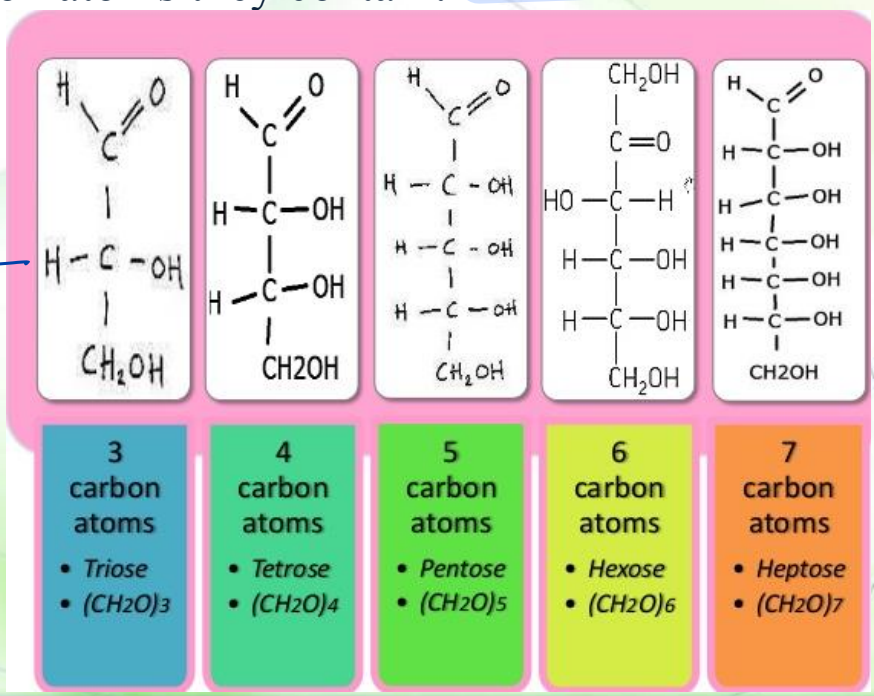
— Forward Backward **Top (C1): Most highly oxidized C**

Classification 2

specific for num of carbon in monosaccharide. * Smallest sugar 3 carbon

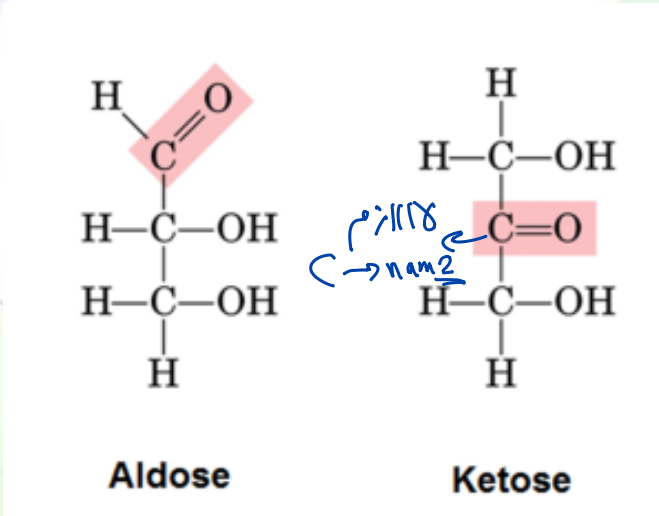
- By the number of carbon atoms they contain. في تصنيف السكريات البسيطة.

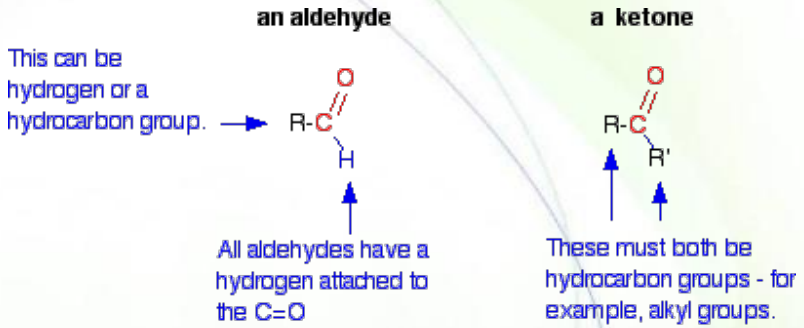
  - Triose
  - Tetrose
  - Pentose
  - Hexose
  - Heptose
  - …



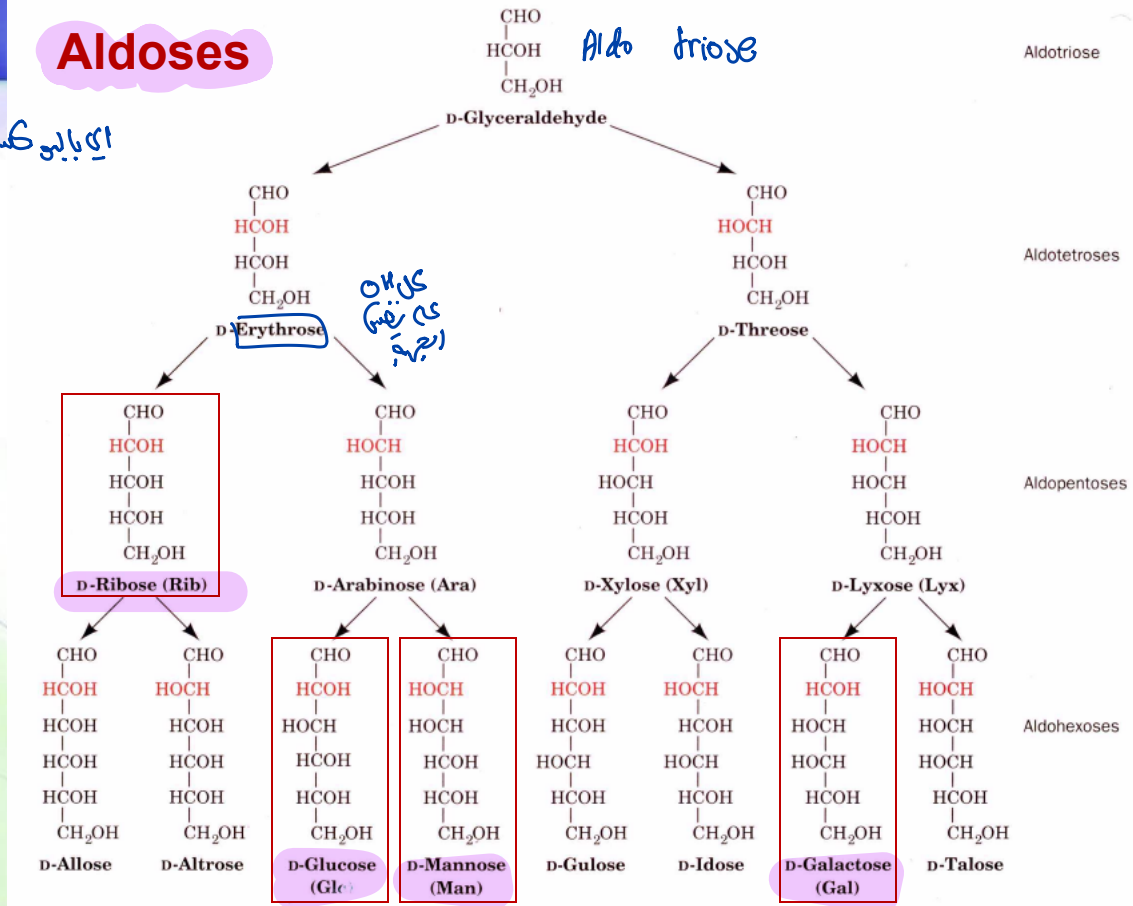
Classification III

- By the functional group



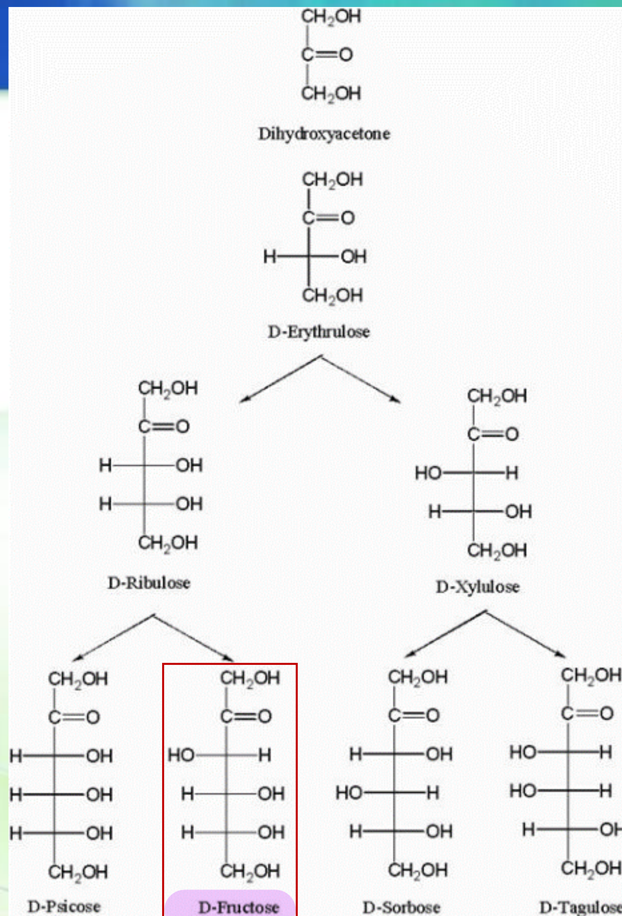


Aldoses



Memorize the ones in boxes.

Ketoses

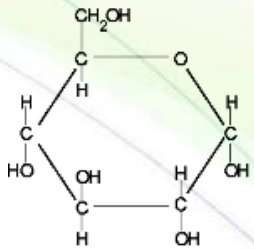


Memorize the ones in boxes.

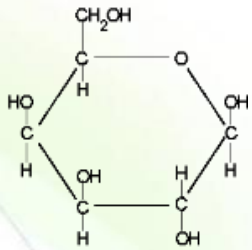
الاهم

Common Monosaccharides

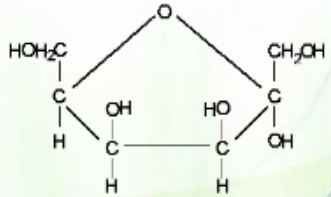
- Glucose:
  - Mild sweet flavor
  - Known as blood sugar
  - Essential energy source
  - Found in every disaccharide and polysaccharide
- Galactose:
  - Hardly tastes sweet & rarely found naturally as a single sugar
- Fructose:
  - Sweetest sugar, found in fruits and honey
  - Added to soft drinks, cereals, desserts



Glucose



Galactose

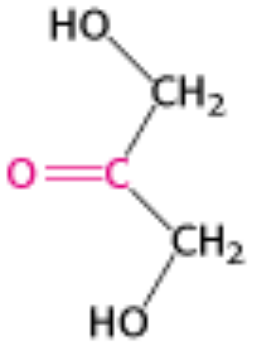


Fructose

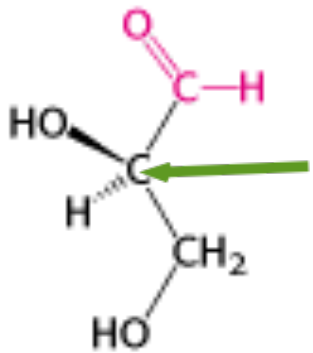
Trioses

What is a chiral carbon?

The simplest sugar (tri).
only



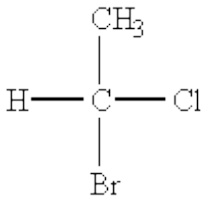
Dihydroxyacetone
(a ketose)

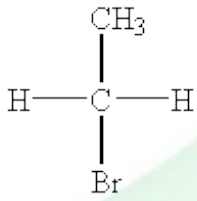


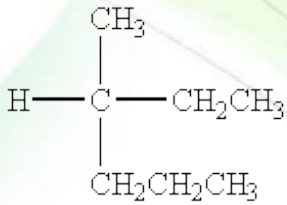
D-Glyceraldehyde
(an aldose)

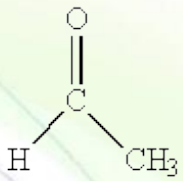
Chiral carbon * 4 Covalent bond
4 different group.

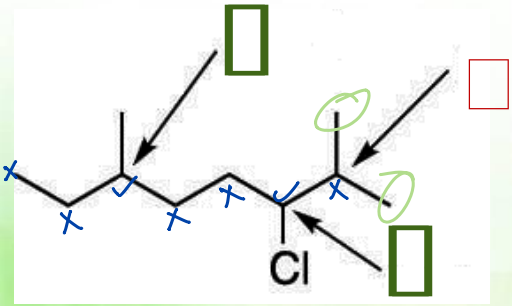
Note what a chiral carbon is…



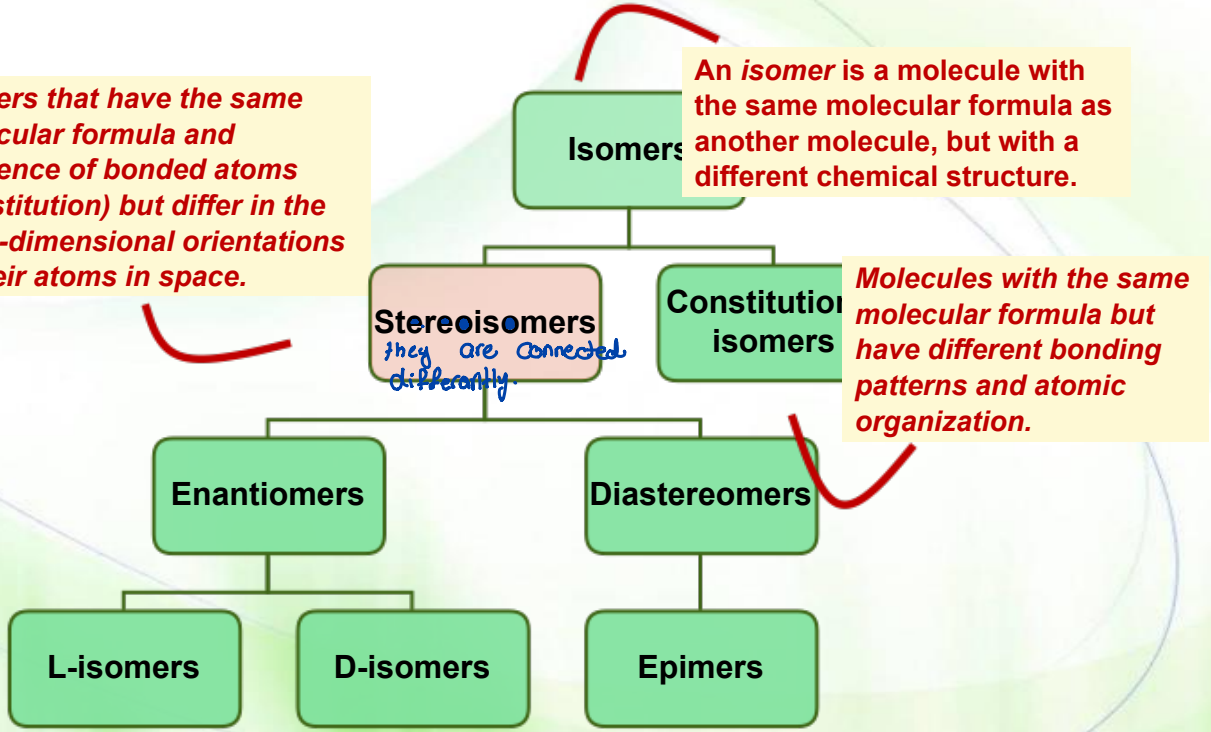








Isomerism



in space they are different

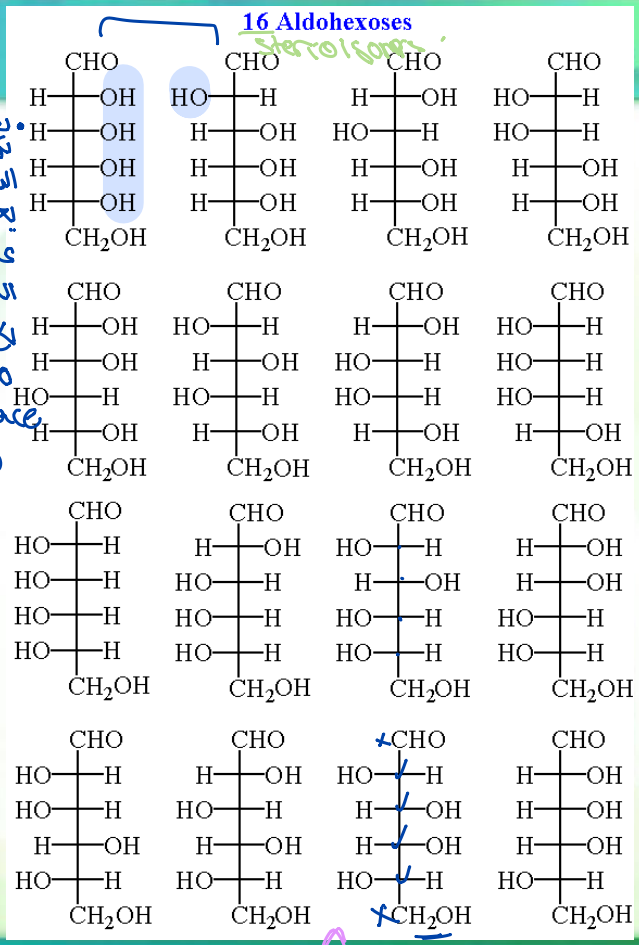
Isomers of glucose

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

Search for:

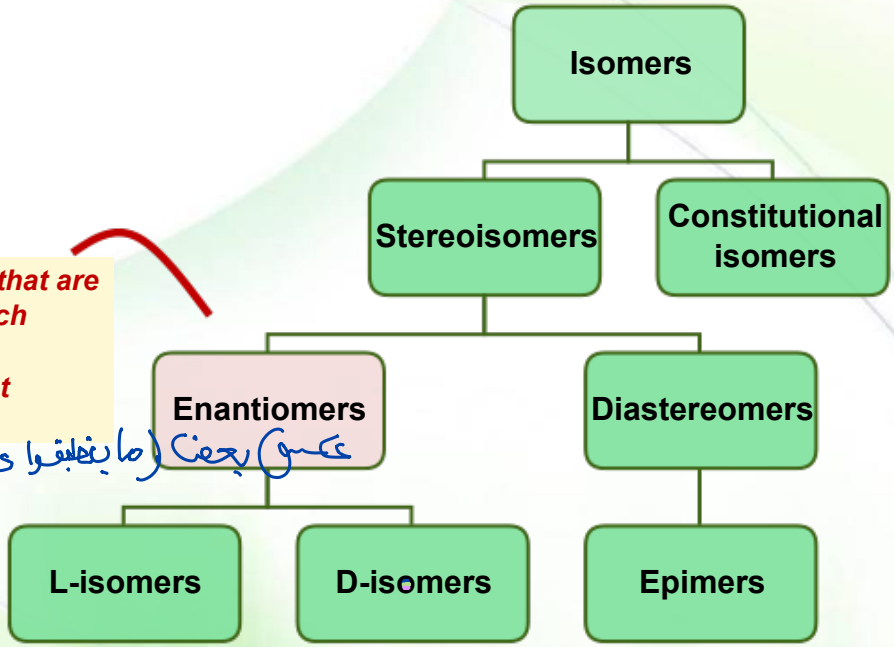
Glucose,
Galactose
Mannose

- How do I know the num of Steriosomers of any sugar? depends on num of chiral Carbon=2^n



Glucose,
Galactose
Mannose

Enantiomers



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

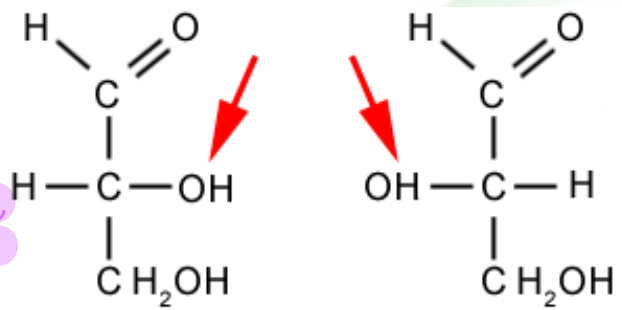
عكس بعض (ما يطبقوا على بعض)

- How many enantiomers does glucose have ?

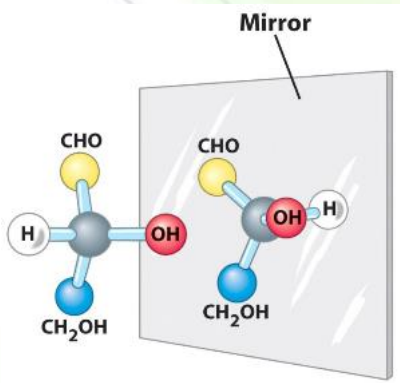
only 1

مركب دائه صورة واحدة فقط .

Sugar enantiomers (D- vs. L-)



D-Glyceraldehyde L-Glyceraldehyde



Ball-and-stick models

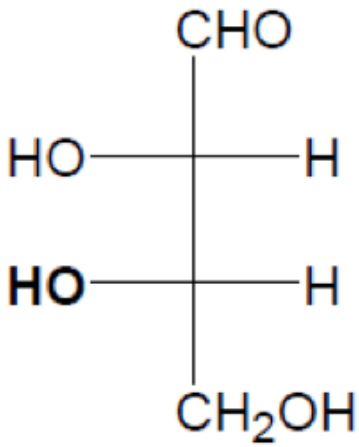
*for each molecule and its mirror image → L → D

How many enantiomers? Only one.

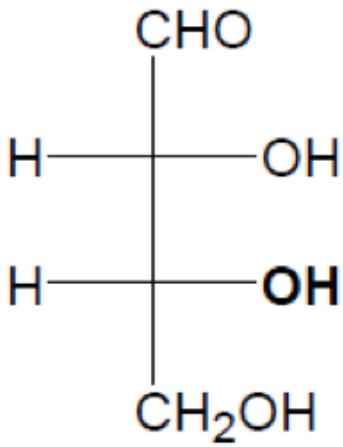
right. (Left)

*using D/L depend on position of OH which is connected to farthest Chiral functional ic group.

Which one(s) is a chiral carbon?



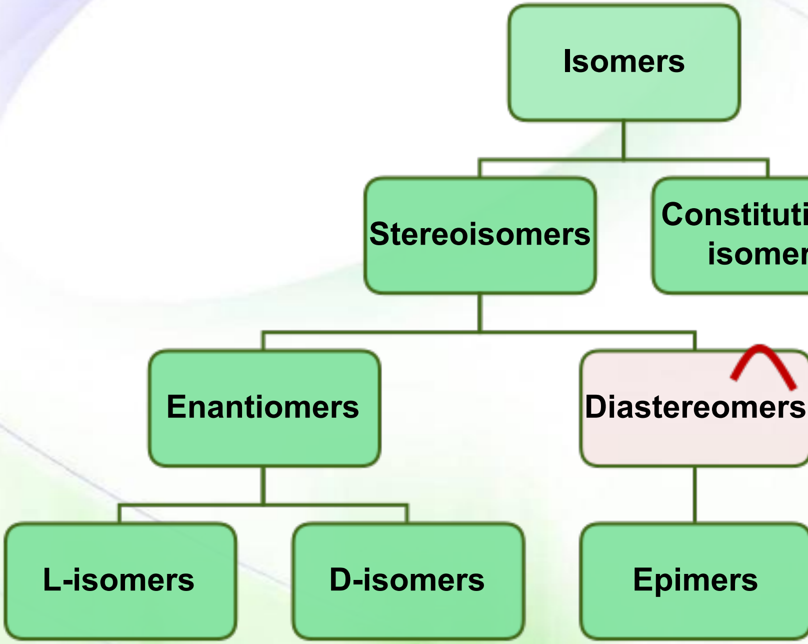
L-erythrose



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.

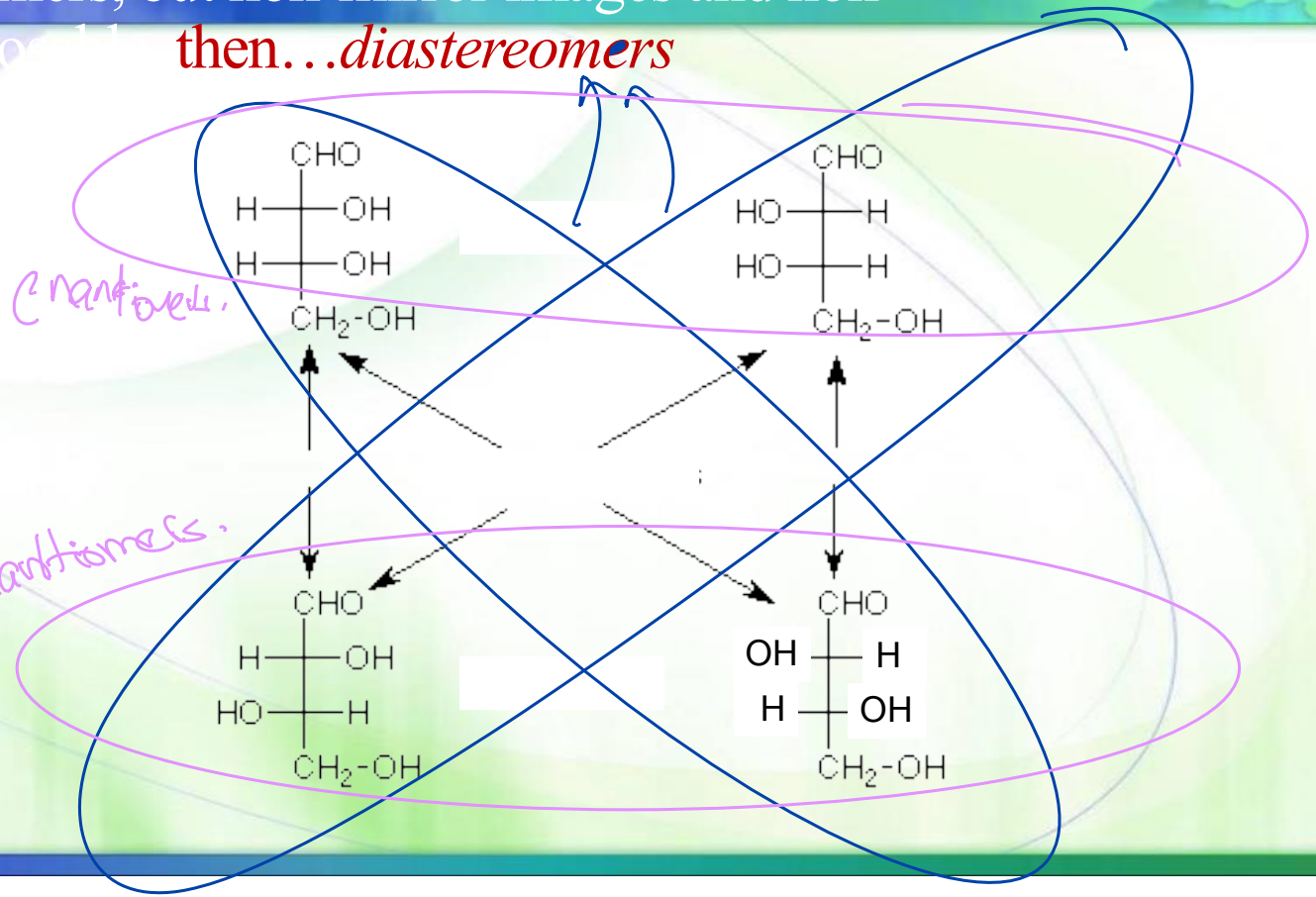
* How many diasteriomers does Glucose have? 14

— 15

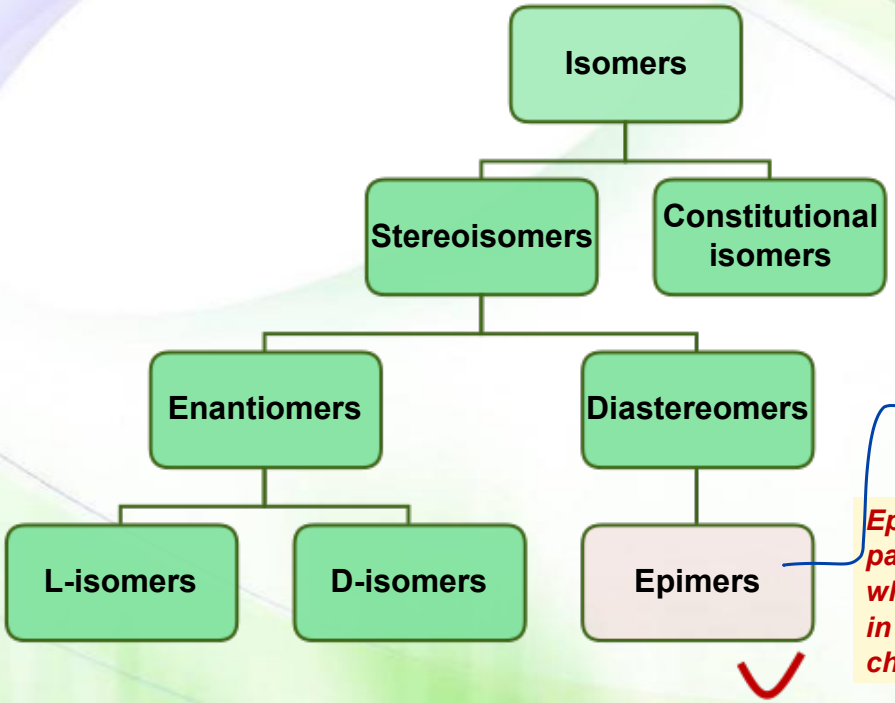
enantiomers 16

Stereoisomers, but non-mirror images and non-superimposable

then…*diastereomers*



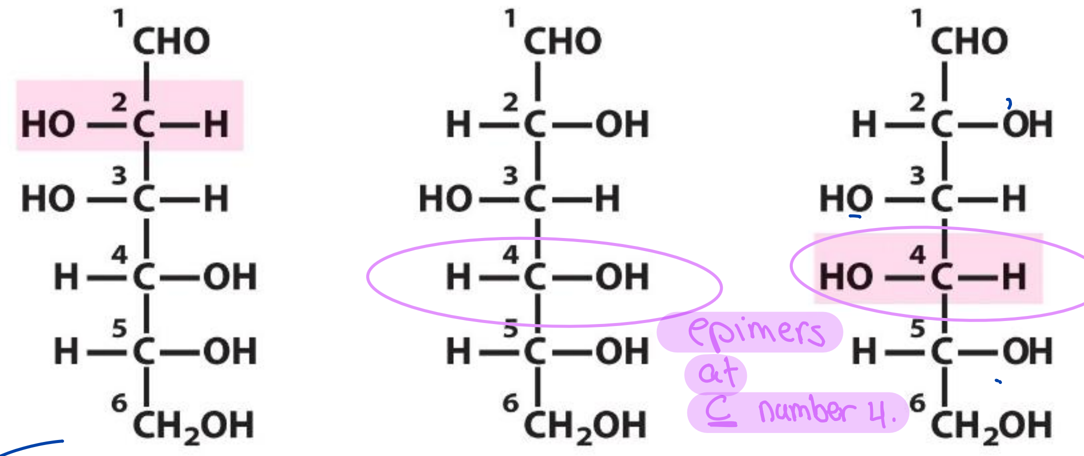
Isomerism



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.



D-Mannose (epimer at C-2)

D-Glucose

D-Galactose (epimer at C-4)

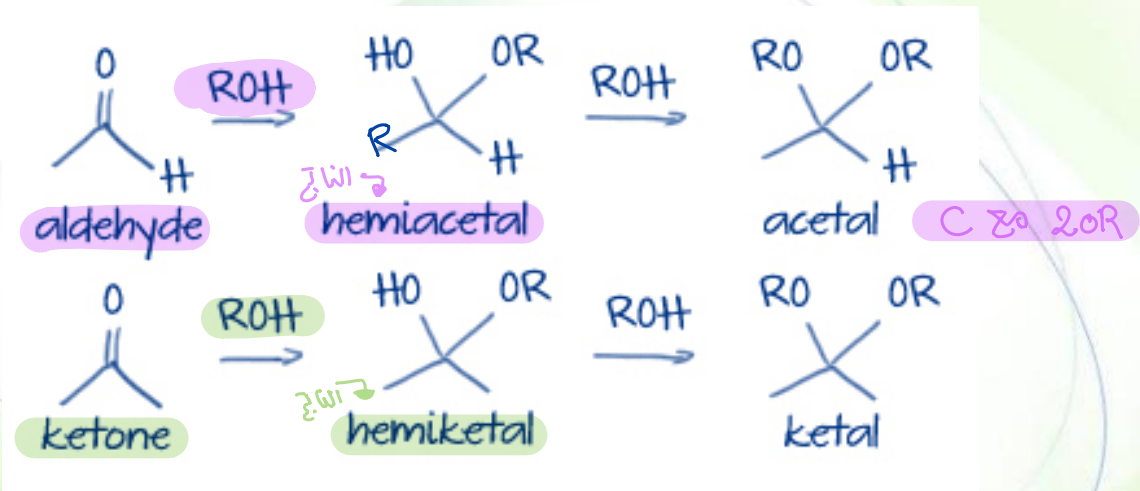
isomers
stero
enantiomers ? X
mirror image
Diasterio
epimers.
chiral

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

Diastereo but not epimer

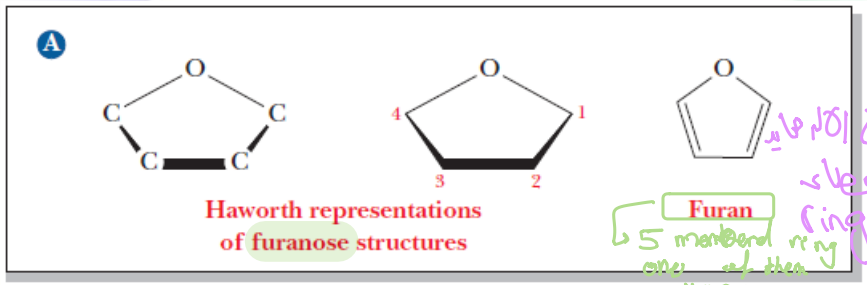
Acetal/ketal vs. hemiacetal/hemiketal

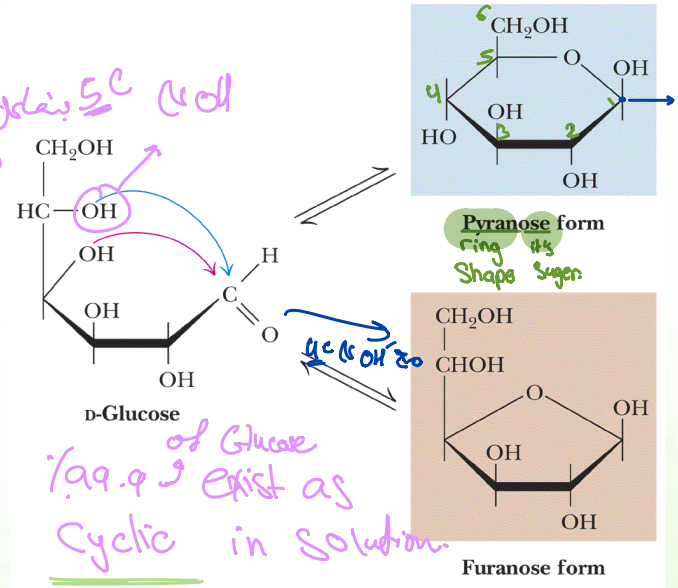
Hemiacetal and hemiketal: ether and alcohol on same carbon
Acetal and ketal: two ethers on same carbon



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

Formation of a ring structure

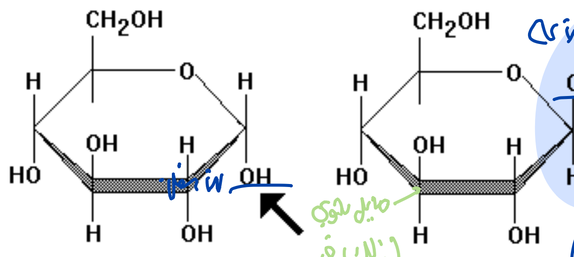




- furan and pyran → name of rings
- Puranose more stable than furanose

Anomers

- In rings form, All groups are stable So the positions don't change. Except the group on Carbon num 1. (إذا فوق بضل فوق إذا تحت بضل تحت) إذا كانت بالأصل هيك.
- لو كان الـ OH متحركة إذا كانت:
  - up the ring → beta
  - below the ring → alpha



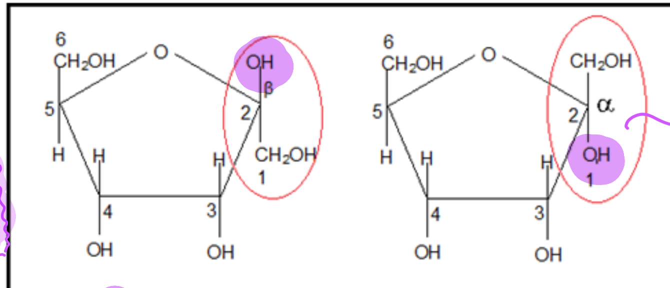
alpha-D-glucose   beta-D-glucose

أو OH باصل كانت functional group.

(C اللي فوقها OH بختلف اتجاهها) → Anomeric Carbon

. المركب اسمه Anomers

- Anomers: Sugar molecule that differ in orientation of position of OH that's Connected to Anomeric Carbon.



β-D-fructose   α-D-fructose

OH up the ring.   OH below the ring.

بالفركتوز منطلع ع Anomeric Carbon which was (C=O) keton → C num 2

β من كلمة بيت، البيت فوق الأرض، إذا OH باكون فوق

α شكلها زي السمكة وين بتسبح السمكة؟ بالبحر تحت، إذا OH تحت

فركتوز منطلع ع 2C

Chain to ring
Left-up, right-down