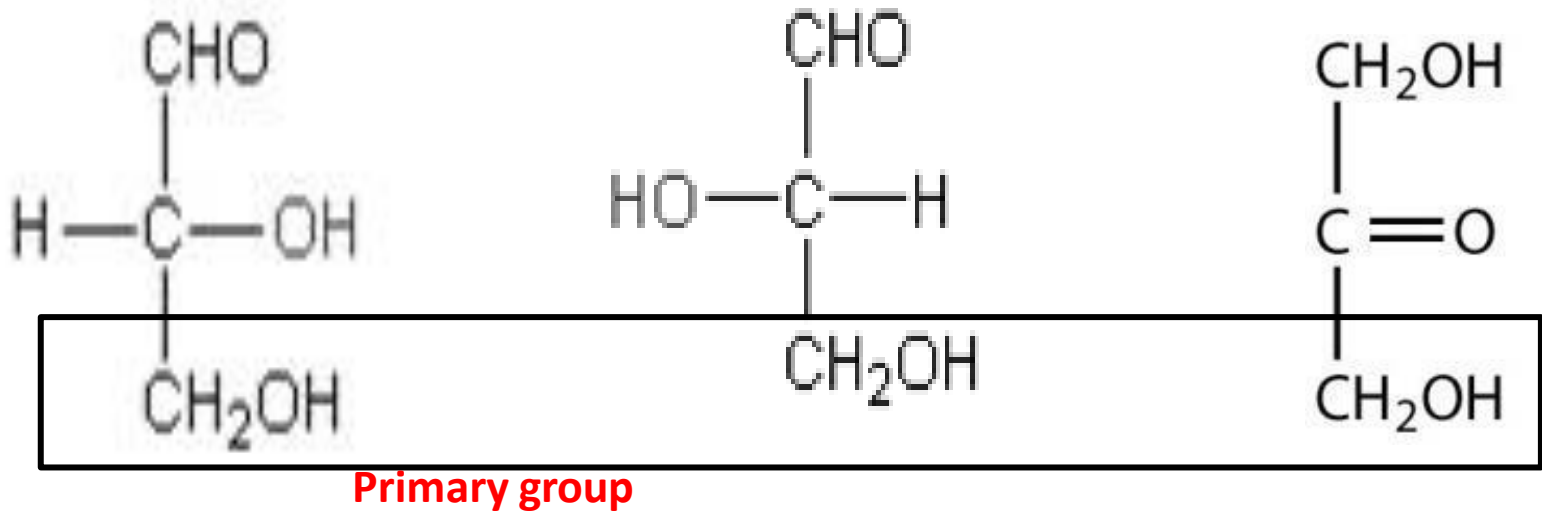


All monosaccharides are optically active except?

- A. Glucose
- B. Galactose
- C. Fructose
- D. Dihydroxyacetone
- E. Glyceraldehyde

- Glyceraldehyde and dihydroxyacetone. (They are intermediates in the break down of glucose).



D- Glyceraldehyde

Dihydroxyaldose

L- Glyceraldehyde

Dihydroxyacetone

Dihydroxyketose

D & L denote the absolute configuration. i.e. D means that OH group on the subterminal carbon atom is at the right but L means OH group on the subterminal carbon atom is at the left.

Which of the following monosaccharides has 4 carbon atoms, the penultimate OH group is to the right and results in rotation of polarized light towards the left?

- A. D-tetrose l(-)
- B. L-tetrose l(-)
- C. D-tetrose d(+)
- D. D-trirose l(-)
- E. D-trirose d(+)

Monosaccharides occur in cyclic form:

- Monosaccharides having 5 or more carbon atoms usually occur in **aqueous solution** as **cyclic ring structures**

لما أضيف الـ monosaccharides لمحلول مائي ترتيب الذرات والشكل الكيميائي يتحول لـ حَلَقِي (cyclic ring structures)

- Here, the carbonyl group (C1 in aldehyde or C2 in ketone) forms a covalent bond with the oxygen of a hydroxyl group along the chain (4th or 5th carbon)

وهاض التحول يتم عن طريق تكوّن covalent bond بين الـ C المرتبطة مع الـ O برابطة ثنائية (C1 بالـ aldehyde و C2 بالـ ketone) وبين الـ O الموجودة بالـ hydroxyl group عالـ C (رقم 4 أو 5 حسب المركب)

- Therefore C_1/C_2 becomes **asymmetric Carbon atom.**

2 stereoisomers:

- If the OH group is on the right side/ down it is (α) sugar
- If the OH group is on the left side/ up it is (β) sugar

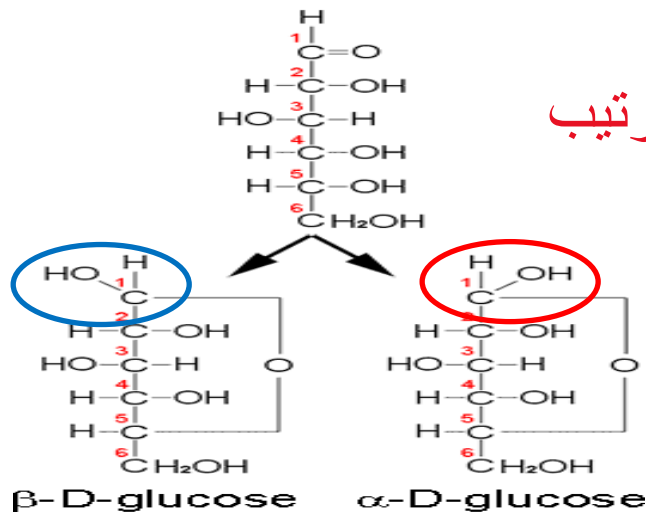
بعد ما المركب يوخذ ال cyclic structure رح تكون رابطة ال OH يا يمين (وبالشكل الحلقي بتكون للأسفل) وبسميه α sugar أو رابطة لليساار (للأعلى في الحلقة) وبسميه β sugar

- The first carbon is called **anomeric carbon atom** & the α and β sugars are called anomers , anomeric C atom رقم 1 و بسمي الكربونة رقم 1 و ال 2 isomers الناتجين يُطلق عليهم اسم anomers
- **Anomers:** These are sugars which have the **same configuration** but differ only in the arrangement of groups or atoms **around the carbon atom of active sugar group**

المركبين نفس التركيبة الكيميائية بس الفرق بينهم هو ترتيب الروابط على C1, فالمركبين يعبرتوا anomers..

لما ظهرت ال OH عاليين سميناه α

ولما ظهرت عاليساار سميناه β

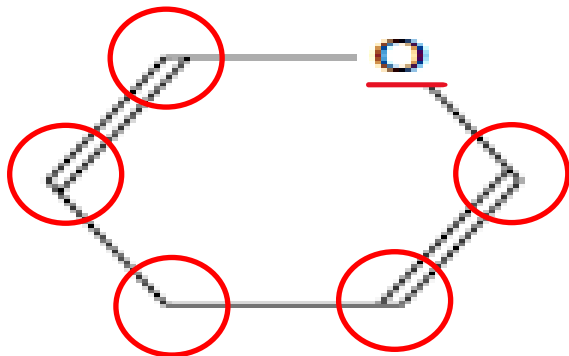


- Two types of cyclic ring structure can be formed:

Pyran ring: a 6 membered ring having 5 carbons.

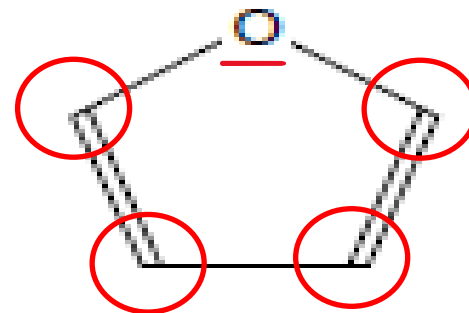
Furan ring: a 5 membered ring with only 4 carbons.

لو عندي بالمركب أكثر من 5 ذرات كربون (مثلا hexose) فالزيادة رح تكون لبرا وتسبب تغير في زوايا الروابط (زي ما موضح بالاسلايد التالي)



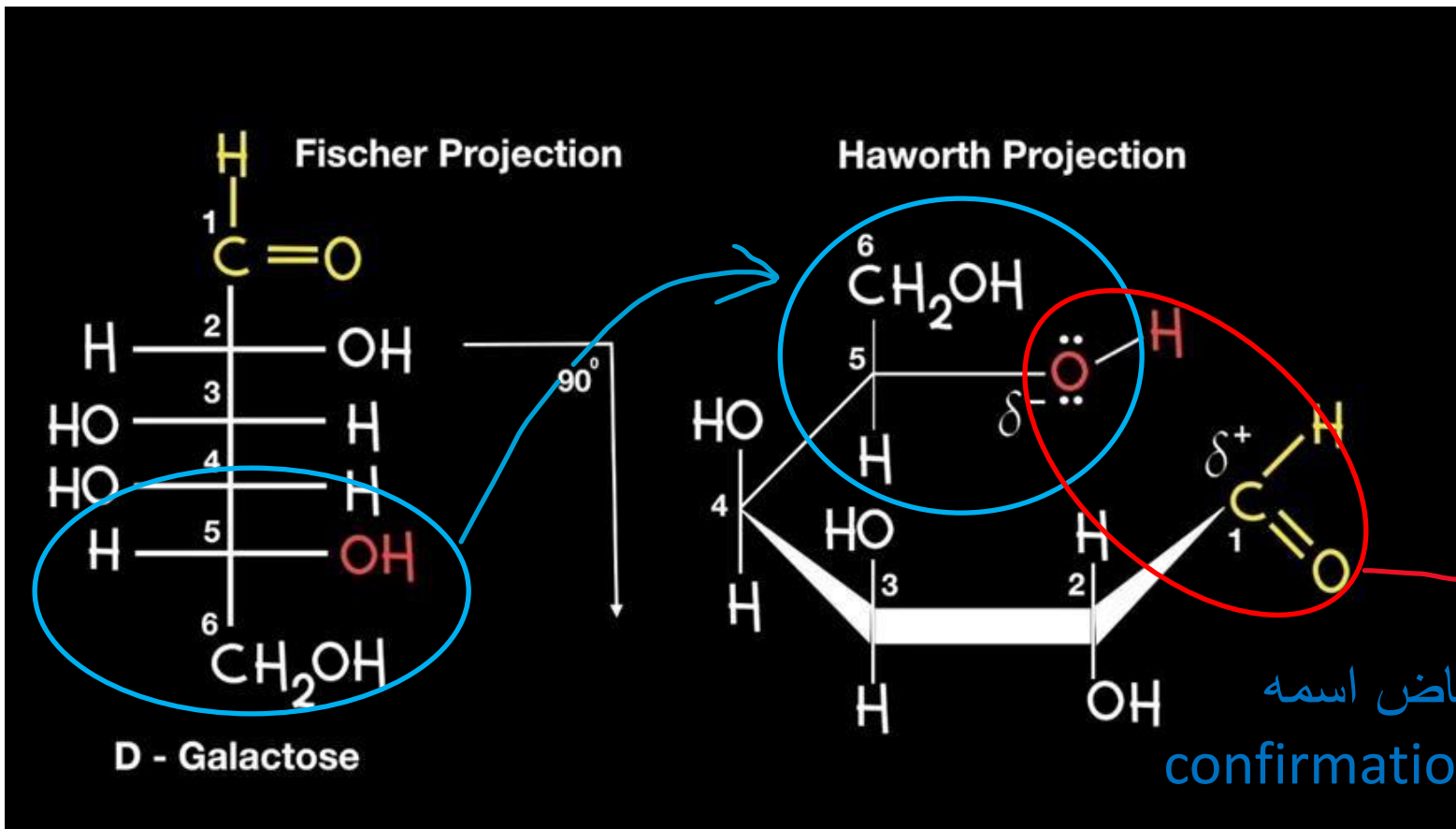
6 membered , 5 C

Pyran Form



5 membered , 4 C

Furan Form



وبصير التغير
عن طريق تغير
بقيمة 90 درجة
في زوايا
الروابط على C5

والتغير هاض اسمه
confirmational change

Question: how to project D vs L sugars in ring structure?

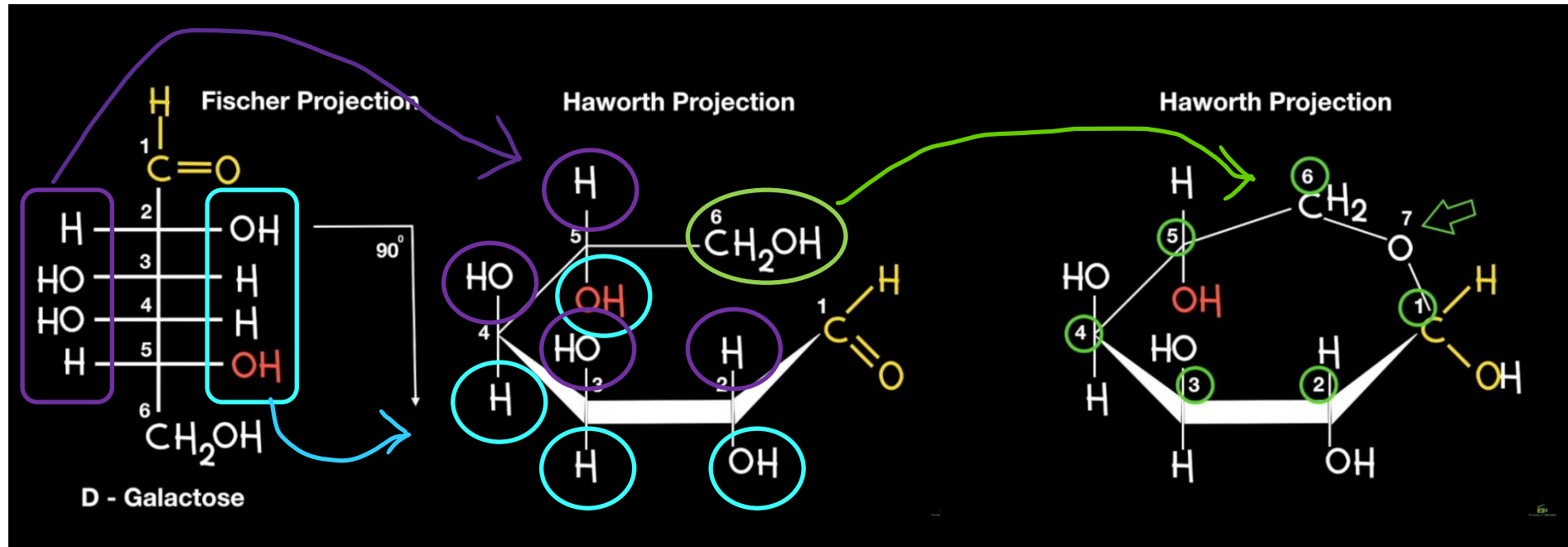
إذا كان المركب D فال primary group رح تكون
للأعلى ولو كان L ال primary group للأسفل

C6 upwards= D sugar
C6 downwards = L sugar

https://www.youtube.com/watch?v=10v_I4HGSAE&t=47s

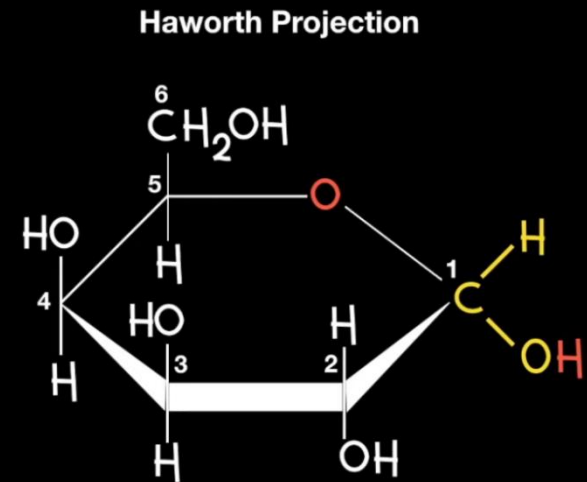
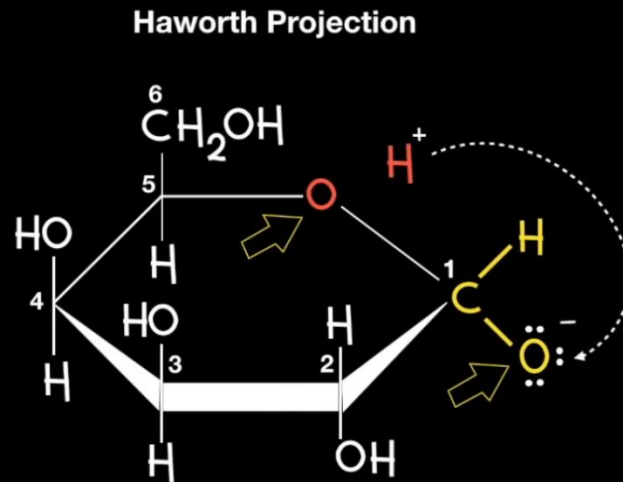
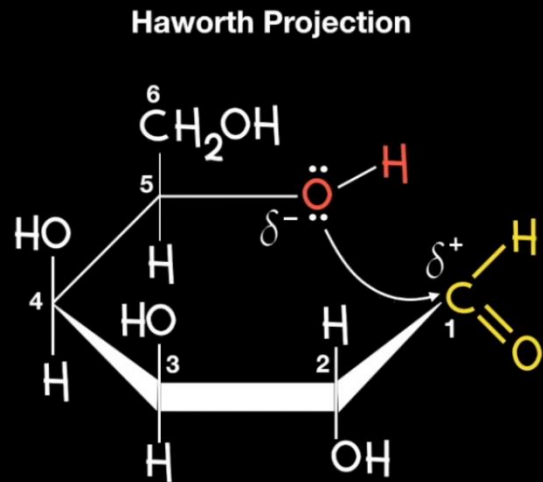
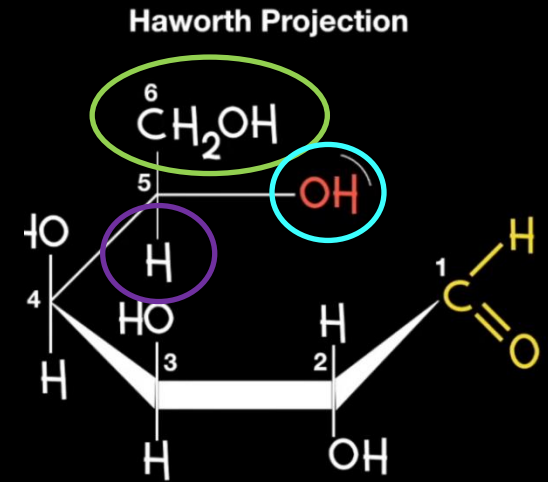
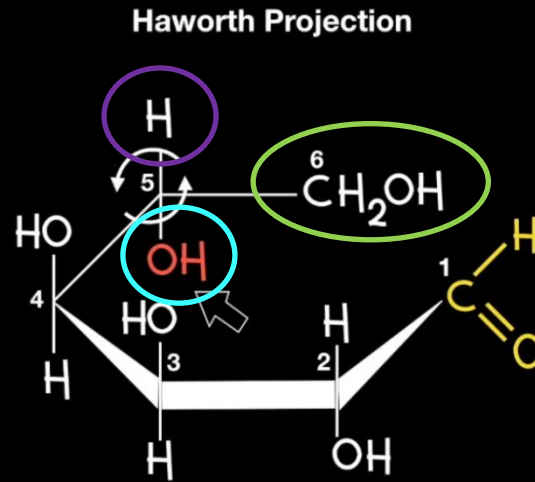
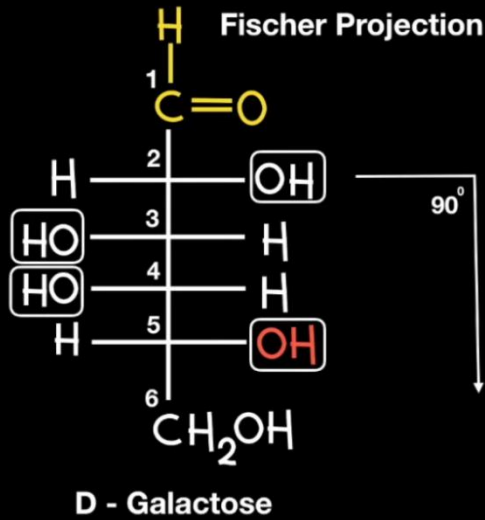
تكون ال O عالطرف عشان تقدر تعمل ال covalent bond ويوخذ المركب cyclic structure والسبب في حدوث تغير في موقعها هو ضرورة أن

في حال إنك مش حاب تحضر الفيديو فوق ف اسمحلي ازيد 4 سلايدات أشرحك شو بصير

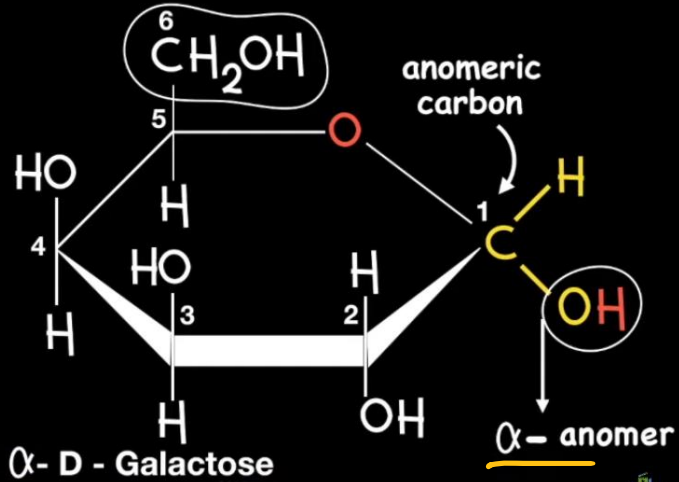


بالوضع الطبيعي المفروض لما المركب يلتف عشان يصير cyclic الذرات والجزيئات اللي على اليمين تظهر من تحت بالحلقة, واللي عاليسار تظهر من فوق, بس هاض الاشي يؤدي بالنهاية لتكوين حلقة سباعية بينما هي المفروض تكون سداسية

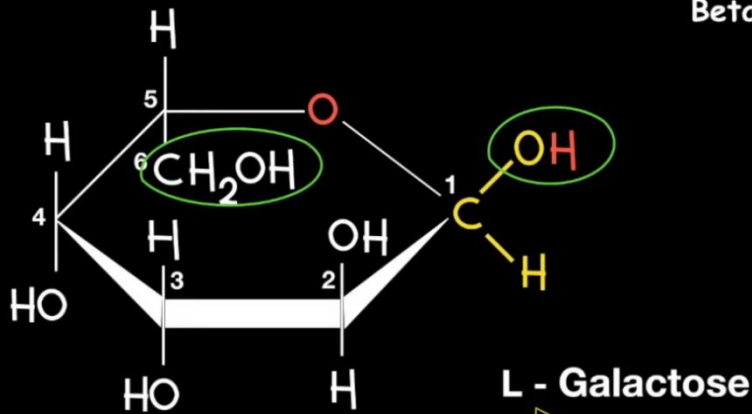
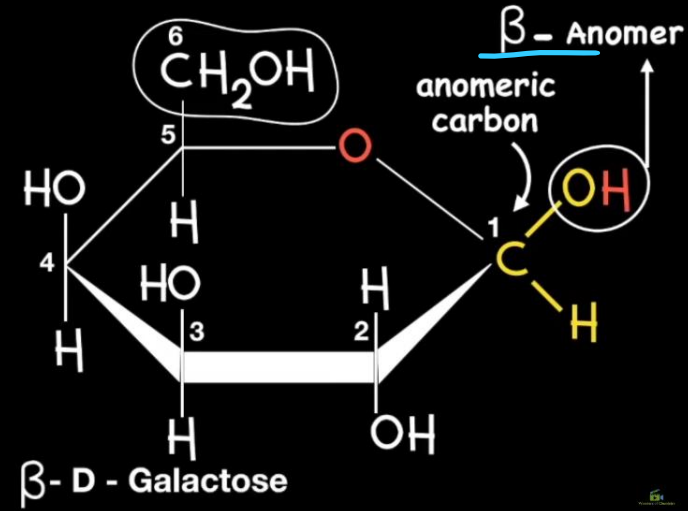
وعشان اتجنب هاض الإشي بصير عندي rotation عال C5 كالتالي



طيب كيف يعرف اذا المركب صار α ولا β



الموضوع معتمد على
اتجاه C6 وال OH
اذا كانوا عكس بعض
المركب α ولو بنفس
الاتجاه (الثنين ل فوق
أو تحت) فالمركب β



Beta or alpha?

It's alpha !

(بس برضه أنصح

بمشاهدة الفيديو)

* ما أعتقد بفتح مباشرة

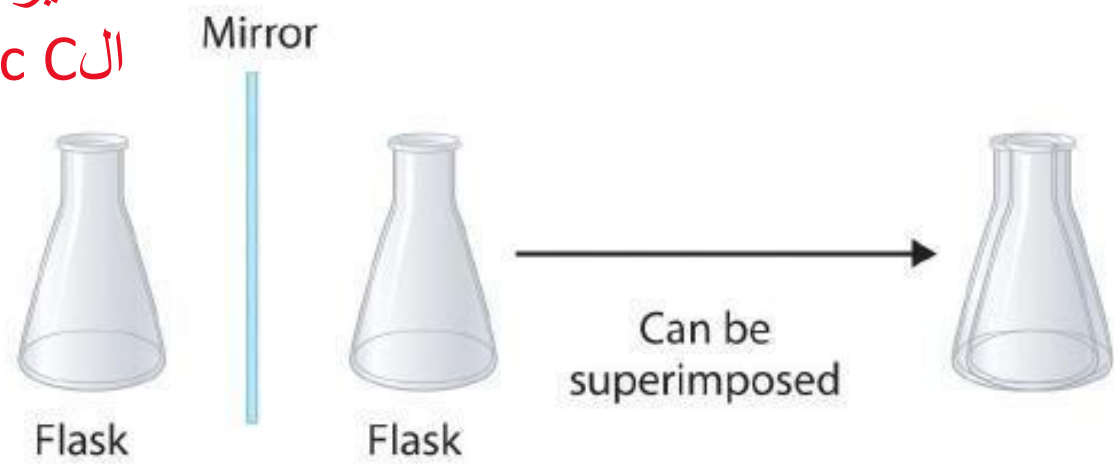
لازم تعمل copy لل link

بعدين paste عجوجل *



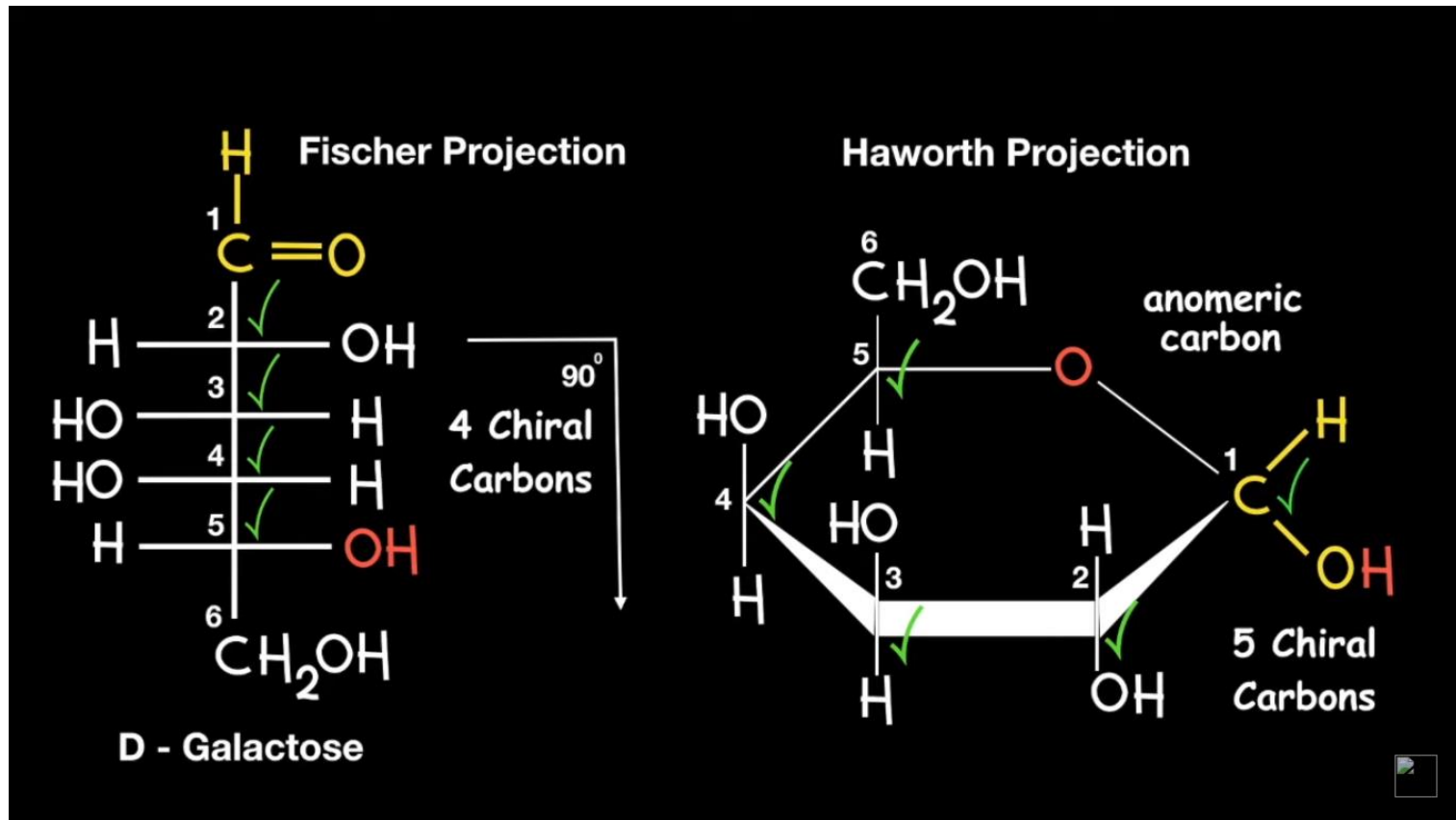
(a) Chiral objects

غير متطابقة (زي)
(asymmetric C)



(b) Achiral objects

بالكيمياء A
تعني النفي



بالبدایة لما كان المركب على Fischer كان يحتوي على 4 asymmetric C
 بس بعد التحويل ل Haworth صار عندي 5 بعد ما ال anomeric C
 صارت asymmetric كمان

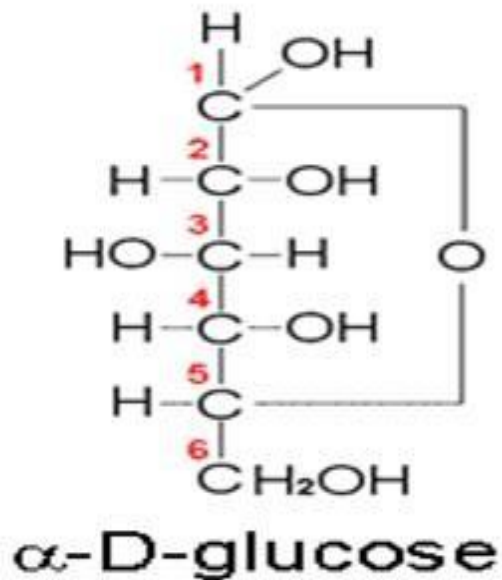
Anomeric carbon: is asymmetric carbon atom
obtained from active carbonyl sugar group:

يتم الحصول عليها

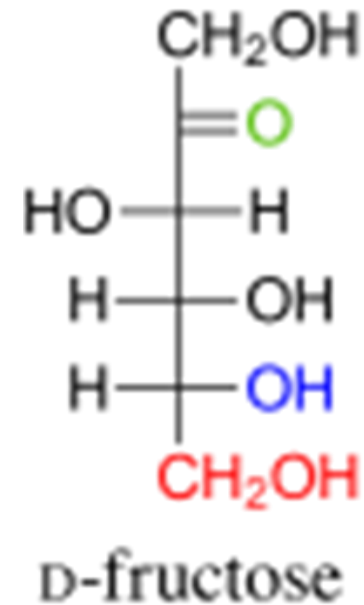
- carbon number 1 in aldoses
- carbon number 2 in ketoses

بتمثل ذرّة الكربون المرتبطة بالO والتي رح تتحول
ل asymmetric atom بعد وضعها في محلول مائي

Linkage between carbonyl group and alcohol group



Hemiacetal link



Hemiketal link

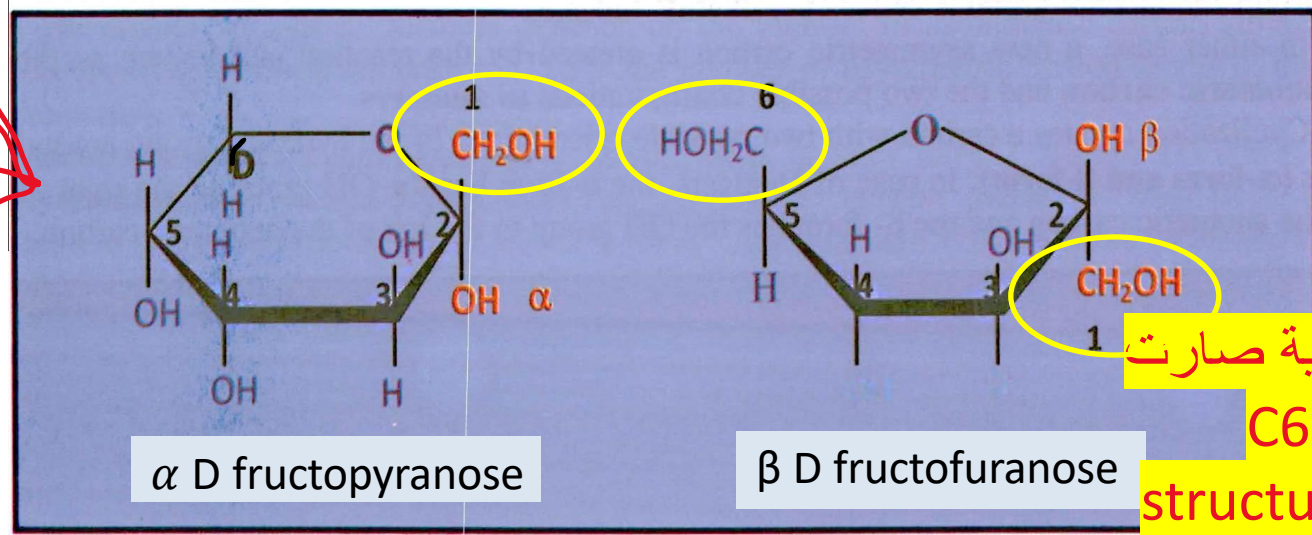
إذا كان المركب الذي تحول ل Haworth من ال Aldo sugars ف اسم
الرابطه بين ال C1 وال OH يكون Hemicetal link.

ولو كان المركب Keto sugar فالرابطه بين ال C2 وال OH اسمها Hemiketal link.

- **Aldohexoses** exist mainly in the 6 membered **pyranose ring** which is thermodynamically more stable than the furan ring
 اكثر استقرارا من الناحية الحركية الحرارية

- When fructose is linked to other sugars or when it is phosphorylated it assumes the furanose form (e.g. as in sucrose)
 (The addition of PO3)

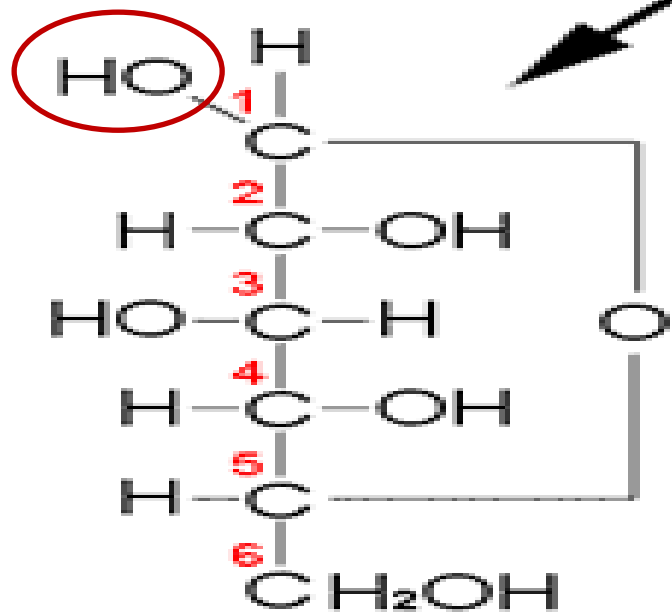
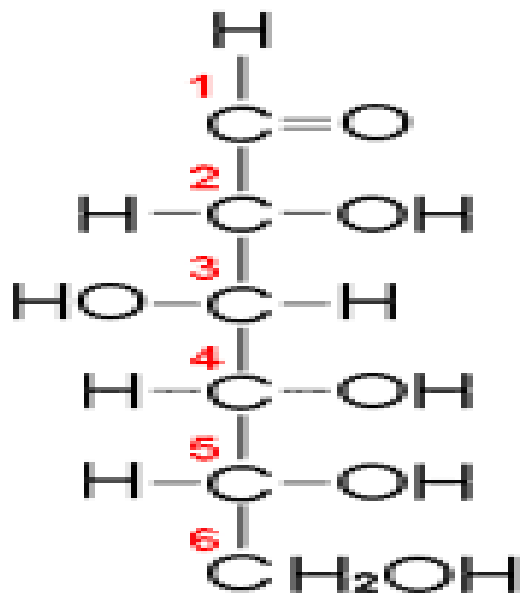
- When it is free in solution, it is present in the pyranose form



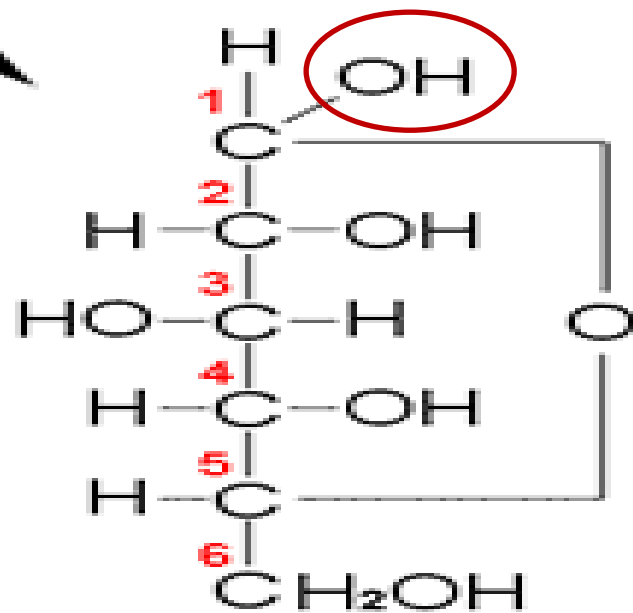
بهائي الوضعية صارت
 C6 و C1
 خارج ال structure

Haworth configuration of cyclic sugars

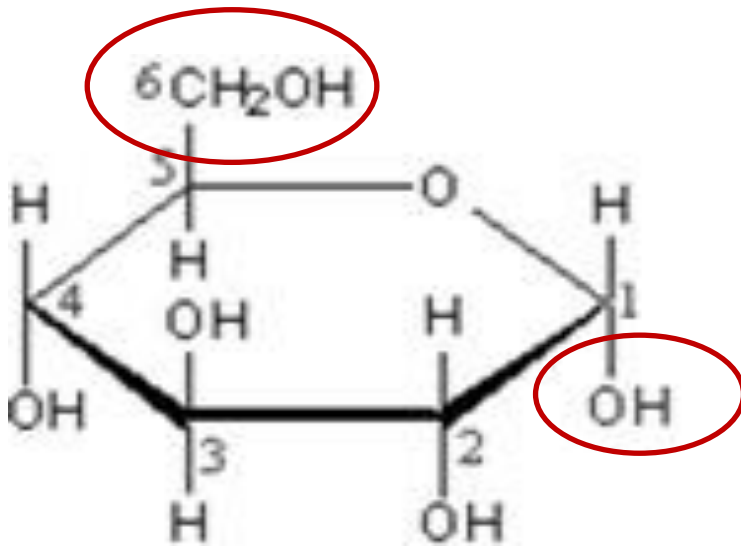
- The Haworth formula adds more detail over the Fischer structure (And adds more isomers)
- All the OH groups on the right side in old ring structure are written downwards in Haworth formula
- All the OH groups on the left side in old ring structure are written upwards in Haworth formula
- C₆ is outside the ring.



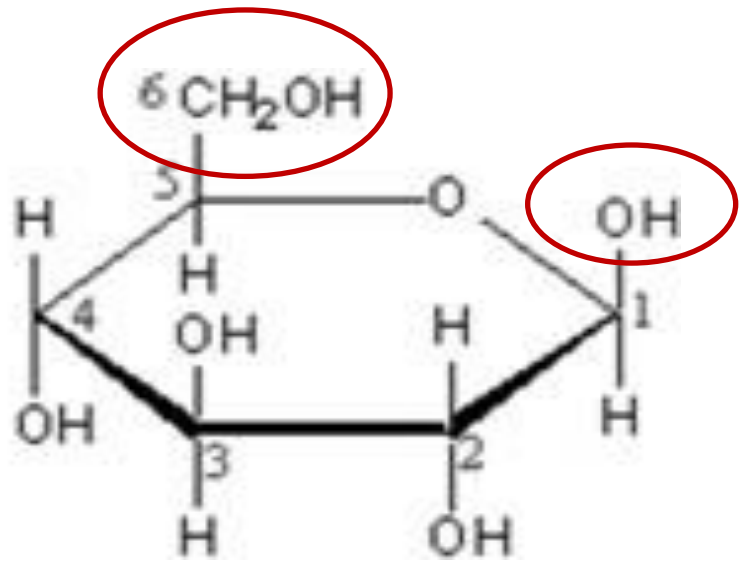
β -D-glucose



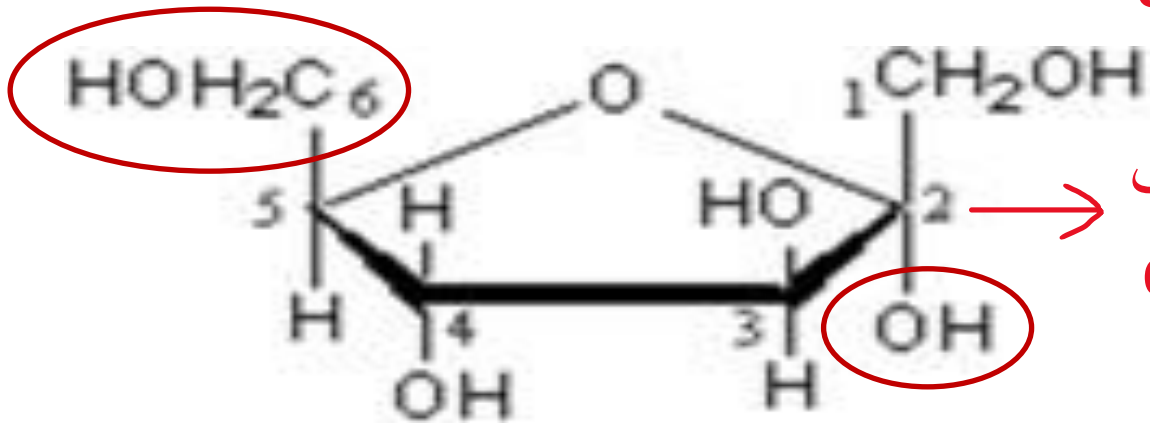
α -D-glucose



α-D-Glucopyranose

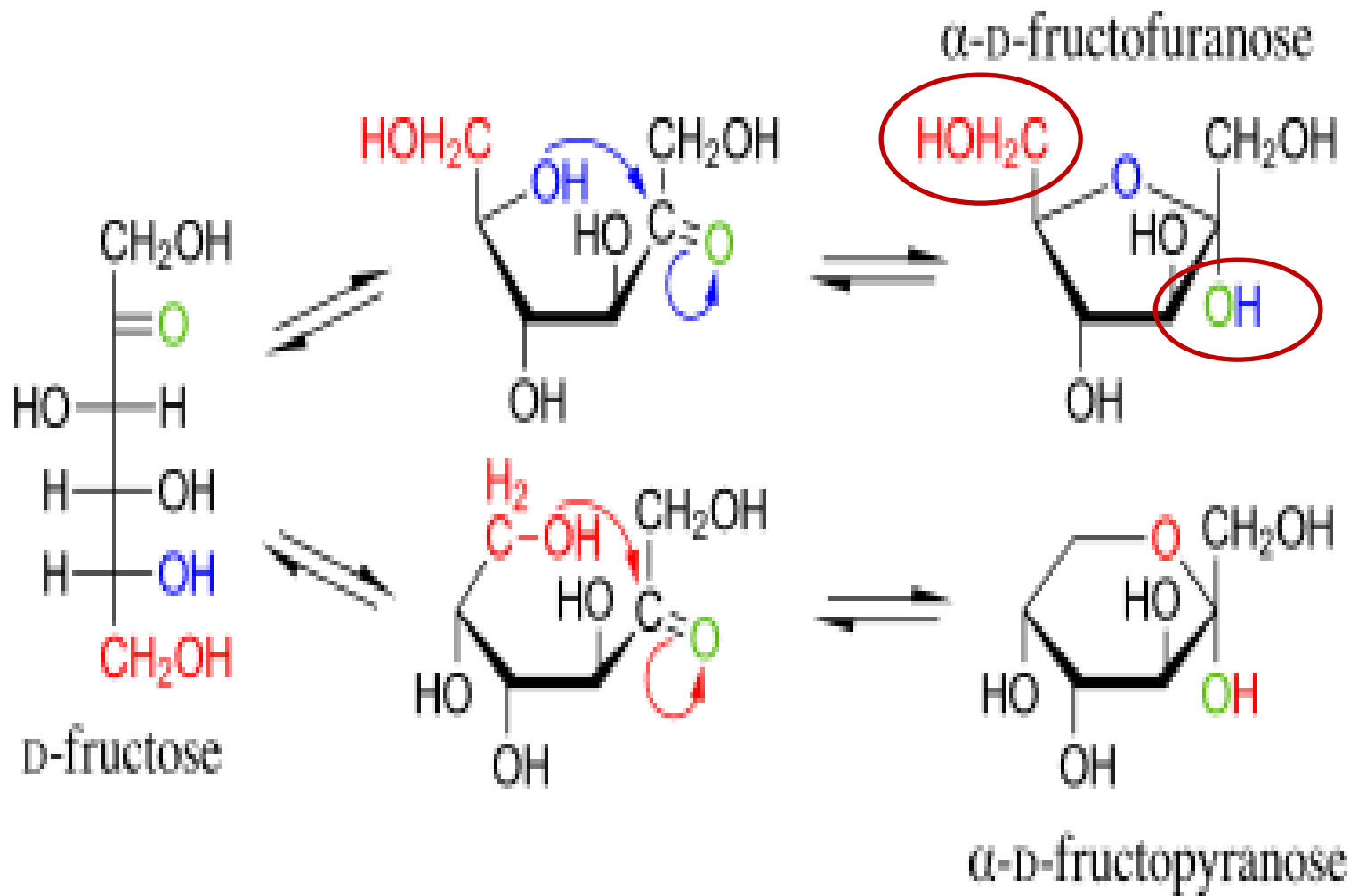


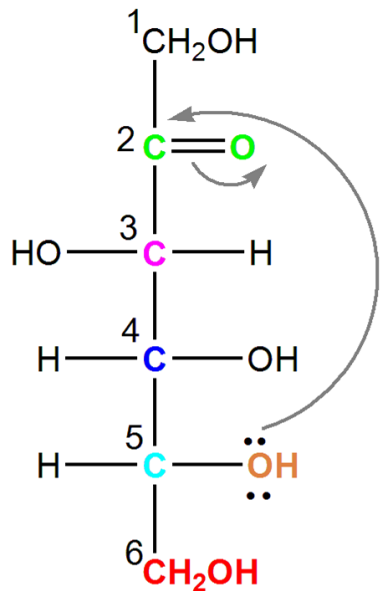
β-D-Glucopyranose



α-D-Fructofuranose

ليش هون اعتمدت
ال C2؟
لانه هي اللي كانت
عامله ال double bond
مع ال O
مش ال C1

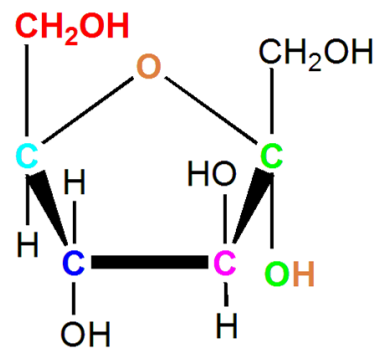
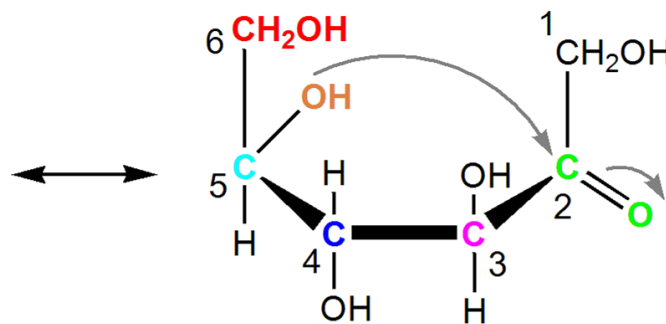




up on
the ring

down on
the ring

D-Fructose
Fischer projection



α-D-Fructofuranose
(hemiketal of D-fructose)

Haworth projection

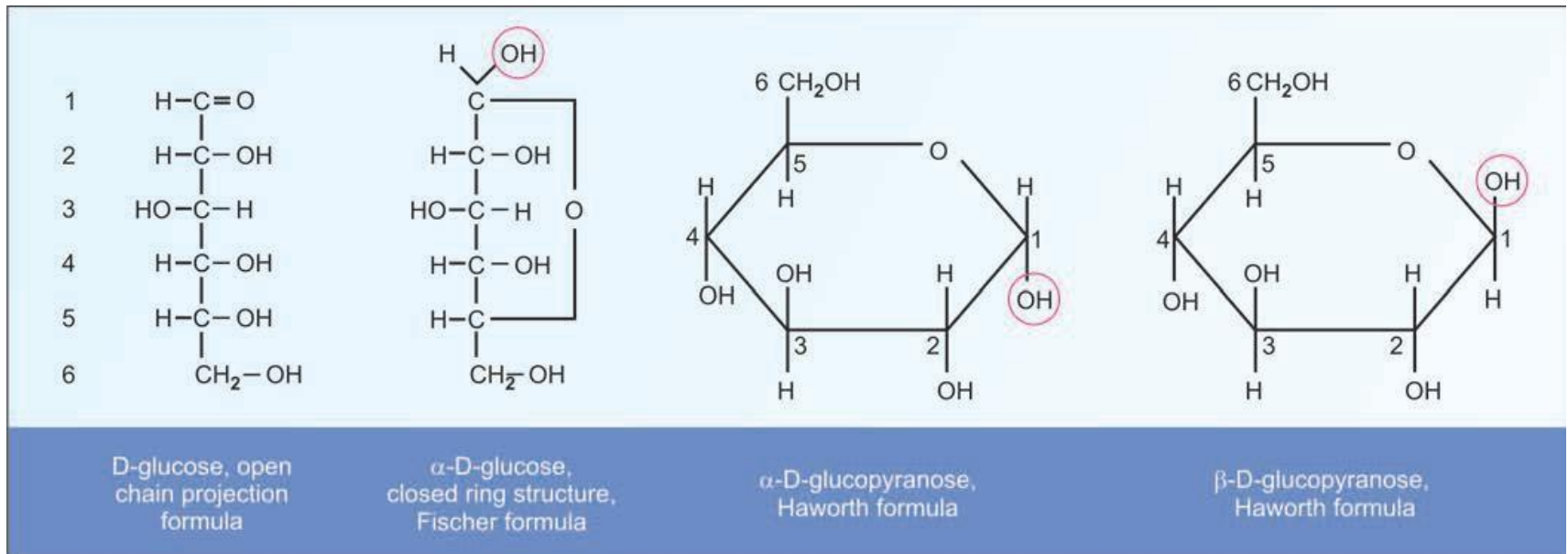


Emil Fischer
NP 1902
1852-1919



Walter Haworth
NP 1937
1883-1950

ذكرنا سابقا إنه ال glucose عنده 16 isomer لانه عنده 4 asymmetric C
 بس هسا صار يقدر يمتلك 5 asymmetric C بعد ما يتحول ل Haworth
 وبالتالي لما نيجي نحسب ال isomers صاروا $2^5 = 32$



Glucose in solution:

- 2/3 in α form
- 1/3 in β form

Physiologically important derivatives of monosaccharides

**بنهاية الملف في شوية شرح
بخط اليد لبعض المواضيع المتعلقة
monosaccharides بمشتقات الـ

1-Amino sugars (e.g. ^{6 C} hexosamines):
Amino group
sugar

The hydroxyl group attached to carbon number 2 is replaced by an amino group (NH₂)

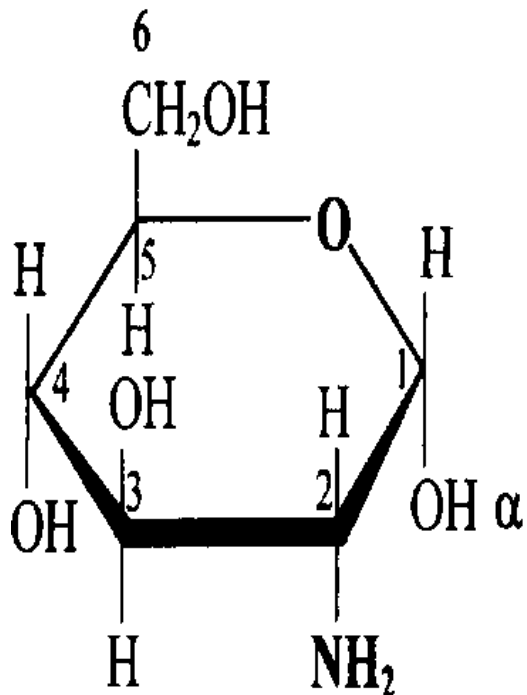
Amino sugars are constituents of glycoproteins, glycolipids & glycosaminoglycan.

اسم ثاني الهم (mucopolysaccharides) ويتكونوا من linear polysaccharides

Examples: Disaccharides اللي بدورهم يتكونوا من

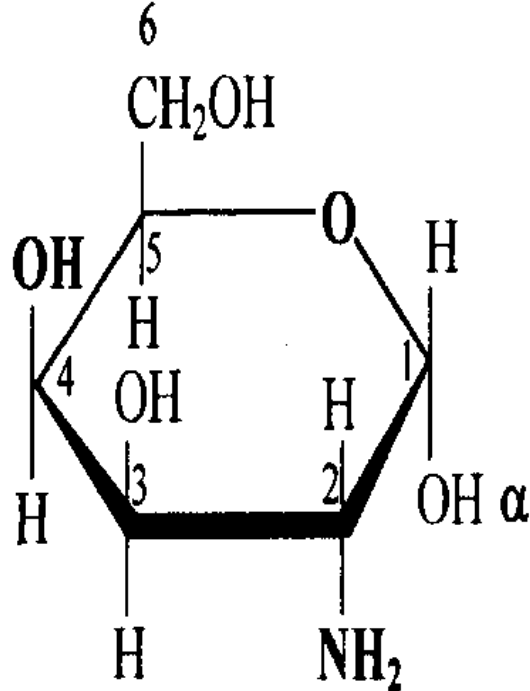
glucosamine, galactosamine & mannosamine.

اسم السكر + amine



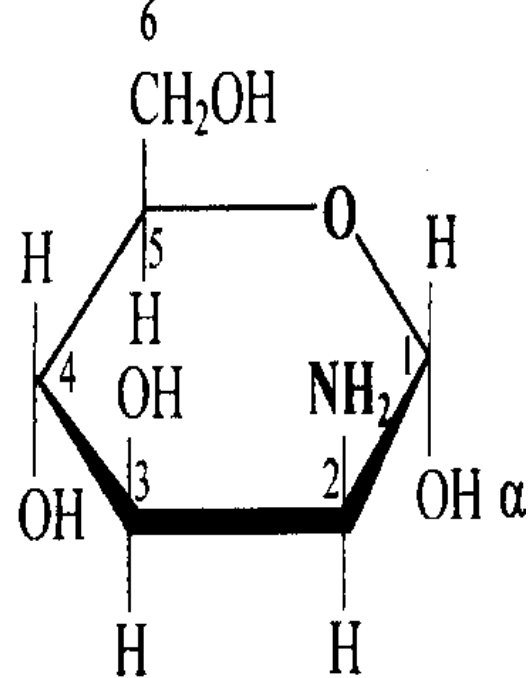
α ,D-Glucosamine

مادة لزجة في الجسم
يوجد في: **ك** تستعمل في الترطيب
Hyaluronic acid, heparin



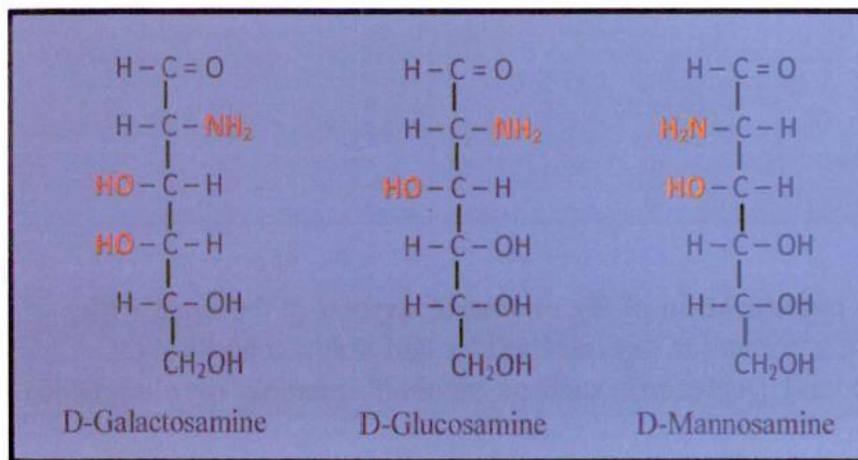
α , D-Galactosamine

In Cartilage, **يوجد في:**
Chondrosamine in chondritin

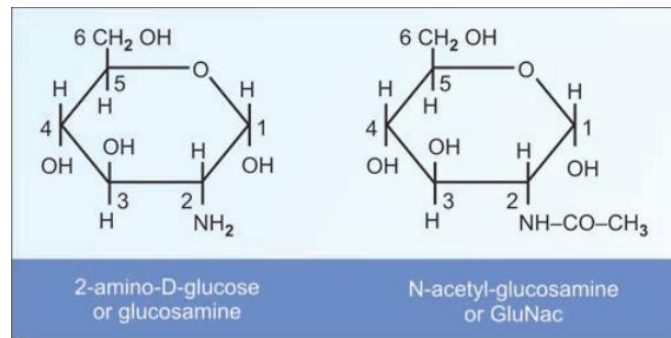


α , D-Mannosamine

يوجد في:
In glycoproteins



Some antibiotics e.g. erythromycin
contain amino sugars



2-Amino sugar acids

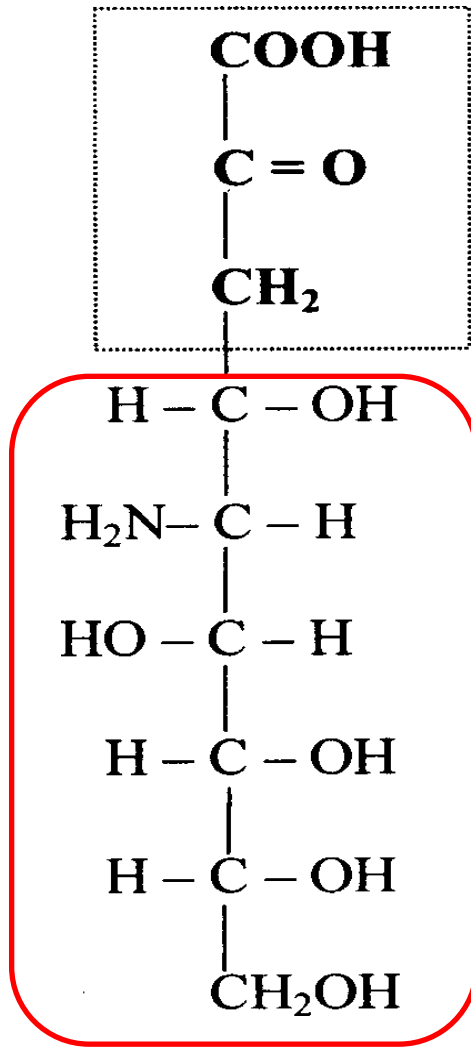
- Formed by addition of acids to aminosugars
- They are occurring in glycoproteins, glycolipids
- Examples include neuraminic acid (pyruvic acid and mannosamine)

بتم اضافة ال pyruvic acid للمannosamine عشان احصل عليه, مش انه الثنين يعتبروا أمثلة عليه

- **Neuraminic acid is unstable** and so, it is present in an acetylated form called sialic acid (NANA)

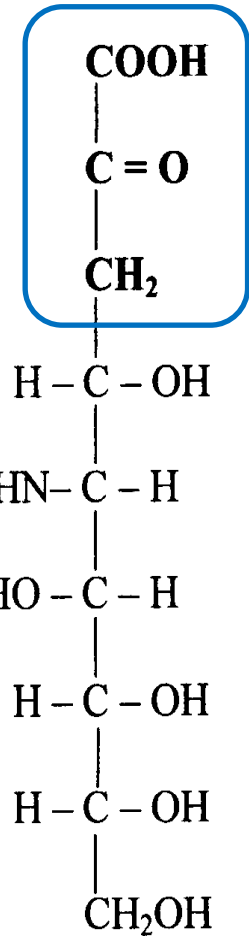
كيف بخلي ال Neuraminic acid بال acetylated form ؟
بإضافة ذرتين C , 3 ذرات H , ذرة O (على شكل CH₃-CO)
يتم التفاعل بوجود النيتروجين

يُفضل حفظ تركيب الـ pyruvic acid



Neuraminic acid

Pyruvic acid



Acetyl group

CH₃-CO

هاض لحاله بمثل الـ mannosamine
بعدين تمت إضافة الـ pyruvic acid
وننتج عنهم الـ neuraminic acid

لأن التفاعل بواسطة الـ N

N-Acetyl neuraminic acid
(NANA)
(Sialic acid)

2nd example on Amino sugar acids



- **Muramic acid:**

- Lactic acid added to glucosamine

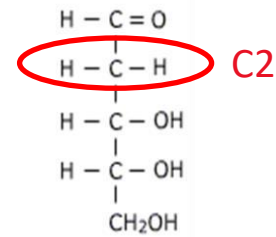
- It is a component of the cell wall of some bacteria

3-Deoxysugars

- These are sugars in which an **-OH group is replaced by a hydrogen atom.**

- The only important examples are:

-D-2-deoxyribose, which is found in DNA

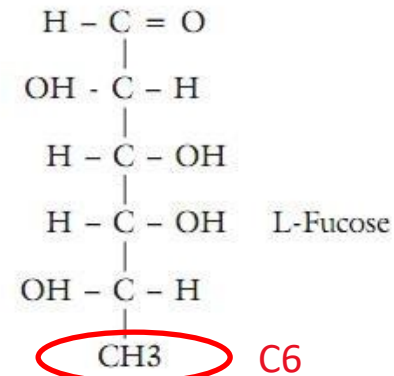


D- deoxyribose

الارقام هاي تمثل رقم ذرّة الكربون اللي تم انتزاع ال oh منها

-L- fucose (6-deoxy-L-galactose) is a constituent of cell membrane glycoproteins and glycolipids, blood group antigens

*is one of the few monosaccharides that exists in the L-configuration.

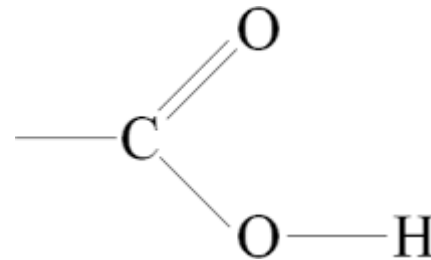


4-Sugar acids

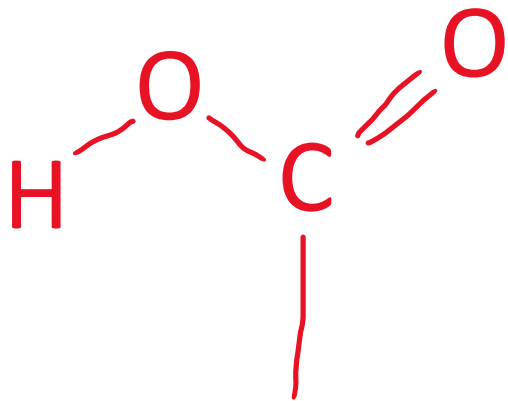
- They are obtained by oxidation of monosaccharides. أكسدة المركب (إضافة أكسجين)
- Only the aldehyde carbon (C1) and the terminal hydroxyl group at carbon 6 of aldoses can be oxidized to form carboxylic group.

So, we have 3 options:

- oxidation of C1
- oxidation of C6
- oxidation of both



Carboxyl group



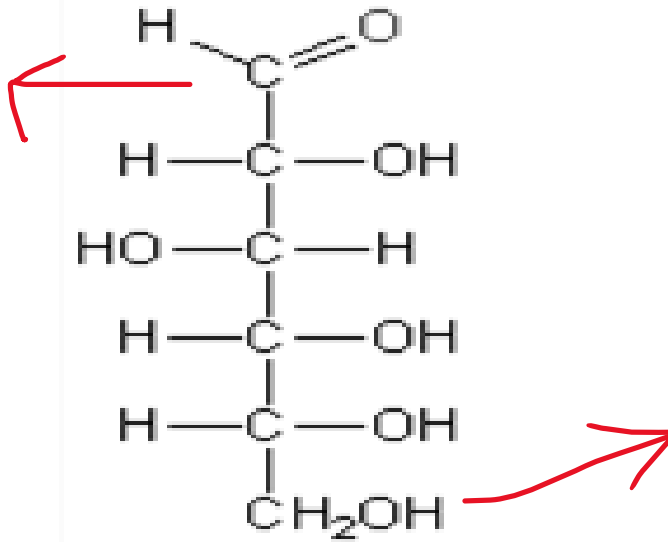
C1 بعد تعرضها
للأكسدة

Aldonic acid: oxidation in aldehyde group (C1)

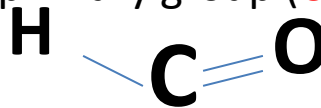


CH₂OH

Gluconic acid
(aldonic acid)

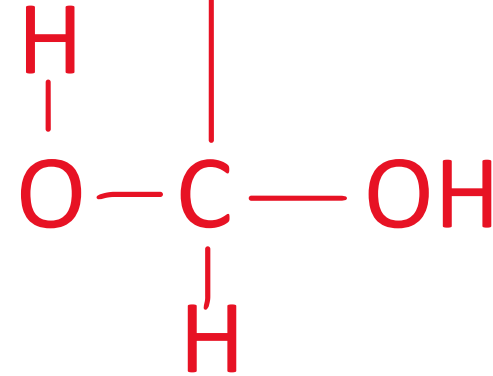


Uronic acid: oxidation in primary group (C6)



Glucuronic acid
(uronic acid)

C6 بعد تعرضها
للأكسدة



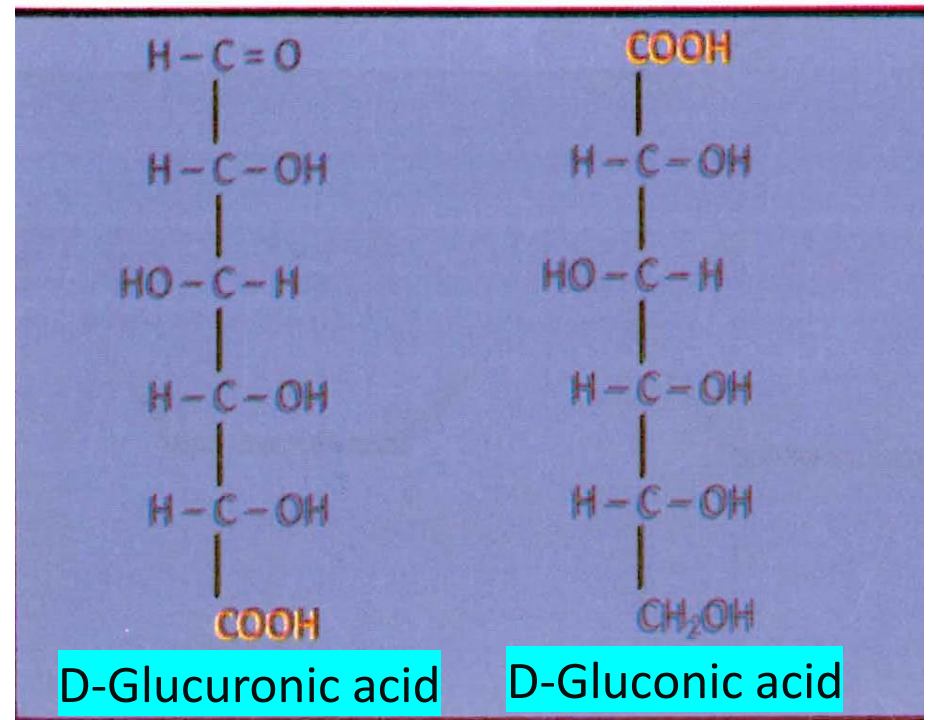
Aldaric: oxidation in both groups (e.g. glucaric)



Glucaric acid
(Saccharic acid)

3 types:

1. Aldonic acid: oxidation in aldehyde group
2. Uronic acid: oxidation in primary group
3. Aldaric: oxidation in both groups (e.g. glucaric)

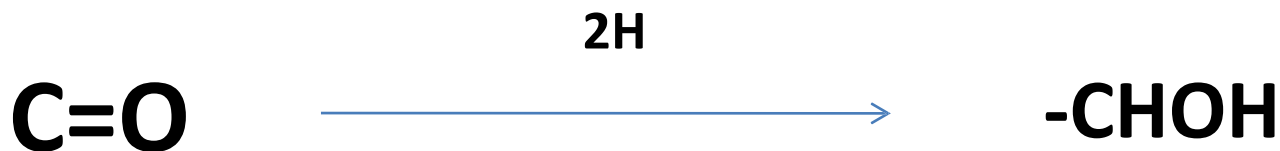


Importance of sugar acids

- L-ascorbic acid (vitamin C) is a derivative of aldonic acid
- Glucuronic acid, the uronic acid of glucose, is a:
 - component of glycosaminoglycans
 - used by the liver for the detoxification of aromatic acids & phenols
 - involved in the metabolism of bilirubin
- L-iduronic acid (IdUA) is the 5-epimer of D-glucuronic acid and it is a component of glycosaminoglycans

5-Sugar alcohols

- Reduction of monosaccharides produce the corresponding alcohols متطابقة
- They are produced by hydrogenation of aldoses and ketoses إضافة 2H



**لاحظ انه الألديهيد بصيرله تأكسد واختزال أما الكيتون اختزال فقط

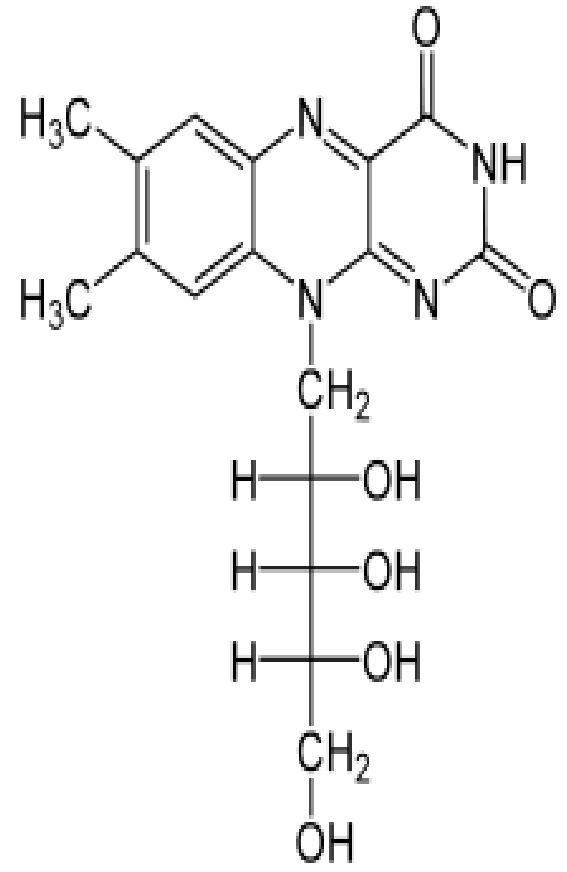
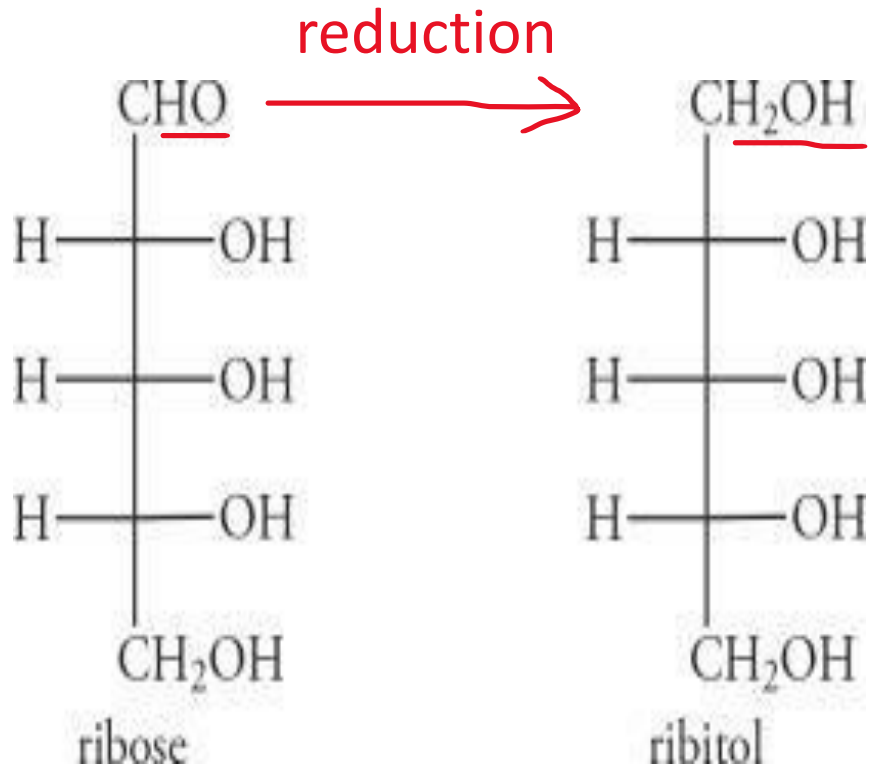
■ There are some sugar alcohols of biochemical important as:

● **Glycerol:**



The alcohol of glyceraldehyde and it is a component of triacylglycerols as well as most phospholipids

● **Ribitol:** The alcohol of ribose and it is a component of riboflavin (vitamin B2).

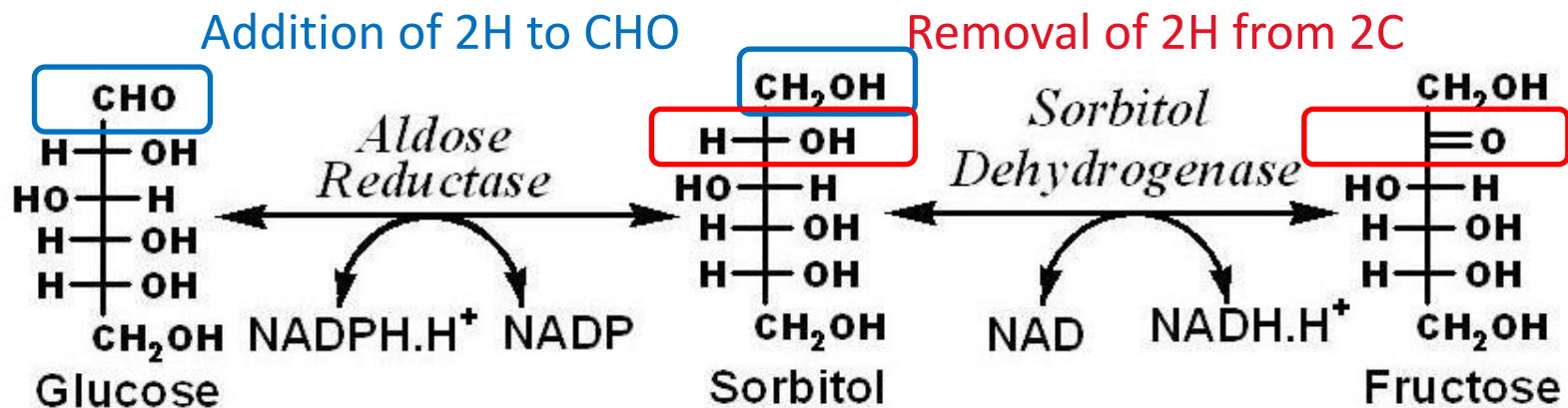


riboflavin

- Mannitol:** The alcohol of mannose, is given intravenously to produce diuresis and to reduce brain edema after brain operations.

إدرار البول

- Sorbitol:** The alcohol of glucose and it is an intermediate in the conversion of glucose to fructose in the seminal vesicles.

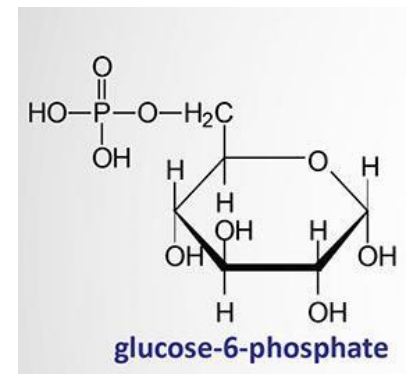
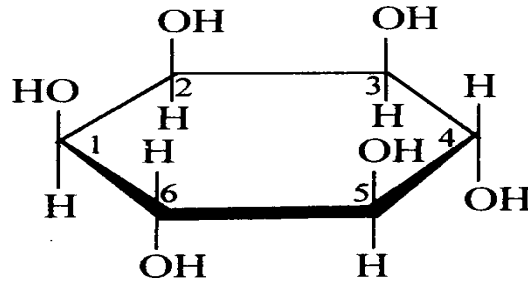


- Conversion of glucose to sorbitol is increased in diabetic subjects
- Sorbitol produces osmotic damage of cells (as it does not diffuse easily)

قد يؤدي إلى

- This may account for production of diabetic cataract, retinopathy, nephropathy and neuropathy.

- **Myo-inositol:**



-**Sugar alcohol** synthesized from glucose-6-phosphate (G-6-P). It is abundant in **brain** and other mammalian tissues (in humans most inositol is synthesized in the kidneys) **يتم صناعته في الكلى**

- it is found in animal tissues in the free state as well as in the form of the phospholipid
- It is a constituent of certain phospholipids and hence its role in the mobilization of fats from the liver (lipotropic action i.e. encourages the export of fat from the liver)
- It forms phosphatidyl inositol that enters in structure of plasma membranes and **can serve as a second messenger in action of some hormones (i.e. mediates cell signal transduction in response to a variety of hormones)**
- ❖ **Second messengers** are intracellular signaling molecules released by the cell in response to exposure to extracellular signaling molecules—the **first messengers**.

الدكتور ما قرأهم اصلا 😊

In plants myoinositol is hexaphosphate (hexaphosphoinositol or phytic acid)

It inhibits absorption of Ca^{+2} , Mg^{+2} , Mn^{+2} & Fe^{+2} from intestine forming phytate salts due to formation of insoluble salts

It contributes to mineral deficiencies in people whose diets rely highly on bran and seeds, such as occurs in developing countries.

في بعض الدول الفقيرة التي أكلها معتمد على الحبوب وغيرها من النباتات الغنية بالphytic acid بعد فترة رح يتم ملاحظة وجود نقص في بعض المعادن المهمة للجسم عندهم, لأنه الphytic acid يمنع امتصاصها وبقلله

6- Sugars esters

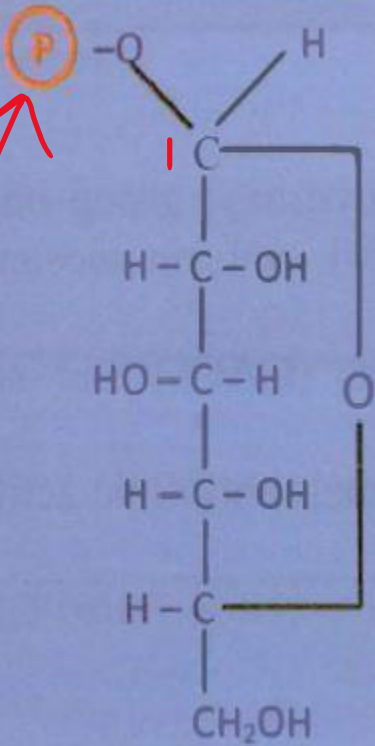
- Hydroxyl group of monosaccharides forms esters with acids
- Types:
 1. Phosphate esters:
 - Intermediates in carbohydrate metabolism
 - Phosphorylation by **kinase enzymes**
 - The phosphate group can be added to the terminal carbon (glucose-6-phosphate) or to C1 hydroxyl (glucose-1-phosphate) as well as to other carbons (fructose 2,6 biphosphate)
 - Sugar phosphates are negatively charged which results in their intracellular trapping (prevents their diffusion out of the cell)

↓
يتم حبسهم داخل الخلية

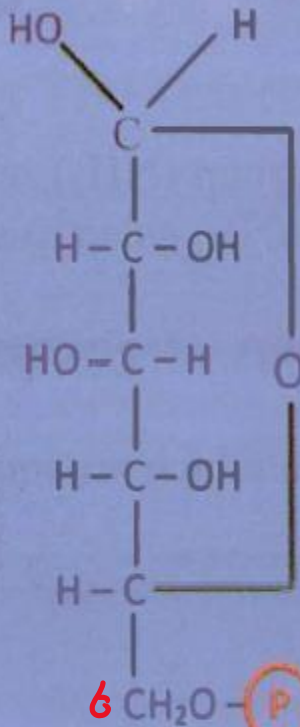
Types:

2. Sulfate esters:

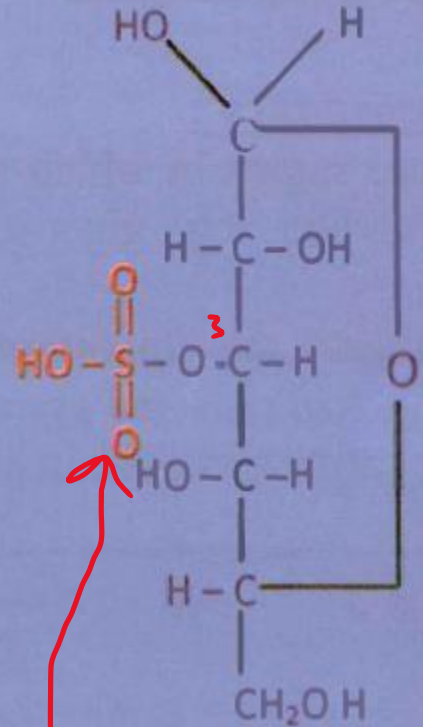
- Present in certain types of polysaccharides and glycolipids (sulfolipids) e.g. β -D galactose 3-sulfate



β -D-Glucose 1-phosphate




β -D-Glucose 6-phosphate



β -D-Galactose 3-sulfate

7- Glycosides

- Are products of condensation of the anomeric carbon of the sugar with:  تفاعل مركبين ينتج عنه H2O
 - **Another sugar (Glycon):** formation of disaccharides & polysaccharides
 - **Non-Carbohydrate compound (Aglycon):** such as alcohols, phenols or nitrogenous bases.
- **Glycosidic bond:** covalent between the hydroxyl group of anomeric carbon

- The glycosidic linkage is named according to:
 - anomeric carbon to which it is attached (α or β)
 - according to the parent sugar e.g. glucosidic, galactosidic or fructosidic bond
- Examples of Glycosides
 - 1) Nucleosides are glycosides formed of ribose or deoxyribose and a nitrogenous base found in nucleic acids
 - 2) Cardiac Glycosides: contain steroids component as aglycone in combination with sugar

- Digitalis, a cardiac stimulant, is composed of galactose and a steroid alcohol
- Digitalis is used in treatment of heart failure (stimulate cardiac muscle contraction)

When are two carbohydrates are epimers?

- a) One is a pyranose, the other a furanose
- b) One is an aldose, the other a ketose
- c) They differ in length by one carbon
- d) They differ only in the configuration around one carbon atom

2. Which of following is an anomeric pair?

- a) D-glucose and L-glucose
- b) D-glucose and D-fructose
- c) α -D-glucose and β -D-glucose
- d) α -D-glucose and β -L-glucose