Doctor 022

Biochemistry

Sheet no. 5

V2

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Acidosis and Alkalosis

Causes	Acidosis (ph<7.35)	Alkalosis(ph>7.45)
Metabolic (Depends on the concentration of H+)	Production of ketone bodies(starvation)	Excessive administration of salts
Respiratory (Depends on the concentration of CO_2)	Pulmonary (asthma- emphysema)	Hyperventilation (anxiety or high altitude)

avg ph is 7.4

Ketone bodies contain carboxylic acid

#Salt: **basic salt only** will cause alkalosis

#Acidosis : increase in CO_2 concentration

#Alkalosis : decrease in CO_2 concentration

Asthma: can not get CO_2 out (a problem in **exhalation**), so increase in CO_2 concentration.

Emphysema: less elasticity of alveoli

-can get it by a **mutation** (less possible)

-side effect of **smoking**

Hyperventilation (تنفس سريع ومتكرر): O_2 will enter rapidly, and CO_2 will leave which will lead to decrease in the acidity.

-About emphysema:

تخيل انو الرئة زي البالون لما تنفخ البالون = شهيق ولما تتنفسه = زفير

فلما ما يكون في مرونة بالبالون بصير في مقاومة وصعوبة في نفخ الرئتين عشان هيك في فراغ حولين الرئتين

Respiratory Acidosis

$H^+ + HCO_3^- \leftrightarrow H_2CO_3 \leftrightarrow CO_2 + H_2O$

(كمية ثاني أكسيد الكربون عالية فرح ينتج الحمض بشكل كبير ورح يتفكك لبروتونات فبتزيد الحموضة)

Respiratory Alkalosis

$H^+ + HCO_3^- \leftrightarrow H_2CO_3 \leftrightarrow CO_2 + H_2O$

(كمية ثاني أكسيد الكربون قليلة فرح ينكسر الحمض لينتج ثاني أكسيد الكربون فبتقل الحمضية مع تكسير الحمض)

Metabolic Acidosis

$H^+ + HCO_3^- \leftrightarrow H_2CO_3 \leftrightarrow CO_2 + H_2O$

If [H+] is high, it will produce H_2CO_3 that will break down into CO_2 and H_2O, And the CO_2 should go out the body, but it can't so the acidity will increase.

Metabolic Alkalosis

$H^+ + HCO_3^- \leftrightarrow H_2CO_3 \leftrightarrow CO_2 + H_2O$

-The [H+] is reduced, the reaction will go toward production of H+, so we need more CO2, we can have it by more retention of it that will make more acid

Causes of respiratory acid-base disorders

Acidosis:

1) Choking (الاختناق)
2) Bronchopneumonia (التهاب القصبات الهوائية)
3) COAD (chronic obstructive airways disease) (انسدادات فى المجاري التنفسية)

-All of the above will obstruct exhalation, so CO_2 will increase and that will make more acid

Alkalosis :

1) Hysterical overbreathing (same as hyperventilation)
2) Mechanical over-ventilation (hyperventilation but mechanichal causes)
3) Raised intracranial pressure.

Causes of metabolic acid-base disorder

Acidosis :

1) impaired H+ excretion
2) increase H+ production of ingestion (taken a huge amount of medicine or food)
3) loss of HCO3-

Alkalosis :

1) Loss of h+ in vomit (losing the acid of the stomach)
2) Alkali ingestion
3) Potassium deficiency

Compensation

Compensation: A change in HCO_3^- or pCO_2 as a result of the primary event in order to return the pH to normal levels.

If the underlying problem is **metabolic**, hyperventilation or hypoventilation alters pCO_2; it is called **respiratory compensation**.

If the problem is **respiratory**, renal mechanisms drive **metabolic compensation** via changing [HCO_3^-].

#**Complete compensation** if brought back within normal limits

#**Partial compensation** if the pH is still outside norms.

#Buffer system acts as the first line of defense… works by compensation

#Regulation of respiratory causes is done by metabolic compensation

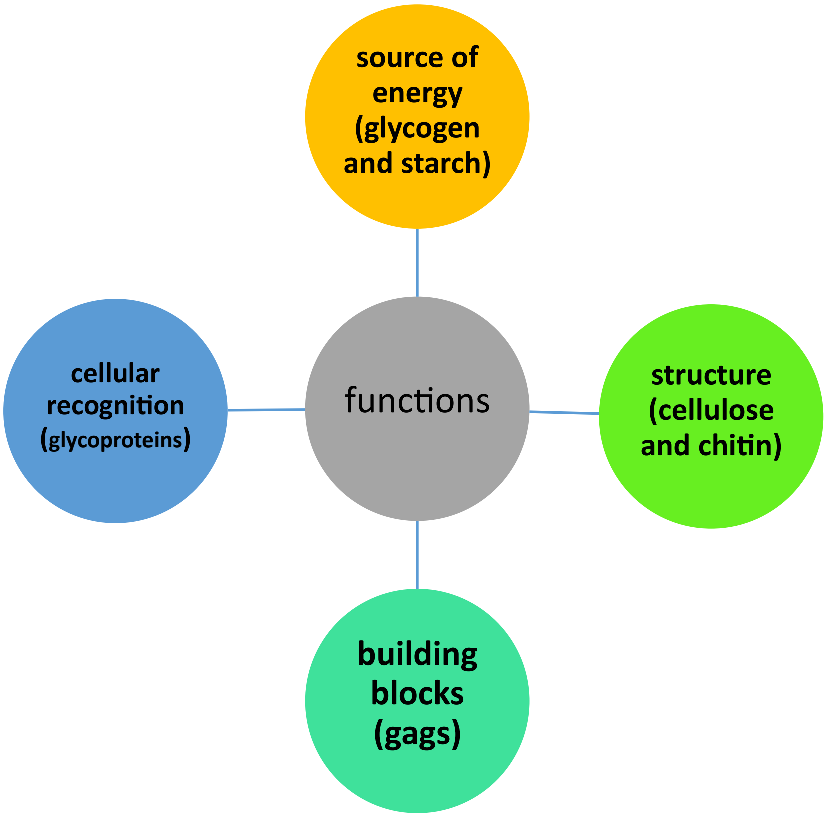
#Regulation of metabolic causes is done by respiratory compensation

#high acidity… reabsorption of HCO3-
in alkalosis…. excretion of HCO3-.

Carbohydrates

Carbohydrate is a polyhydroxy (poly OH group) aldehydes (carbonyl group on carbon 1) or ketones (carbonyl group on carbon 2)
saccharide: sugar

-It is the major source of energy
-Structural function: it can be found in another organism (cellulose in the cell wall of plant, chitin can be found in organisms (insects mainly have exoskeleton)
-Building block: they interact with the environment (cells) and filling the space in ECM, It's dynamic structure.
-We can distinguish between cells through sugar components of the glycoproteins such as ABO system of blood.
-Cellular recognition important in treatment of cancers.
SIDE MEDICAL NOTE: we use the above concept on corona virus as they discover the spikes protein that facilitate vaccine discovery.



Monosaccharides

Sugars that contain an aldehyde group-terminal carbonyl group- we call them aldoses. (oses=sugars)

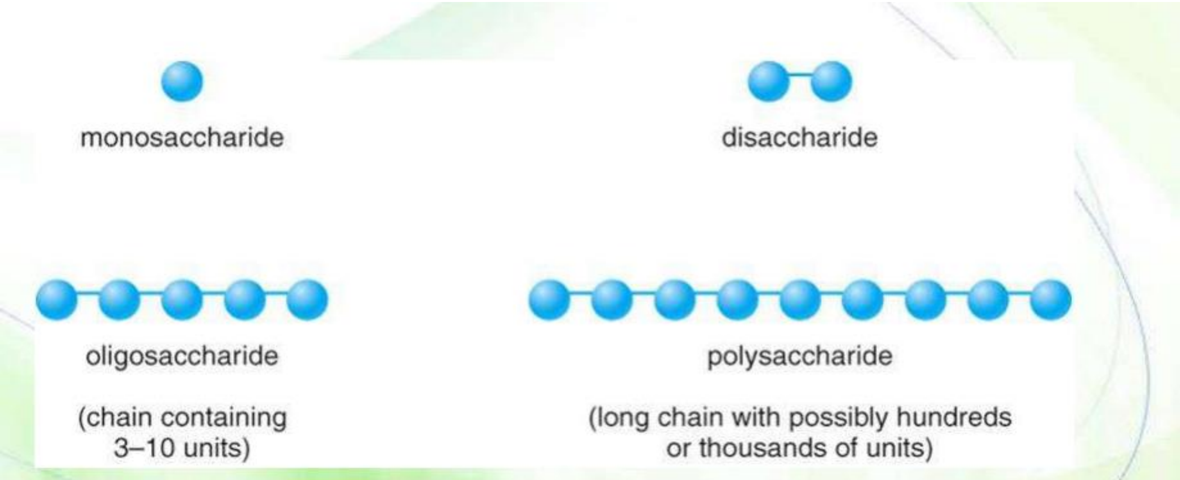
And sugars that contain ketone group we call them ketoses.

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

There are artificial sweeteners that have sometimes similar structure as carbohydrates.

Classification of sugars I

First method to classify sugars is depending on their complexity in forms of:



A) Monosaccharides	**B) Disaccharides**	**C) Oligosaccharides**	**D) Polysacccharides**
Mono = one	**Di = two**	**Oligo = 3-10**	**Poly = high No.**

Polysaccharides (starch, cellulose, inulin, gums)

In the form of monosaccharide, we use it mainly as a source of energy, in the form of polysaccharides as a storage of sugars (we store sugars in the form of polysaccharides)

in our bodies we store sugars as glycogen, plants store sugars as starch.

NOTE: cellulose is a structural polysaccharide not a storage one

Glycoproteins and proteoglycans (hormones, blood group substances, antibodies)

Another place where I can find sugars is in glycoproteins (sugars attached to protein), glycoproteins help in cell recognition like interactions between cells or cell and ECM, also help in immune response.

Example on immune response: when bacterial cell or a virus enters your body how does immune system recognize viruses or bacterial cells?

Immune system recognizes them by their glycoproteins on their surface.

We also have proteoglycans, they exist in the ECM between cells, composed of polysaccharides and small amount of protein component making interactions with the surrounding environment (cells)

Glycolipids (cerebrosides, gangliosides)

Lipids ''sphingolipids'' not phospholipids or other lipids we know.

Their polar head attached to sugars maybe monosaccharides, disaccharides, polysaccharides which will make different types of glycolipds.

Glycosides: larger or more complex sugars, monosaccharide linked to monosaccharide we call it glycoside (disaccharide), disaccharide linked to oligosaccharide for example

Sum up: A sugar linked to another sugar we call it glycoside.

EXTRA INFO: A glycoside is a molecule in which a sugar is bound to another functional group via a glycosidic bond.

Mucopolysaccharides (hyaluronic acid): GAGs components.

-nucleic acids (DNA, RNA) containing sugar ribose or deoxyribose sugar which are carbohydrates.

عَلى قَدرِ أَهلِ العَزمِ تَأتي العَزائِمُ

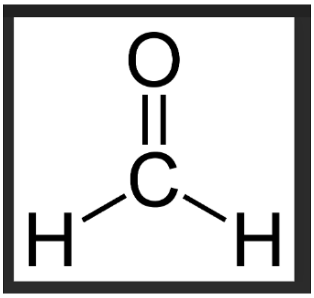
وَتَأتي عَلى قَدرِ الكِرامِ المَكارِمُ

Monosaccharides

They contain two or more hydroxyl groups.

Monosaccharides are the simplest form of carbohydrates in a basic chemical formula of $(CH_2O)n$

For example, glucose contain 6 carbons so n=6 → $C_6H_{12}O_6$



NOTE: n is at least =3

Explanation: The simplest aldehyde that we have is formaldehyde containing one carbon, can I add a a hydroxyl group on it?

ANS: No, I can't because carbon is attached to carbonyl and two hydrogen atoms.

IF we have an acetaldehyde (containing two carbons), I can add just one hydroxyl group on carbon number 2 (next to the carbon that contain carbonyl group)

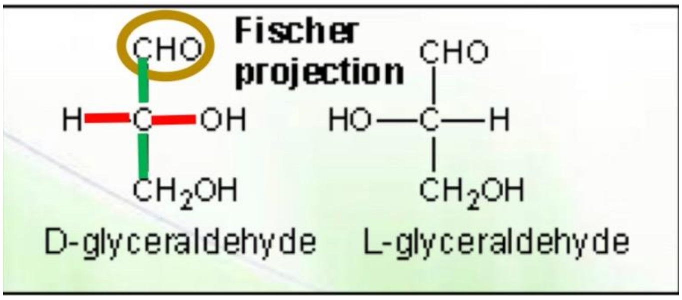
So it is not a polyhydroxyaldehyde

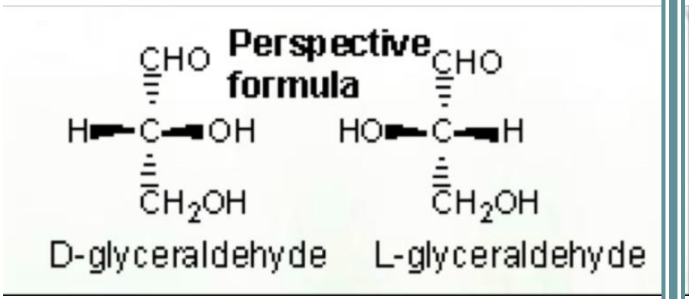
If I have a 3-carbon aldehyde molecule I can add hydroxyl group on two carbons so we can call it a polyhydroxyaldehyde , the simplest aldehyde sugar(aldose) is made of three carbons = glyceraldehyde.

-PAY ATTENTION THAT THE PREVIOUS EXAMPLES ARE FOR UNDERSTANDING .

How many carbons the simplest ketone contains? 3 carbons, called acetone.

If I add a hydroxyl group on carbon number 3 and carbon number 1 then we call it dihydroxyacetone, and this is actually the simplest ketone sugar.





Take a look at glyceraldehyde's structure (the simplest aldehyde sugar as we discussed a while ago) we notice that carbon number one contain carbonyl group, carbons number 2 and 3 contain hydroxyl groups.

NOTE: Carbon 1 in aldose is most highly oxidized.

If we are looking for chiral centers: carbon number 1 is achiral center because it contains double bond with oxygen atom

(remember : achiral means not chiral while a chiral means it is chiral center)

Carbon number 2 is chiral while carbon three is achiral because it is attached to 2 hydrogen atoms.

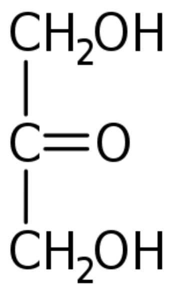
NOTE: chiral centers are attached to 4 different GROUPS not atoms

D-glyceraldehyde is a mirror to L-glyceraldehyde because they are enantiomers.

Now how did the doctor classify glyceraldehydes to L (levo) and D (dextro) ?

We always look at carbon number 2 (chiral one) exactly on its hydroxyl group (OH) if it is on the right side then we call it D, if it is on the left side then we call it L.

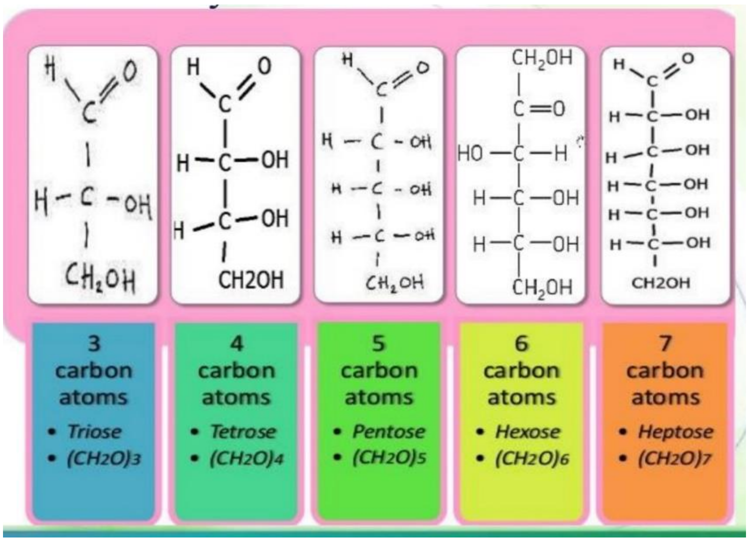
Now let's take a look at dihydroxyacetone, does it have a chiral center?



ANS: no, it doesn't have a chiral center, so it doesn't have a D, L stereoisomers.

Classification of sugars II

#Depending on number of atoms they have.



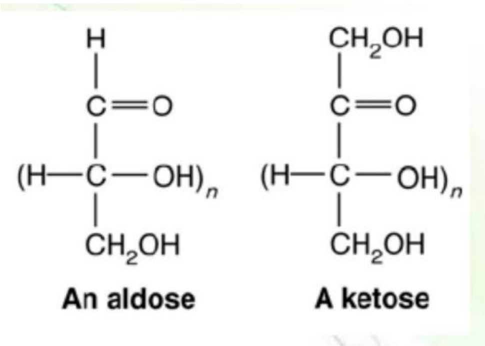
As we said that the simplest form of sugars contains 3 carbon atoms, so we call it triose, 4 carbons we call it tetrose, 5 carbons pentose, 6 carbon hexose… etc.

The most common sugars are hexoses and pentoses, but on the other side we have glyceraldehydes in our bodies (trioses), and 4 carbon sugars also (you will study details in metabolism course).

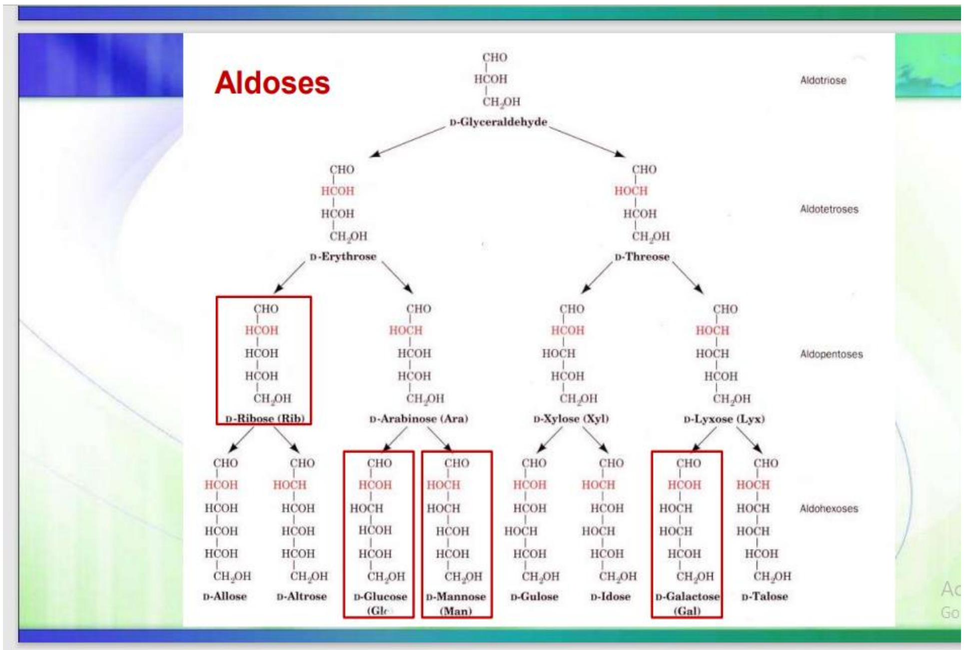
#يعني على سنة ثانية اذا ضلينا عايشين مع هالشمس 😉

This type of classification doesn't tell you what type of sugar, only tells you about number of atoms they have.

-I can add aldo or keto to this type of classification to tell more about the sugar I have, like aldo triose = aldehyde and contain three carbon atoms.



Classification of sugars III



Depending on the functional group.

Aldehyde = aldose   Ketone = ketose

In our bodies all used sugar are in a form of D, we don't use L.

You will notice that most pictures contain D form of sugar because it is the most used as we said.

This picture shows D-Glyceraldehyde , then I increased the number of carbon atoms , now I have 4 carbon atoms on the right side and 4 carbons on the left side , if you noticed that the number of chiral centers increased when it has 4 carbons , first and last carbons are achiral carbons while 2nd and 3rd carbons are chirals, so both hydroxyl groups may be on the the right side then I call it D-Erythrose and maybe one hydroxyl group comes to the left side (2nd carbon) while the other one is on the right side(3rd carbon) then I call it D-Therose (both are sugars contain L and D forms).

Then I increased the number of carbons to become 5 carbons and so I increased the number of chiral carbons to become 3 chiral carbons, with a different directions of hydroxyl groups, right-left-right, left-right-right… etc all possibilities are shown in the picture and each molecule has its own name.

Red squared molecules are the most important and the most common molecules, which we will always deal with them.

يعني احفظوا المركبات الي فيها ثلث كربونات والي عليهم مستطيل ، باقي الشرح لإيصال الفكرة

We increased the number of carbons to have hexoses and aldohexoses forming 8 molecules, most important are glucose, galactose, mannose…. as shown in the figure.(there are another 8 L forms)

CONCLUSION: as we are increasing the number of carbons, we are increasing the number of chiral centers, so we are increasing the number of possibilities.

How can I calculate the number of stereoisomers expected for types of sugar depending on the number of carbons atoms?

ANS: by using formula of 2^n (n represents the number of chiral centers).

Now how can I calculate the number of chiral centers for an aldose?

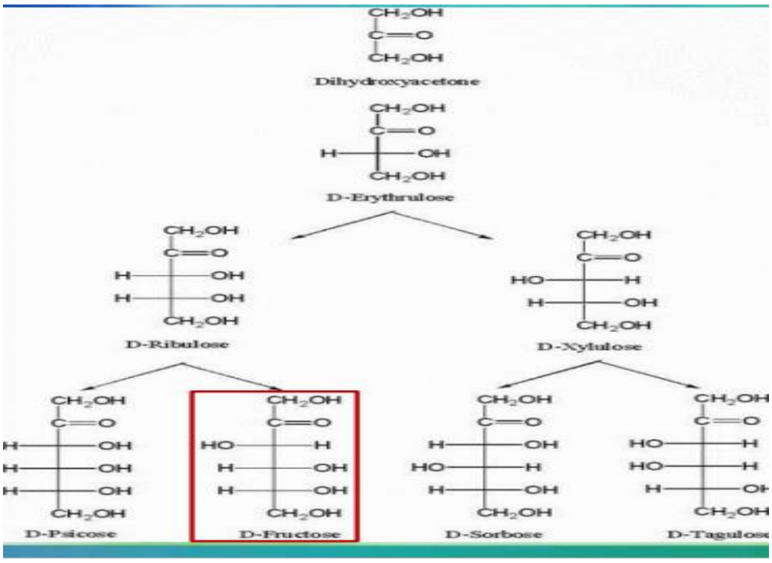
Number of carbon atoms – 2 = chiral centers

Number 2 represents the 1st carbon and the last one.

So, an aldose with 5 carbon atoms will contain 5-2= 3 chiral centers

Using the formula of 2^n → 2^3=8 so I should have 8 stereoisomers .

4 of them are in the form of D structure ,the other 4 are in the form of L isomer .



Now let's talk about ketoses,

we said that dihydroxyacetone doesn't have D, L isomers

Now we added a carbon atom to the dihydroxyacetone to have a molecule which is called D-Erythrulose (ulose=ketose) with a one chiral center

Then we should have a (D and L) Erythrulose .

We added another carbon having a 5 carbons molecule then I have 2 chiral centers then I should have 4 stereoisomers (D, L)-Ribulose and(D, L)-Xylulose.

Then we added another one so we have a 6 carbons molecule with 3 chiral centers so I should have 8 steroisomers , 4 in the form of D and the other 4 are in the form of L isomer.

ملاحظة: بالنسبة للرسمة الي فوق الحفظ بس الثلث كربونات والي عليه مستطيل والكلام الي فوق مش كله تحفظه ، بل هو للفهم

Doctor asked: why is the number of chiral centers decreased right here?

(so, the number of isomers decreased)

ANS: because 1st is achiral, 2nd is achiral, the last is achiral too.

To sum up :

the number of chiral carbons in aldoses is Number of carbons – 2

while the number of chiral carbons in ketoses is Number of carbons – 3

Common Monosaccharides

We will discuss the most common monosaccharides.

1) **Glucose:**

   Mild sweet flavor, known as blood sugar, Essential energy source, Found in every disaccharide and polysaccharide.

   so important in many metabolic pathways in our bodies but of course we can deal with other sugars not only glucose, having their own metabolic pathways or used to help glucose completing its pathway.

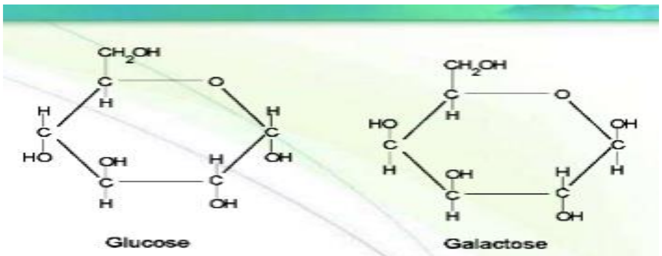
Glucose is more universal, major source of energy.

Now when we are measuring the sugars in our blood, the concentration that appears after measuring is the conc. of Glucose.

In terms of physical properties, glucose has medium sweetness(moderate)

As we said glucose in an aldohexose and because of the existing functional groups (active function groups) there will be an interaction between carbonyl group (on carbon number 1) and the last CHIRAL center (carbon number 5), they interact and form a ring structure, because they are very active, they mostly form a ring structure, we can see them as a linear structure (when opening the ring or during interactions).

Hydroxyl group could be seen up or down.



Notice that there is an oxygen atom linking to carbons and carbon number 6 is outside the ring.

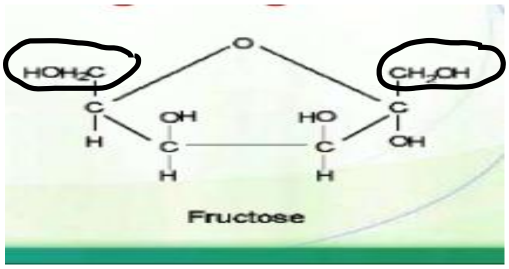
2) Galactose :

As we have previously mentioned, the difference between glucose and galactose is the placement of the hydroxyl group attached to carbon number 4, where the Fischer projection of glucose places the hydroxyl group on the right side of carbon 4 while in galactose it's placed on the left side. When drawing the Haworth ring structure of the sugars, this difference translates into the hydroxyl group appearing to be below the ring on carbon 4 for glucose and above the ring for galactose.

In terms of physical properties:

Hardly tastes sweet & rarely found naturally as a single sugar, you can find it in disaccharides or poly, oligo… or in digestion where bonds are broken, and galactose appears as a monosaccharide.

3) Fructose: ketohexose, carbonyl group (on the 2nd carbon) interacts with the last CHIRAL carbon (number five) forming a 5 membered ring



Notice that carbon number 1 and carbon number 6 are outside the ring while in glucose and galactose only the carbon number 6 is outside the ring.

In terms of physical properties

Sweetest sugar, found in fruits and honey.

Added to soft drinks, cereals, desserts.

لاتنسونا من دعائكم دفعتنا الجميلة ❤

V2

Page 3: **-The [H+] is reduced, the reaction will go toward production of H+, so we need more CO_2, we can have it by more retention of it that will make more acid**

Page 8: **-nucleic acids (DNA, RNA) containing sugar ribose or deoxyribose sugar which are carbohydrates.**

Also we add extra info in the same page :

EXTRA INFO: A glycoside is a molecule in which a sugar is bound to another functional group via a glycosidic bond.

Page 10: **NOTE: Carbon 1 in aldose is most highly oxidized.**

Page 14: **ulose**

ملاحظة مش تعديل :

The fructose ring structure is not for memorization.