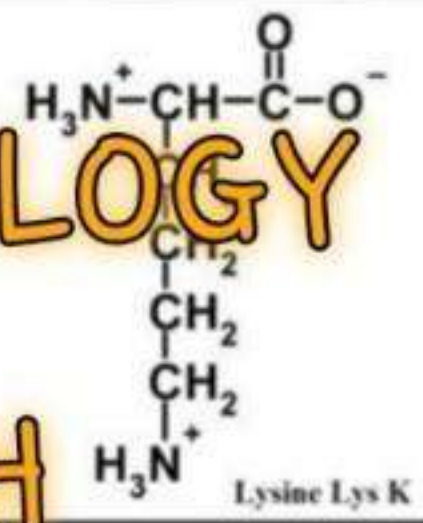


Aspartic acid Asp D

MOLECULAR BIOLOGY

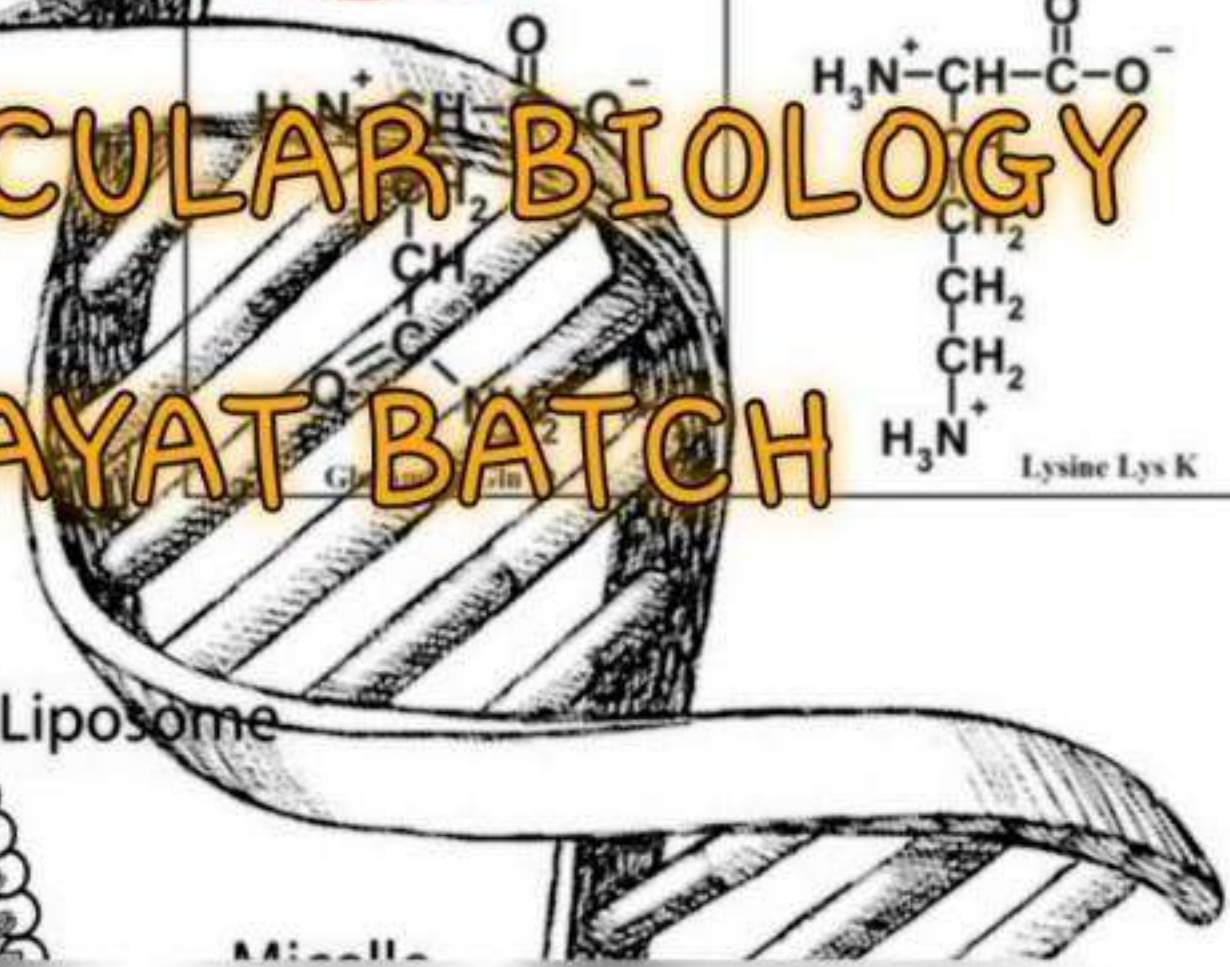
HAYAT BATCH



Lysine Lys K



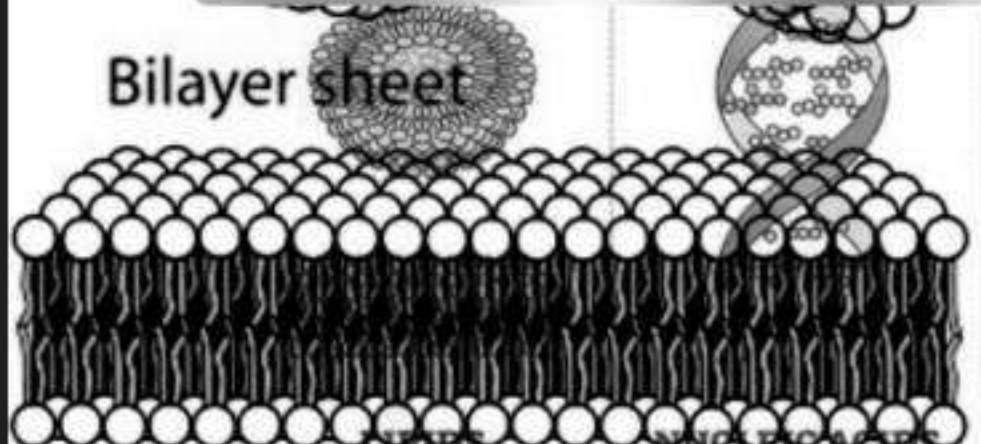
Liposome



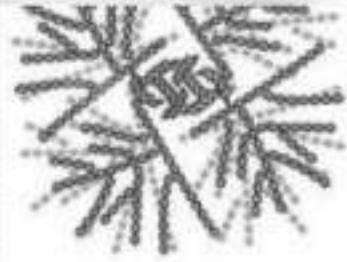
Micelle

done by : *Rahaf Al-Qawasm*

lecture no: 1



Bilayer sheet



CARBOHYDRATES



PROTEINS

• in this chapter we're gonna know the structure of macromolecules:

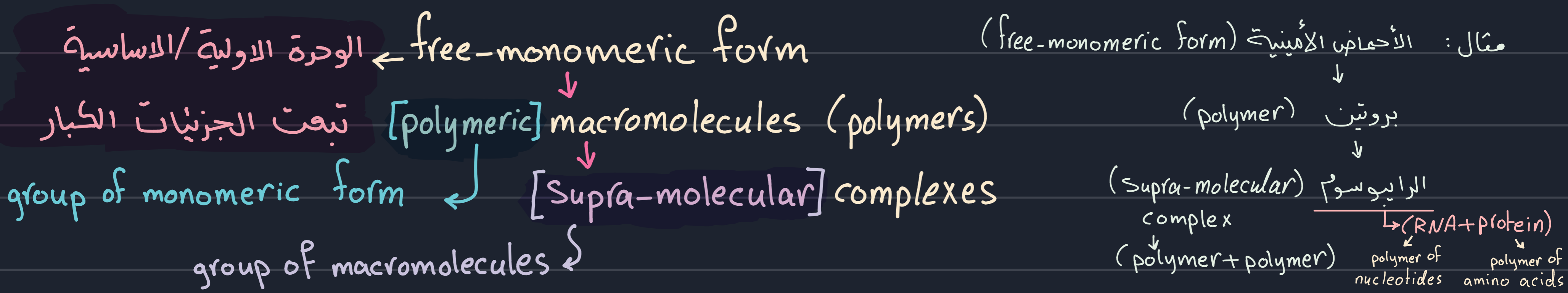
- carbohydrates chemistry (the structure of carbohydrates)
- Lipids chemistry
- protein chemistry



• Health: is the harmless reaction that happens between a different molecules in the body.

• اذا صار عنا لخبطة بالجين بصير في كنبطة جسمنا , لانه الجين هو الأساس

• ال biomolecules (الجزيئات الحيوية) ابي رح ندرسها وكل فروعها (كاربوهيدرات , بروتينات , دهون) , يكون موجودين جوا الخلية على هيئة :



• this section talks about carbs and some of its functions, and what's the metabolic pathways that carbs are gonna be a part of it.

باللاتيني معناها : حياة (Life)

chemistry of life

What does **biochemistry** deal with?

(التمثيل الغذائي)

- Metabolism:

- Anabolism (تفاعل بناء)
- Catabolism (تفاعل هدم)

- Foods:

قابل للتأكسد ← يتفاعل مع الاكسجين

دهون

- Oxidizable: carbohydrates, lipids, proteins

غير قابل للتأكسد

المعادن

- Non-oxidizable: minerals, vitamins, water

• الكربوهيدرات: مركبات عضوية تتكون بشكل رئيسي من الكربون والهيدروجين والأكسجين. وهي سكريات بسيطة أو مشتقاتها

• فيهم كربونات و فيهم هيدروجين و أكسجين بنسبتهم بالماء: (H_2O)

يعني لو هاد الجزيء

فيو أكسجينتين لازم

يكون الهيدروجين فيو ٤ .

• الصيغة العامة للكربوهيدرات (the general formula): $(CH_2O)_n$

أقل رقم فيها ٣ .

(يعني أقل واحد من الكربوهيدرات

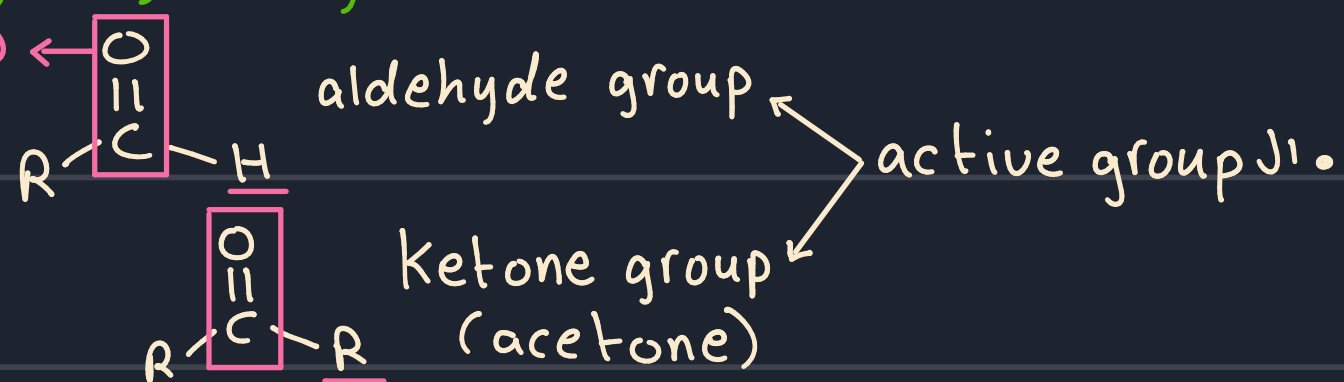
صيغته $C_3H_6O_3$)

• الكربوهيدرات يهنفوا ك: polyhydroxyketones* ← ال active group فيها رح تكون ال ketone group

حسب ال active group الي فيه

polyhydroxyaldehydes* ← ال active group فيها رح تكون ال aldehyde group

carbonyl group (الأساسية بدون إضافات)



• بما انه polyhydroxy معناها كل كربونة لازم يكون ماسك فيها H و OH

• يهنفوا ك كيتونات أو أليهايدات حسب ال carbonyl group وبن موقعها ← عالطرف: أليهايد (Aldose)
← بالنص: كيتون (Ketose)

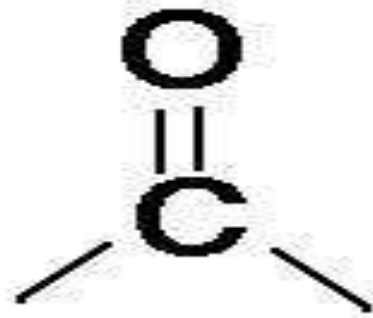
- Carbohydrates are organic compounds composed of carbon, hydrogen, and oxygen.
- Carbo=carbon, hydrates=hydrogen and oxygen in their proportion in water H₂O
- They generally have the common formula **(CH₂O)_n** where the least number of n=3

اسم تاني [Sugars]

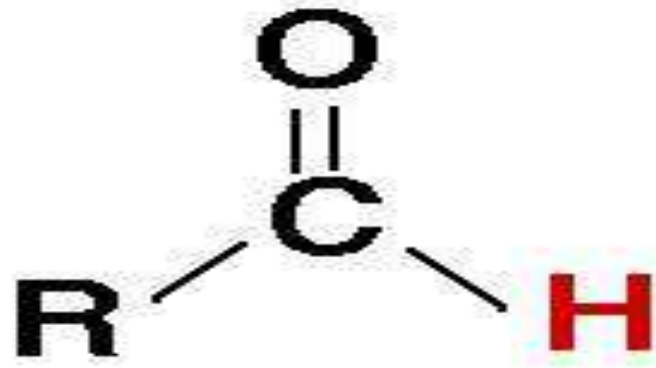
Definition of carbohydrates

سكر الطعامة: Sucrose

- Simple sugars or its derivatives
- Simple sugars are considered as polyhydroxyketones or polyhydroxyaldehydes

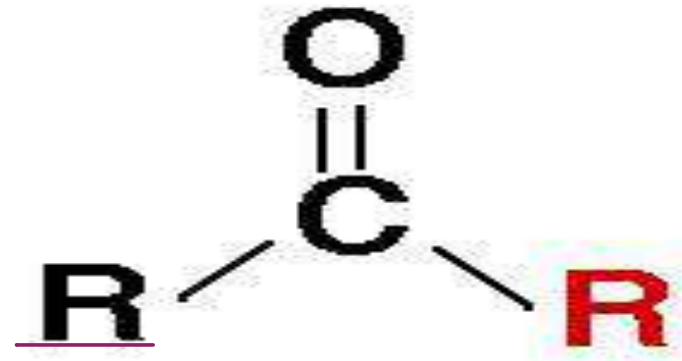


**Carbonyl
group**



← وحدة بناء **Aldehyde**

Makes Aldose (aldo sugar)
Aldehyde sugar



← وحدة بناء **Ketone**

Makes Ketose (keto sugar)
ketone sugars

• **Ketones and aldehydes are simple compounds that contain a carbonyl group (a carbon-oxygen double bond).**

• *where R can be a carbon-containing substituent.*

سبيل

تصنيفات

Classification of Carbohydrates (according to hydrolysis):

السكريات الأساسية

- **Monosaccharides:** contain one sugar unit

– E.g. glucose.
 لهما اي ال unit اصغر اتي فيها في الكربونات او ممكن يكون اكثر من ٣ .
 ما بقدر نكسره لاكثر من هيك

- **Disaccharides:** contain two sugar units

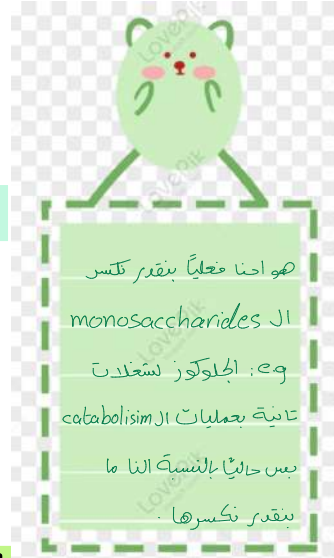
– Maltose. → (glucose + glucose)

- **Oligosaccharides:** contain 3-10 sugar units

– E.g. Raffinose

- **Polysaccharides:** contain more than 10 sugar units / monosaccharides

– Starch or glycogen.



I. Monosaccharides

تعريف

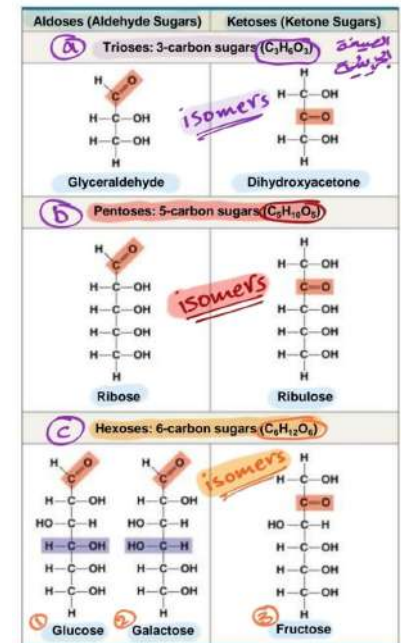
- **Definition:** They are simple sugars that cannot be hydrolyzed into smaller one.

ما بقدر اكسرها، بس بقدر احرقها (أكسر كل الذرات ابي فيها)
و اطلع منها ATP (glycolysis)

- **Classification of monosaccharides:**

I. According to the number of carbon atoms: e.g.

- 1) **Trioses:** contain three carbon atoms.
- 2) **Tetroses:** contain four carbon atoms.
- 3) **Pentoses:** contain five carbon atoms.
- 4) **Hexoses:** contain six carbon atoms.



Classification of monosaccharides:

Classification of monosaccharides:

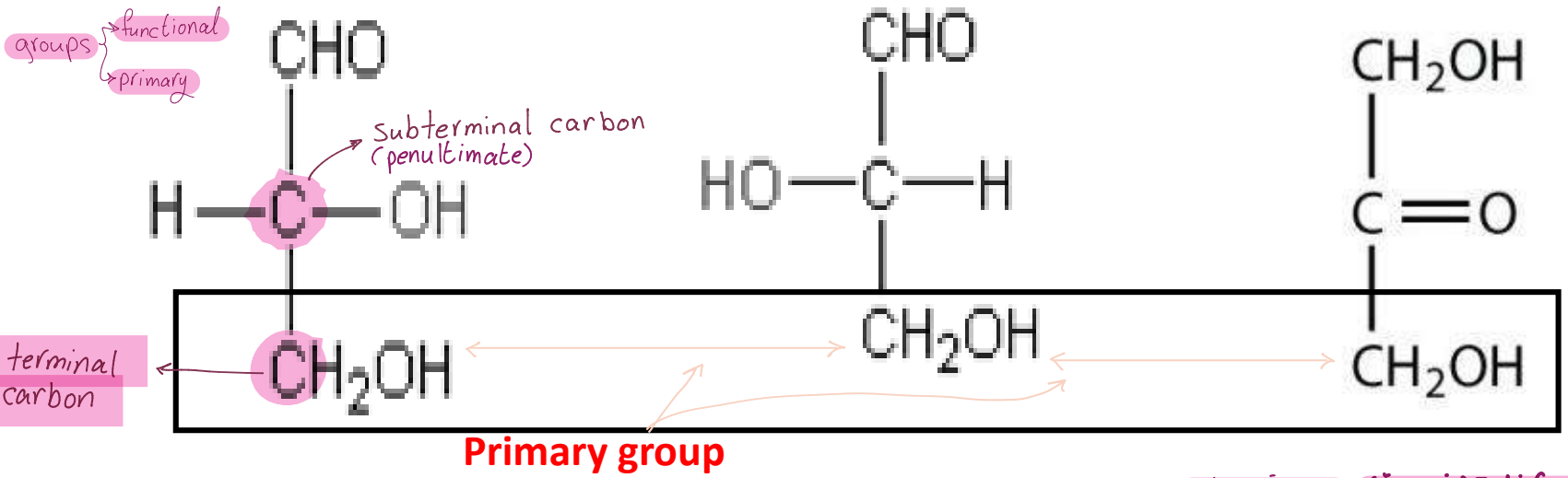
II. According to function group:

- **Aldose** (Aldehyde group)
- **Ketose** (ketone group)

← ايسر اسي

Number of carbons	Aldo-sugars (e.g.)	Keto-sugars (e.g.)
3C (triose)	Glyceraldehyde <small>(glycerose)</small>	Dihydroxy acetone <small>(metabolic pathway for glucose) glycolysis</small>
4C (tetraose)	Erythrose <small>لونہ احمر</small>	Erythrulose
5C (pentose)	Ribose Aldopentose	Ribulose
6C (hexose)	Glucose	Fructose

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



D- Glyceraldehyde

Dihydroxyaldose

L- Glyceraldehyde

يعني كيف الذرات الي
مربوطين بالكربونة
ترتيب متوزعين

Dihydroxyacetone

*there's no D/L configuration

Dihydroxyketose

بتميز بشغلة (خاصية): ما بيحتوي على
chiral carbon

الكربونة
قبل الاخيرة

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.

terminal carbon
↑
• $\underline{\text{C}}\text{H}_2\text{OH}$ (primary group) ← موجودة بكل الكربوهيدرات غالبًا

ان Glyceraldehyde يصنف لـ
D-Glyceraldehyde ←
L-Glyceraldehyde ←

* we judge the glyceraldehyde whether it's D or L according to the "OH" that's connected to the subterminal carbon atom.

if the OH is on the right the glyceraldehyde is D-Glyceraldehyde

if the OH is on the left the glyceraldehyde is L-Glyceraldehyde

• أغلب السكريات الي رح تدخل بـ metabolic pathways واي نحسنا بتكون من ال D-form

"أنت لا تدرس للأمتحان ، بل تدرس لليوم
الذي تكون أنت فيه الفاصل بين المريض وقبره."

- **Examples of Tetroses are:**

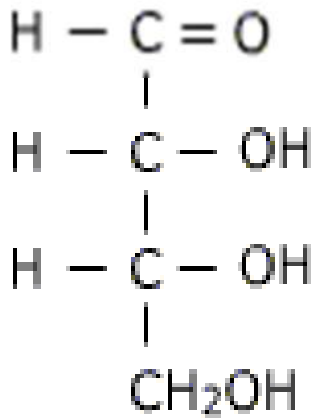
- **Aldotetrose: Erythrose**

← لونهم أحمر

→ there's D&L configuration

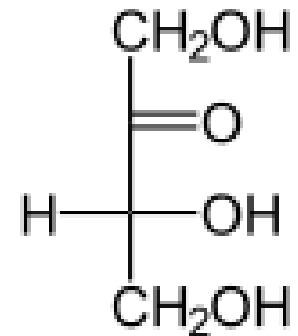
- **Ketotetrose: Erythrulose**

Erythrose was first isolated in 1849 from rhubarb



D-Erythrose

Erythrulose/DHA reacts with the amino acids in the proteins of the first layers of skin (the stratum corneum and epidermis)



D-Erythrulose

D-Erythrulose

↓ you can find it in the layers of the skin

- **Most physiologically important isomers that can be utilized in the body are the D form**

بِس هَاد مَا بِلِي وَجُود ال L-form مِن جِسْمِنَا، لَكِنَّهُ فِي بَعْضِ السُّكَّرَاتِ مَوْجُودَةٌ طَبِيعِيًّا بِتَكُونِ عَهِيدَةً L-form بِس مَا بِتَدْخُلُ بِلِ metabolic pathways

- Some sugars occur naturally in their L-forms:

- ^{sugar (carb)} L-arabinose and ^{sugar (carb)} L-fucose (C₆H₁₂O₅) which are components of ^{مَكُونَاتٌ لِبَعْضِ ال} glycoprotein → بروتين + كاربوهيدرات

- L-xylulose (pentose) is an intermediate in metabolism and can be utilized by isomerization into D-form

- L- arabinose is an aldopentose present in some fruits such as cherries, grapes, plums, and prunes. Ingestion of large quantities of these fruits leads to the appearance of L-arabinose in the urine, a condition called **alimentary pentosuria**.

فِي pentose نَزَلَ بِلِ urine أَي هُوَ ال arabinose

جاي من ال diet

• ال L-xylulose بيطلع أثناء أحد ال metabolic pathways ابي رح فاخدها
glucuronic acid pathway: (minor pathways for glucose pathways)

• عنا major pathways و عنا minor pathways

- ال glucose لما يدخل على الجسم ال major pathway هي ال glucose

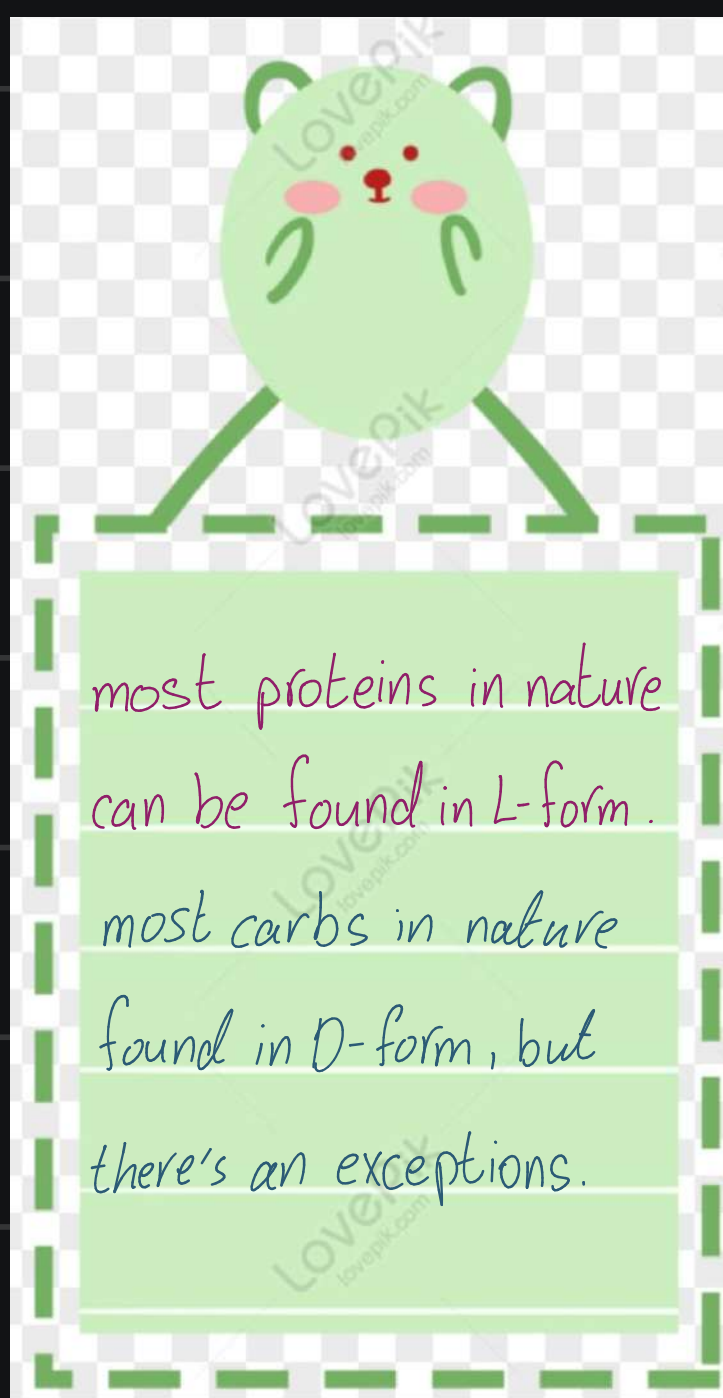
بس برضو في minor pathways من ضمنهم [glucuronic acid pathway] ← رح ندرسها بعدين, بس حكيينا عنها هلا لأنه باحدى خطواته

بيطلع ال L-sugar ابي هو ال L-xylulose

• جسمنا ما يتعامل مع L-sugars, و بـهاد ال metabolic pathways يكون فيو انزيم يحول ال L-xylulose ل

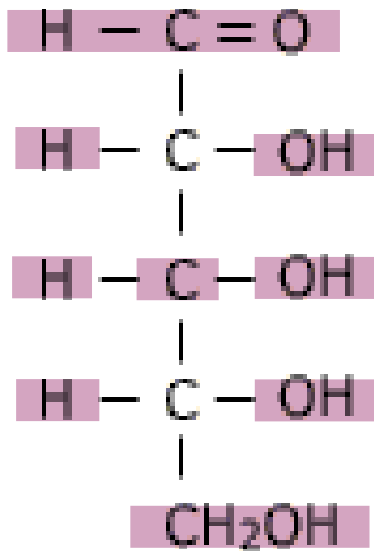
D-form عشان يصير مناسب لجسمنا

• لو في خاس عندها خلل بل انزيم ابي يحول ال [L → D], بينزل ال L بل بول تبعهم لانه جسمنا ما رح يعرف يتعامل (يتفاعل) معاه



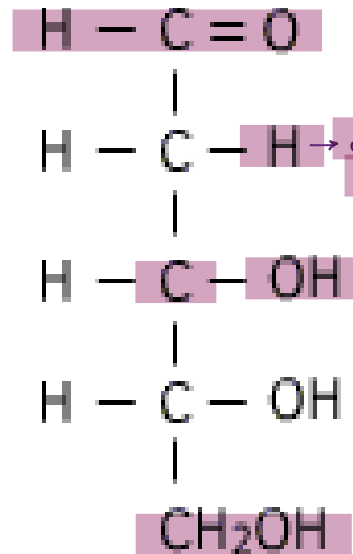
- **Examples of pentoses are:**
- **aldopentoses: ribose and deoxyribose,**
- **ketopentose: ribulose**

حفظ structure ج1



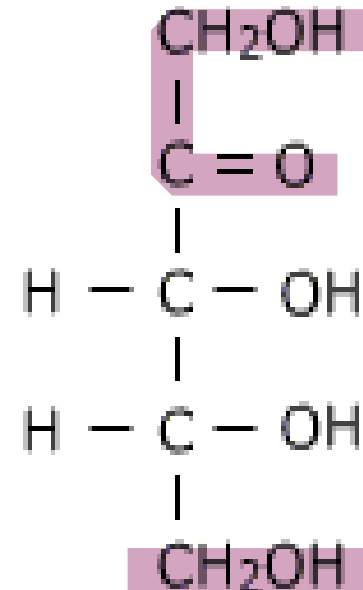
ج1 ال OH عالمين
subterminal C ↑
carbon

D-Ribose



ما فيها اكسجين
عشان صيك
deoxy

D-deoxyribose



D-Ribulose

🌟 Functions of pentoses:

- Ribose and deoxyribose enter in the structure of nucleic acids RNA and DNA. → *the structure of life*
- Ribose enters in the structure of ATP, GTP and other high energy phosphate compounds. → *مكونات فيها فوسفات بنسختها عشان تحصل على طاقة.*
- Ribose enters in the structure of coenzymes NAD, NADP and flavoproteins. → *انزيمات مساعدة*
→ *FAD (Flavin adenine dinucleotide)*
→ *FMN*
- Ribose phosphate and ribulose phosphate are intermediates in pentose phosphate pathway (a minor pathway for glucose oxidation). → *رايبوز فوسفات* → *رايبولوز فوسفات* → *مهم جدا* → *(HMP shunt)* → *اسم ثاني*
- They are components of some vitamins (ribose in vitamin B2)

Vitamin	Major Dietary Sources	Major Functions in the Body	Symptoms of Deficiency
Water-Soluble Vitamins			
B ₁ (thiamine)	Pork, legumes, peanuts, whole grains	Coenzyme used in removing CO ₂ from organic compounds	Beriberi (tingling, poor coordination, reduced heart function)
B ₂ (riboflavin)	Dairy products, meats, enriched grains, vegetables	Component of coenzymes FAD and FMN	Skin lesions, such as cracks at corners of mouth

• نقص الفيتامينات مضر لانهم مهمين جدا و يدخلو بتكوين ال coenzymes و مهمين كثير للاغلب ال metabolic pathways الي جسمنا .

Adenosine triphosphate

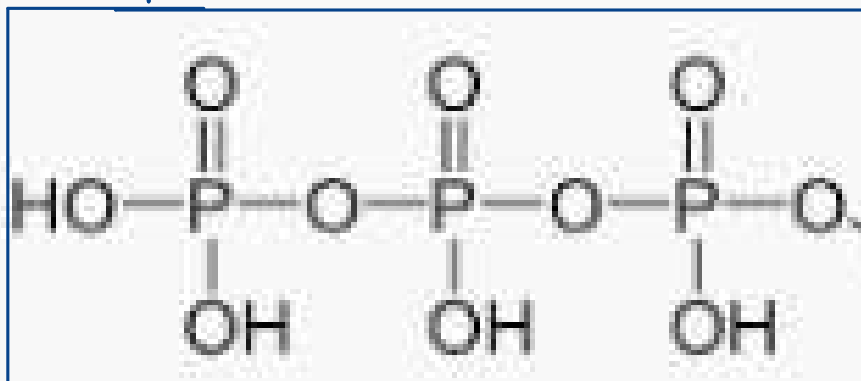
[adenine+ribose]

nitrogenous base

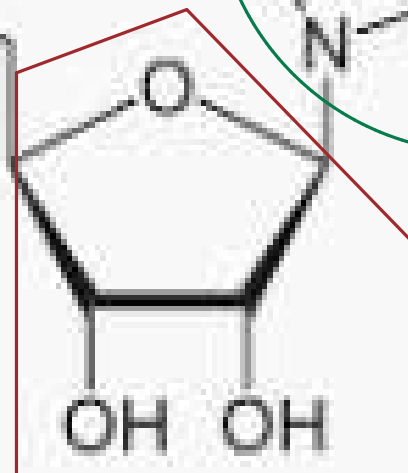
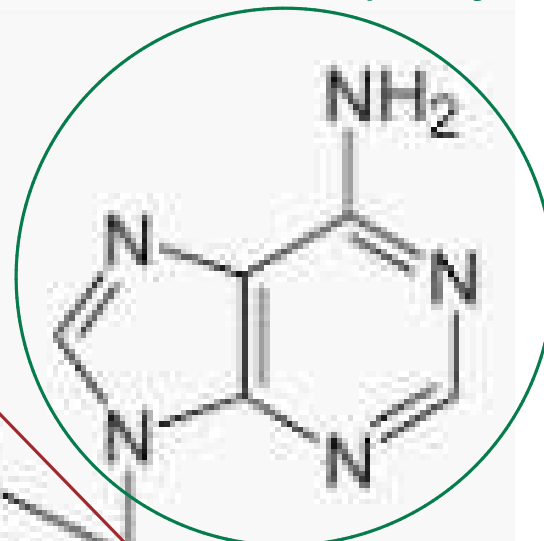
ATP

The structure of ATP

phosphate group

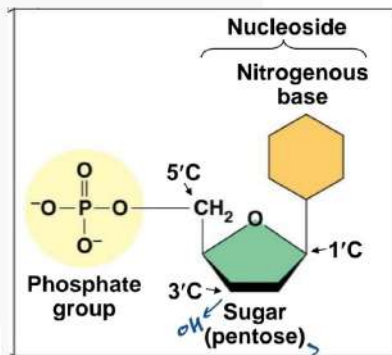
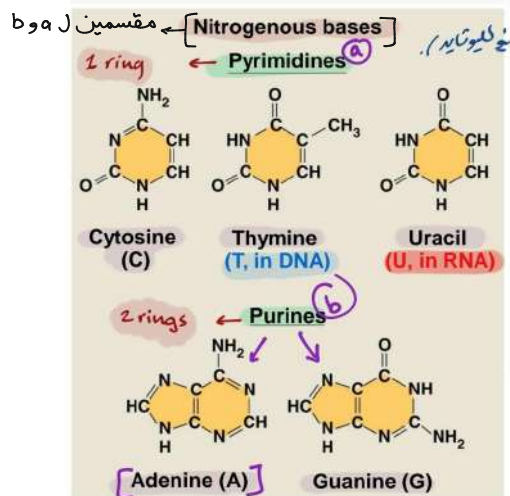


Adenine



Adenine + ribose
 (برون مجموعة الفوسفات)
 ↓
 nucleoside (adenosine)

Ribose



(b) Nucleotide

سلسلة عازلة
 وحدة نووية

لو كان في Guanine بدل ال Adenine جيب

اسمو [GTP] ← Guanosine triphosphate

و ال Guanosine = Guanine + ribose

غير متماثل

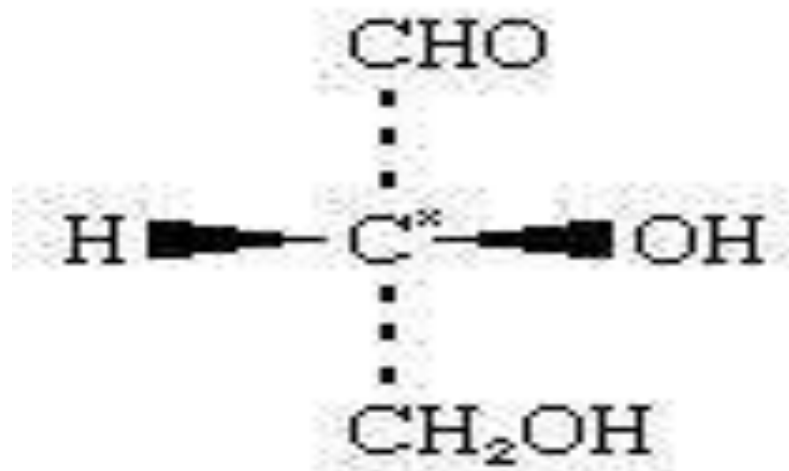
(غير متماثل)

← اسمها اسم ثاني : chiral carbon

Asymmetric carbon atom: (A.C.A)

له متصلة بـ 4 ذرات / مجموعات مختلفة (4 روابط مختلفين)

- It is the carbon atom to which four different groups or atoms are attached. Any substance containing asymmetric carbon atom has optical activity & optical isomerism



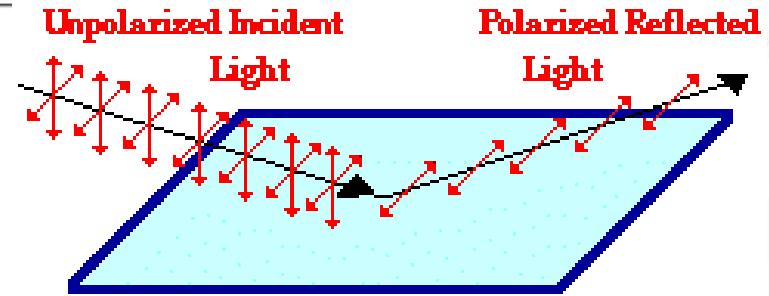
لها لف الضوء الليمين/الليسار لفاكم درجة

- A **polarimeter** is a scientific instrument used to measure the angle of rotation caused by passing polarized light through an optically active substance.

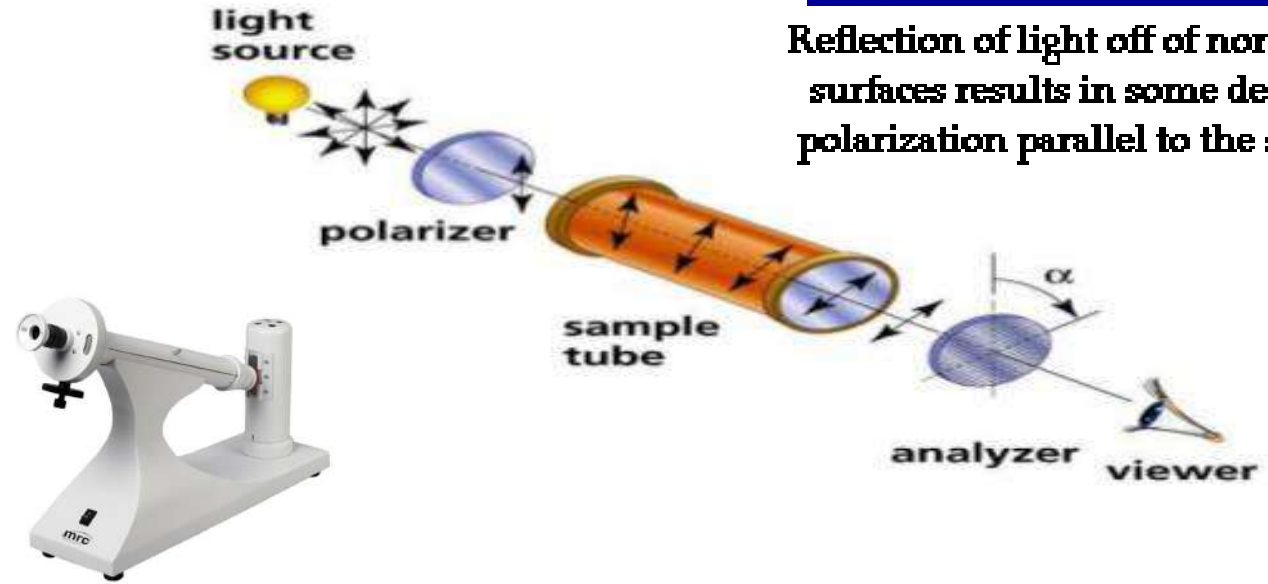
أداة

المبدأ

PRINCIPLE



Reflection of light off of non-metallic surfaces results in some degree of polarization parallel to the surface.



يستعمل لقياس شغلات منها: التركيز، النقاوة، ..

Optical activity

بناءً عليه بقدر نقيس تركيز المركبات جوا المحلول.

يعني أي مادة عندها القدرة حول مسار □ لليمين أو اليسار هاد بنحكي عنه optical activity

• It is the ability of substance to rotate plane polarized light (P.P.L) either to the right or to the left.

الضوء المستقطب المستوي

• If the substance rotates plane polarized light (light vibrate in one direction) to the right it is called:

dextrorotatory or d or (+).

Small

* تركب انو هون الأحرف Small, لانه ال capital بدروع اسمي تاني.

يعني انو هاي المادة انما القدرة انما تدور ال لليمين (P.P.L)

• If it rotates plane polarized light to the left it is called levorotatory or l or (-).

Small

يعني انو هاي المادة انما القدرة انما تدور ال للشمال (P.P.L)

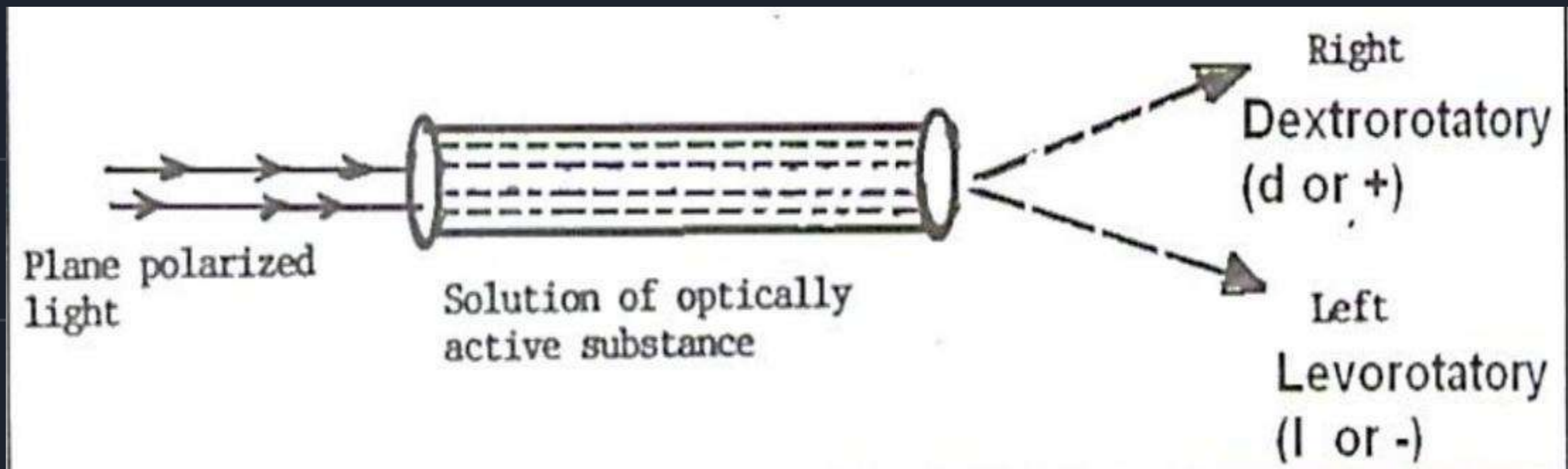
Glucose contains 4 asymmetric carbon atoms. It is dextrorotatory so it is named dextrose. Fructose contains 3 asymmetric carbon atoms. It is levorotatory so it is called levulose.

اسم تاني للجلوكوز ال ال 0.9 تبعه قوي

موجود بالحسل

سمينه هيك لانه فيو (A.C.A) خلت عنده optical activity ولما حطينا عليه ال (p.p.L) عمل دوران للضوء للييسار

سمينه هيك لانه فيو (A.C.A) خلت عنده optical activity ولما حطينا عليه ال (p.p.L) عمل دوران للضوء لليمين



• لو جينا المادة الي بدنا ياها و حطيناها ب tube معين بجهاز معين اسمه polarimeter , و احنا

عارفين انو هاي المادة الها optical activity (يعني : باي مادة بتكون جواتها (A.C.A) و بنحط عليها

(p.p.L) بصير لها الضوء تدوير يا إما لليمين (أو لليساار) , المادة لما احطها بل tube و احط عليها (p.p.L) بتعمل

rotation (تدوير) للضوء هاد , و يكون في مؤشر بتسوف هاد الضوء يلف يمينا و لا يساره .

• كل م كان التركيز تبع المادة اي احنا بتقيس ال optical activity الها عالي , بتلاقي زاوية التدوير كبرت (الدرجة) / الدوران تبعها

صاار اكبر . (proportional)

• هاي الطريقة بتفيد الناس اي بصنعوا أدوية عشان يشوفو تراكيز
الأدوية المختلفة أو بتفيد الناس اي بعيّنو المكونات (المقادير) بتعت الأكل (المنكهات / خط شو مع شو...)

إذا حابين تعرفو عن التجربة أكثر احرصوا هاد الفيديو :

Polarimetry Tutorial / keester03

<https://www.youtube.com/watch?v=rvfLXm1aiM4>

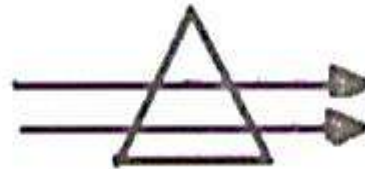
You deserve it



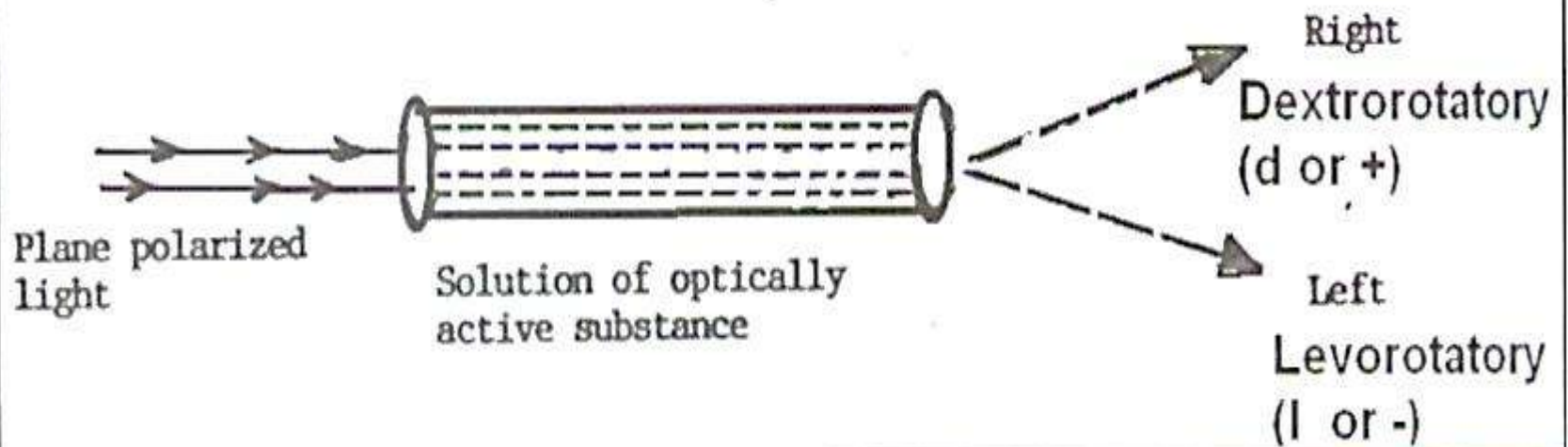
: كافئ نفسك



Ordinary light
(i.e. light vibrates in all directions)



Plane polarized light
(i.e. light vibrates in one direction)



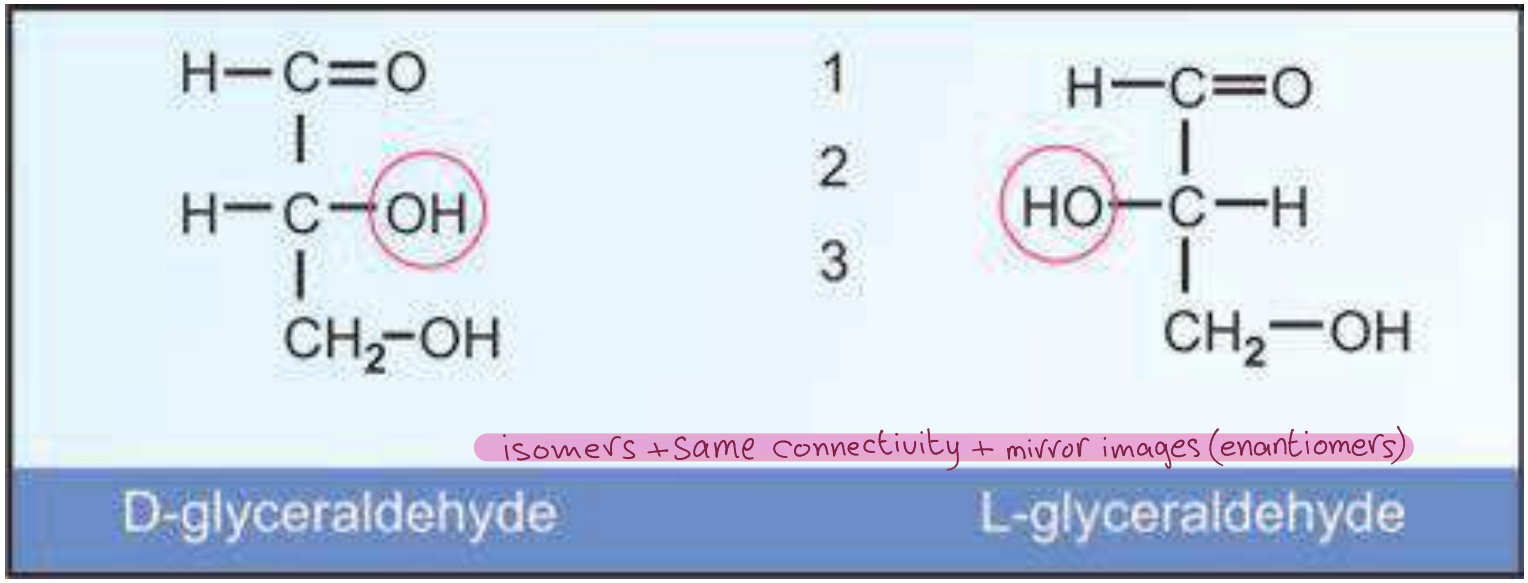
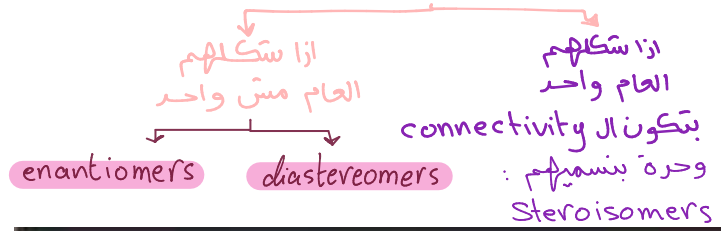
- The optical rotation is proportional to the concentration of the optically active substances in solution. Polarimetry may therefore be applied for concentration measurements
- Concentration and purity measurements are especially important to determine product or ingredient quality in the food & beverage and pharmaceutical industries.

Stereoisomerism

- It is the ability of substance to present in more than one form (isomer).
- A substance containing one asymmetric carbon atom has 2 isomers.
- A substance containing 2 or more asymmetric carbon atoms can exist in a number of isomers ^{تتواجد} = 2^n where n is the number of asymmetric carbon atoms. e.g. glucose has 4 asymmetric carbon atoms so the number of its isomers equal $2^4 = 16$ isomers.

Isomers

العنوان الأشمل ←
(بكونو نفس الصيغة الجزيئية)



Compounds having same structural formula, but differing in spatial configuration are known as stereoisomers

نظائر

isomers: they've the same molecular formula, but different structural formula

* optical isomers هي صفة من صفات المادة الي عندها (A.C.A)

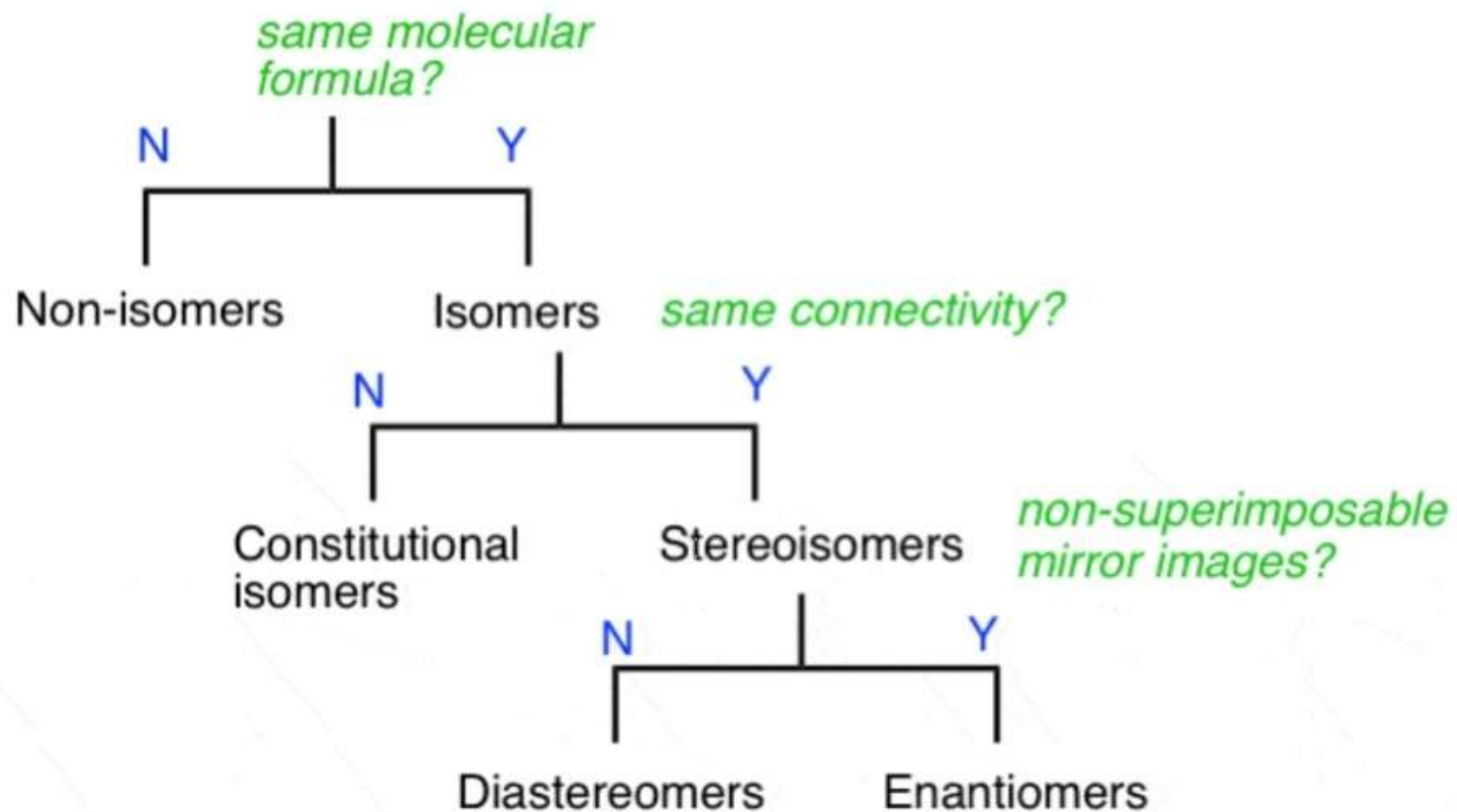
• 1(A.C.A) \rightarrow 2 isomers

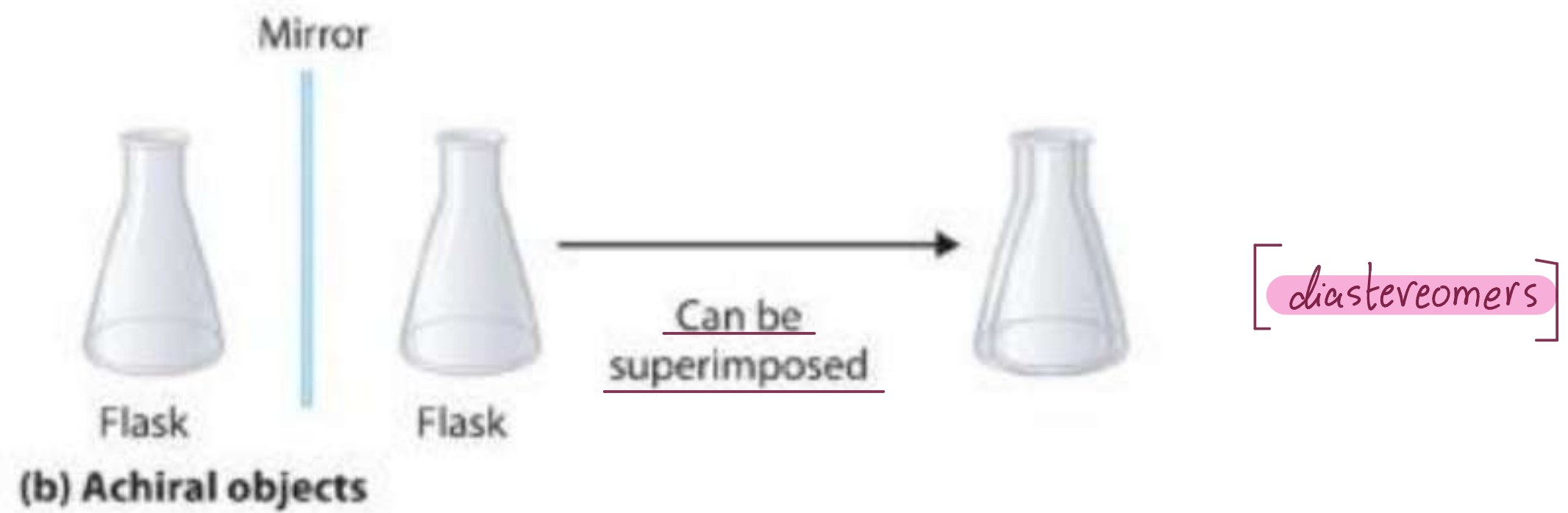
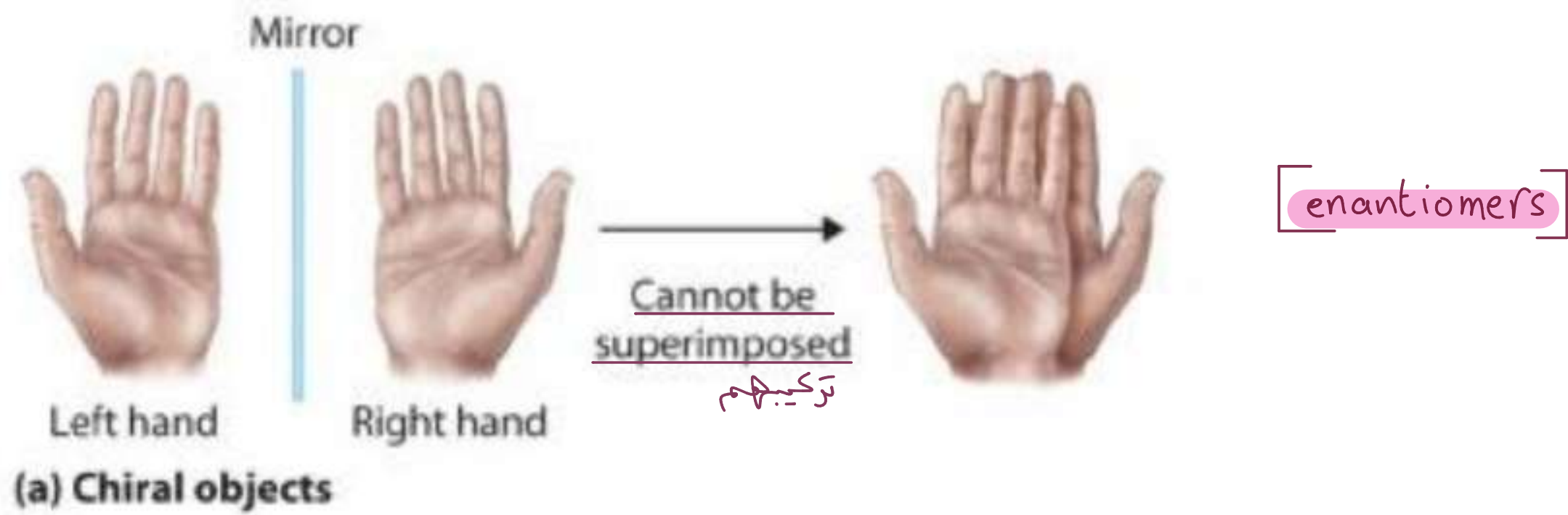
• 2 or more A.C.A $\rightarrow 2^n$ (while n is the number of (A.C.A))

e.x: Glucose contains 5 (A.C.A), how many isomers does it have?

answer: $2^5 = 32$ isomers

Possible relationships between two molecules





Epimeric carbon & epimers:

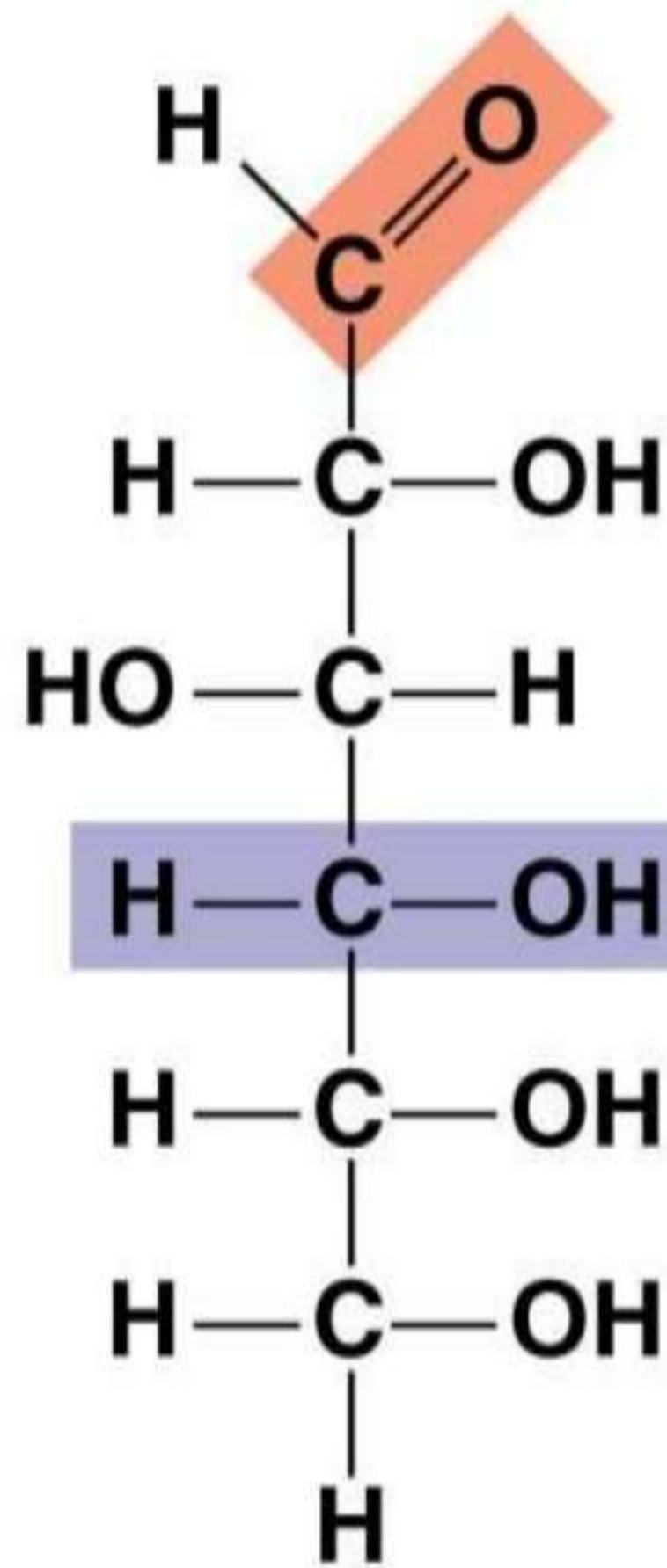
- **Epimers:** These are sugars which differ only in the configuration around a single carbon atom. e.g. Glucose & mannose with respect to C₂. Also, glucose & galactose with respect to C₄.
تكوين / توزیع
- They contain more than one asymmetric carbon atom, all of which identical but only one is different.
- **Epimeric carbon:** e.g. carbon number 2 in glucose & mannose & carbon number 4 in glucose and galactose.

Aldose (Aldehyde Sugar)

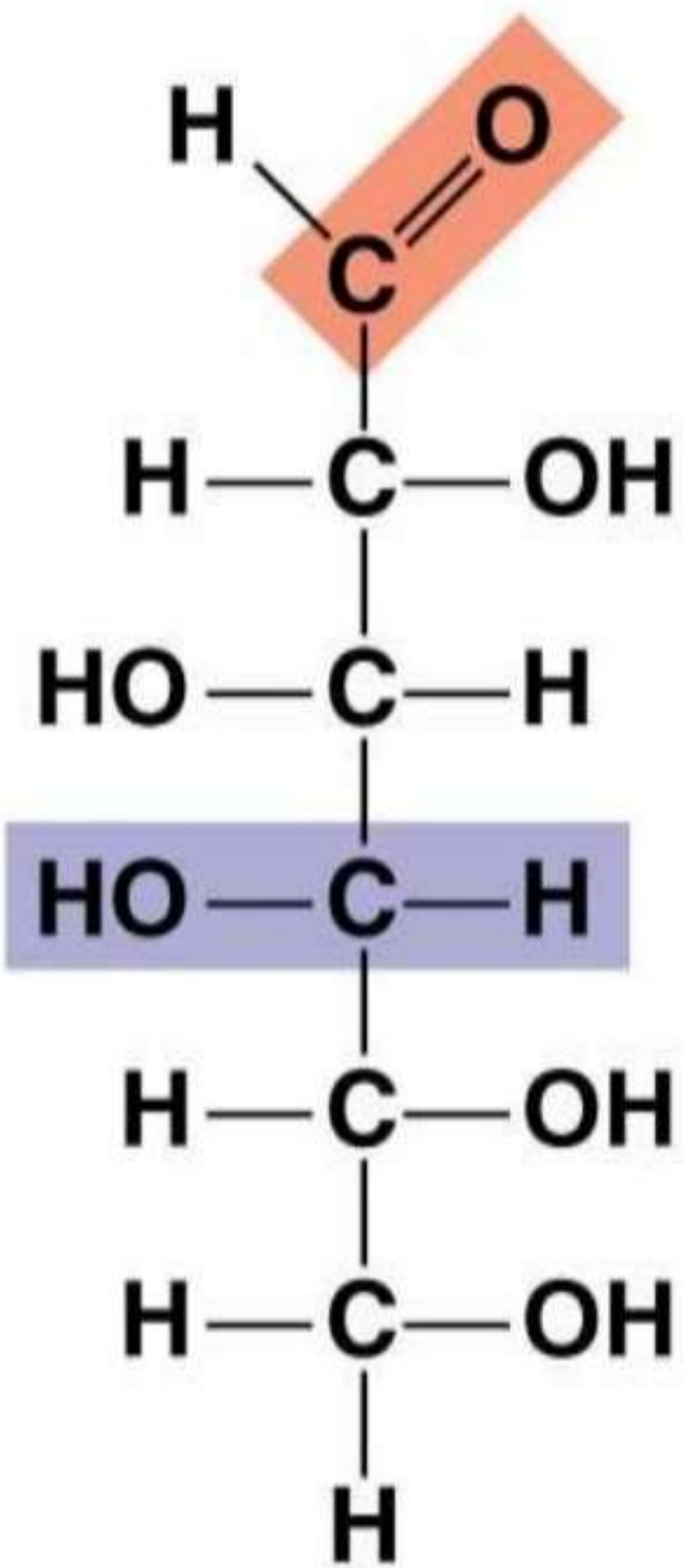
Ketose (Ketone Sugar)

Hexoses: 6-carbon sugars (C₆H₁₂O₆)

(Aldo keto isomers)

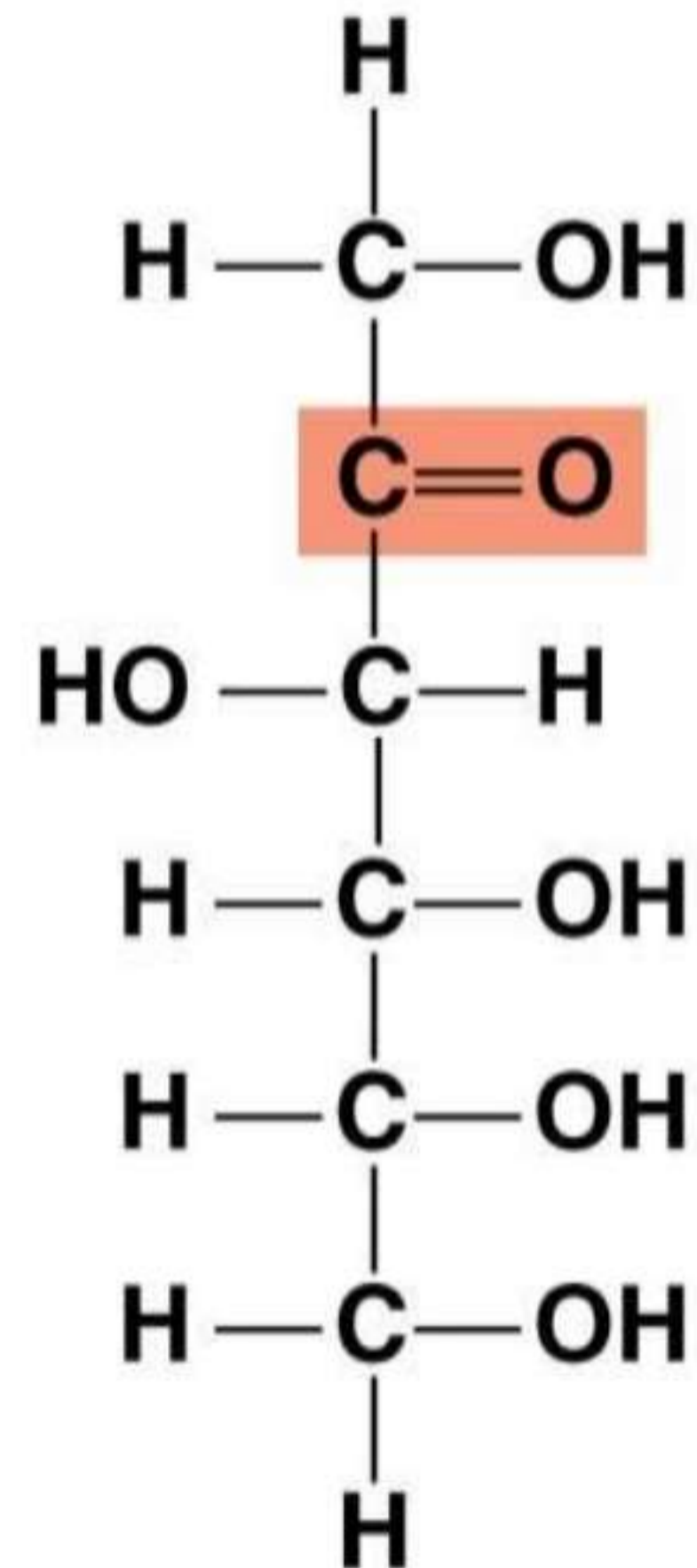


Glucose



Galactose

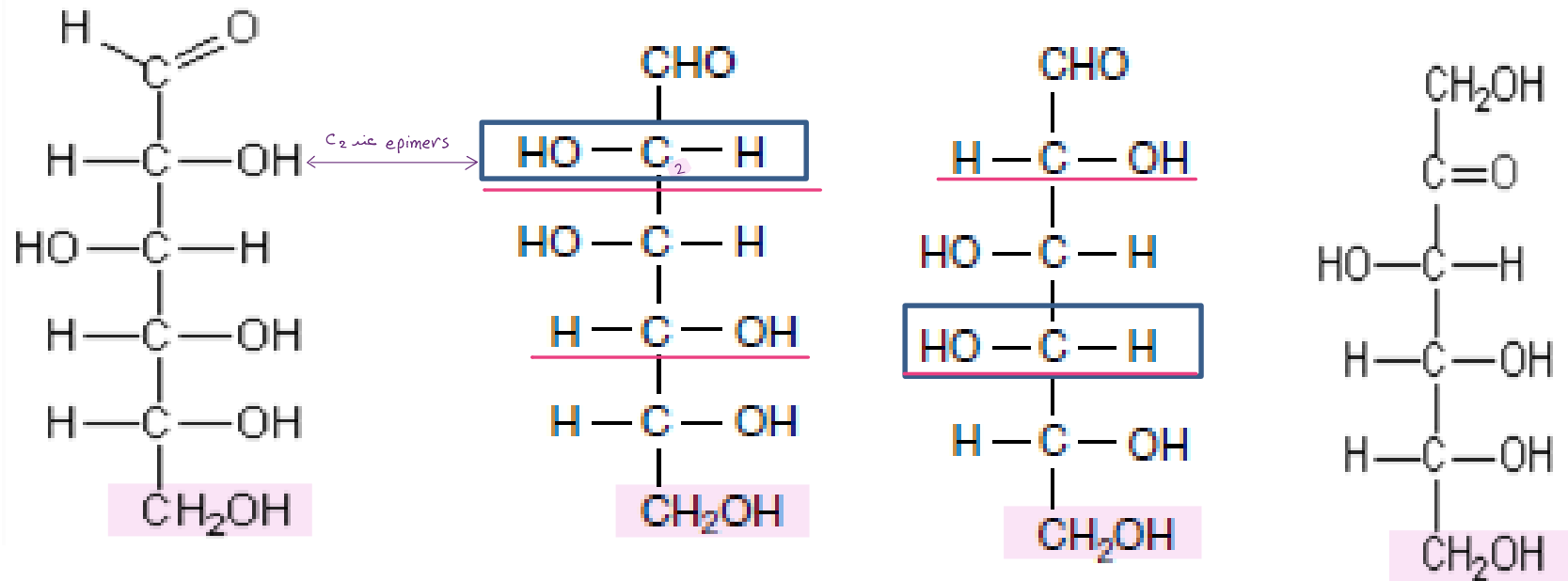
epimers



Fructose

Examples of hexoses are:

- aldohexoses: glucose, mannose and galactose,
- ketohexoses: fructose



D-Glucose

D-Mannose

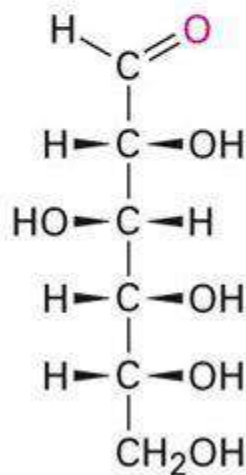
D-Galactose

D-Fructose

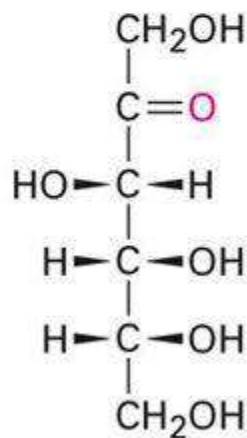
Galactose and mannose are not epimers but diastereo-isomers.

Aldoses and Ketoses

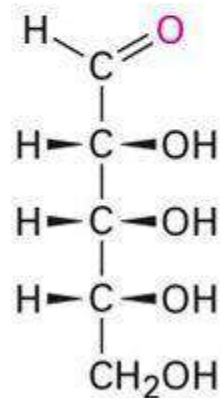
- *aldo-* and *keto-* prefixes identify the nature of the carbonyl group
- *-ose* suffix designates a carbohydrate
- Number of C's in the monosaccharide indicated by root (*-tri-*, *tetra-*, *penta-*, *hexa-*)



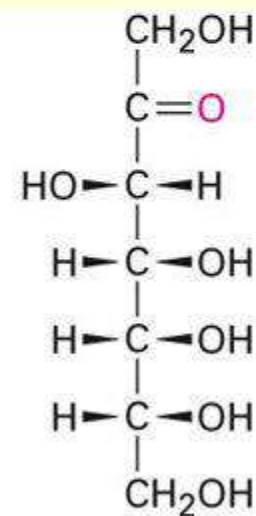
Glucose
(an aldohexose)



Fructose
(a ketohexose)



Ribose
(an aldopentose)



Sedoheptulose
(a ketoheptose)

• Importance of hexoses:

D-glucose "grape sugar":^{عنب}

كل السكريات بالكاربوهيدرات اي روح ندرسها مهمين , بس اهم واحد يعتبر هو الجلوكوز

- It is called dextrose (dextro-rotatory).
- It is the most important sugar of carbohydrates.
- It is the main sugar in blood, ranging from 70-110 mg/dl. ^{صارت ل 100} ^{واحد صابمين}
- ✳ It is one of major sources of energy in the body. → [fermentation & cellular respiration]
- ✳ It is the principle sugar used by the tissues.
- It is widely present in fruits & vegetables associated with fructose. ^{مرتبط}
- It enters in the formation of disaccharides & polysaccharides.
- In the liver & other tissues, it is converted to all carbohydrates in the body e.g. glycogen, galactose, ribose & fructose. ^{يحول / يتم تحويله}

✳ : الجلوكوز يعتبر مصدر للطاقة الي كل الانسجة بتقدر تستخدمه , لانه في مصادر ثانية للطاقة مش كل الانسجة بتقدر تستخدمه

• disaccharides: consist of (2) monosaccharides

• polysaccharides: consist of (3 or more) monosaccharides

D-fructose "fruit sugar":

- It is called Levulose (levo-rotatory).
- It is the main sugar of semen (Source of energy for the sperms).
 - المسائل المنوية (المني)
 - حيوانات منوية
 - الحوبيصلات المنوية
 - it could use glucose also, but fructose is the major source.
 - [Seminal vesicle] are the glands that secretes fructose to nourish sperm.
- It is sweeter than glucose.
- It is present in honey & fruits.
 - that's why honey is sweeter than sugar
- It enters in the formation of sucrose.
 - disaccharide (glucose+fructose)
- In the liver, it is converted into glucose.

← تفاصيل المعلومة هاي مهمة (رج ناخذهم بعين) بس بنركز عليها خاصة للناس الي عندهم سكري

D-galactose "milk sugar":

- It is synthesized in **mammary gland** to make the lactose of milk.
الغدة الثديية
يُنتج
السكر الأساسي الموجود بالحليب
→ glucose is converted here to galactose
→ Lactose consist of : glucose+galactose
- In the liver, it can be converted into glucose.
- It enters in the structure of **glycolipids** which are found in many tissues especially in C.N.S.
الجهاز العصبي المركزي
→ it's a lipids with carbohydrates attached with it
→ these ones contain galactose
→ central nervous system

D- mannose:

- It is a constituent of many **glycoproteins**.
أحد مكونات
→ it's a proteins with carbohydrates attached with it
→ contain mannose

Test Yourself

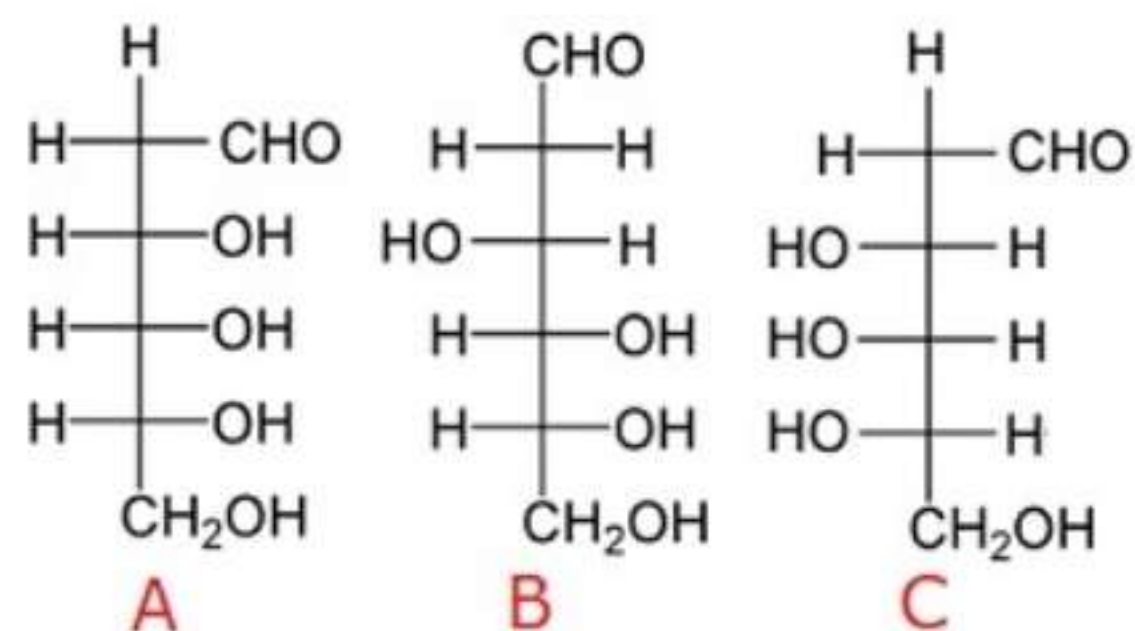


UmiZ

☺

Use the provided material to answer questions 1-2.

Use the following structures to answer the questions.



1. Which of these molecules are enantiomers of each other?


- None of them
- Only A and B
- Only B and C
- Only A and C

2. Which of these molecules are diastereomers of each other?

- All of them
- A and B
- A and C
- B and C

3. What is the difference between enantiomers and diastereomers?


- Enantiomers have all stereocenters opposite, and diastereomers simply have at least one (but not all) opposite.
- Diastereomers have all stereocenters opposite, and enantiomers simply have at least one (but not all) opposite.
- Enantiomers are chiral and diastereomers are not.
- Diastereomers are chiral and enantiomers are not.

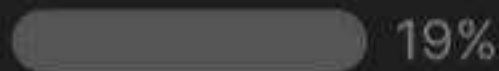
Types of sugars 



Square structures



Ring structures 



Types of proteins



Which of the following monosaccharides has 5 carbon atoms, the penultimate OH group is to the right and results in rotation of polarized light towards the left? 6/10

L-pentose l(-)

11%

L-tetrose l(-)

5%

D-pentose l(-)

55%

D-tetrose d(+)

20%

L-pentose d(+)

9%

Which of the following monosaccharides has 5 carbon atoms, the penultimate OH group is to the right and results in rotation of polarized light towards the left? 6/10



15

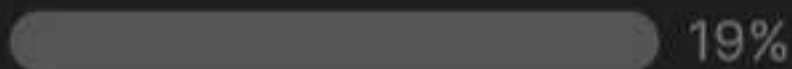


- L-pentose l(-)
- L-tetrose l(-)
- D-pentose l(-)
- D-tetrose d(+)
- L-pentose d(+)

Mannoheptulose is?

8/10

8 carbon ketose



7 carbon aldose



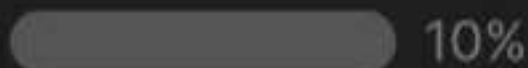
7 carbon ketose



6 carbon ketose



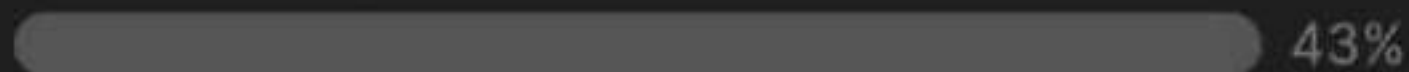
6 carbon aldose



Normal post prandial blood glucose level in blood is?

5/10

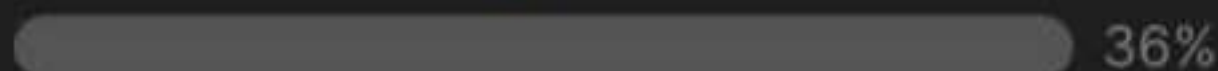
up to 120 mg/dL



up to 130 mg/dL



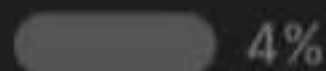
up to 140 mg/dL



up to 150 mg/dL



up to 160 mg/dL



مفیش وقت للانھیار, اشتغل

وانت بتعیط

