Bio-Chem

Lecture 2
- intro

* Functional Groups

17/oct/2024

Functional groups : They are specific groups of atoms or bonds within molecules that are responsible for characteristic chemical reactions of these molecules

مجموعات الوظيفية :

* Same functional groups will undergo the same or similar chemical reactions regardless of the size of the molecule its part of

* Some elements involved forming functional groups :

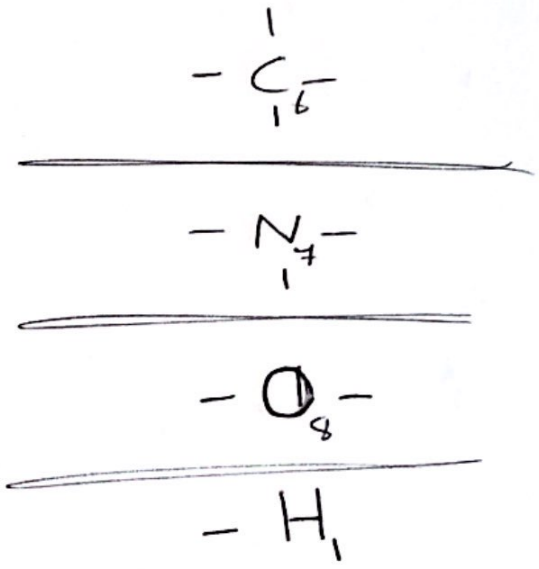
Oxygen, Carbon, Nitrogen, Hydrogen, Phosphorus

O C N H P

PHONC

*

elem	Bonds can make
Carbon	4
Nitrogen	3
Oxygen	2
Hydrogen	1



* Some functional groups :

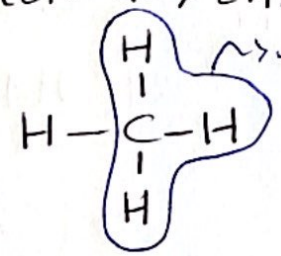
① Hydrocarons : (↖ CH_3)
↳H C↲

* Long chains of carbon and hydrogen ending with a:
Methyl group ⇝ RCH_3 / $R-\overset{H}{\underset{H}{\overset{|}{\underset{|}{C}}}}-H$

* They are hydrophobic bc they are (non-Polar) ⇝ isn't soluble in water
the E.N diff between C, H is (2.5, 2.1) 0.4 < 0.5

* They form the back'bone for most organic ~~Compounds~~ Molecules

Ex of hydrocarbons : Methane, CH_4



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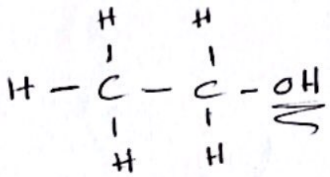
② Alcohols :
↳OH

* Characterized by hydroxyl group ⇝ ROH / R-OH

* They are hydrophilic bc they are Polar
E.N diff of O, H = 0.9 < 2.0 and > 0.5 (O: 3.5, H: 2.1)

* They easily dissolve in water (Polar dissolves Polar)
Like = Like
and are good ~~Fuels~~ fuels

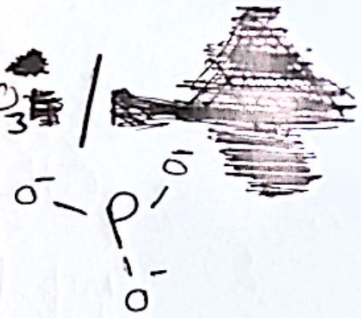
Ex of alcohol : ethanol, CH_3CH_2OH



③ Organic Phosphates :

$-PO_3$

* characterized by a Phosphate group ↝ PO_3^{-} /



* These compounds are usually **acidic**
* can be found in **ATP** and **DNA**

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④ Carboxylic acids :

↳ COOH

* char by a carboxyl group ↝ $RCOOH$ / $R-\overset{O}{\overset{\|}{C}}-OH$

is a carbonyl group ← $C=O$

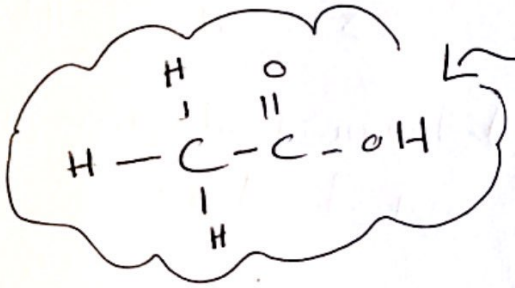
bonded to hydroxyl OH

* referred to as organic acids
* They are water soluble (Polar) (hydrophilic)
* They are weak acids that are often aromatic

عطري ←

Ex of carboxylic acids : **acetic acid**

↳ known as **Vinegar**



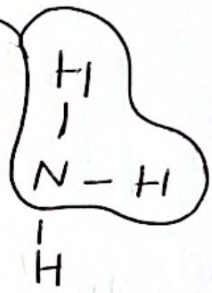
⑤ Amines :
↳ NH_2

* chared by an Amino group ↝ RNH_2 / $R-N(H)-H$

* These compounds are water soluble (Polar) (hydrophilic).

* They are weak bases

Amine



Ex of Amines : ammonia NH_3

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⑥ Aldehydes :
↳ CHO

* chared by aldehyde group ↝ RCOH / $R-C(=O)-H$

* These compounds are Polar (hydrophilic)

Ex of aldehydes : formaldehyde

CH_2O

↝ aldehyde

⑦ Ketones :

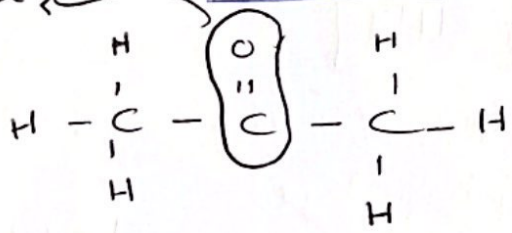
↳ RCOR

* shared by a **Ketone group** ↳ RCOR / $R-\overset{O}{\overset{\|}{C}}-R$
* **Polar** and **hydrophilic**
* Many **steroids** contain Ketones

Ex of Keytone : **acetone**

CH_3COCH_3

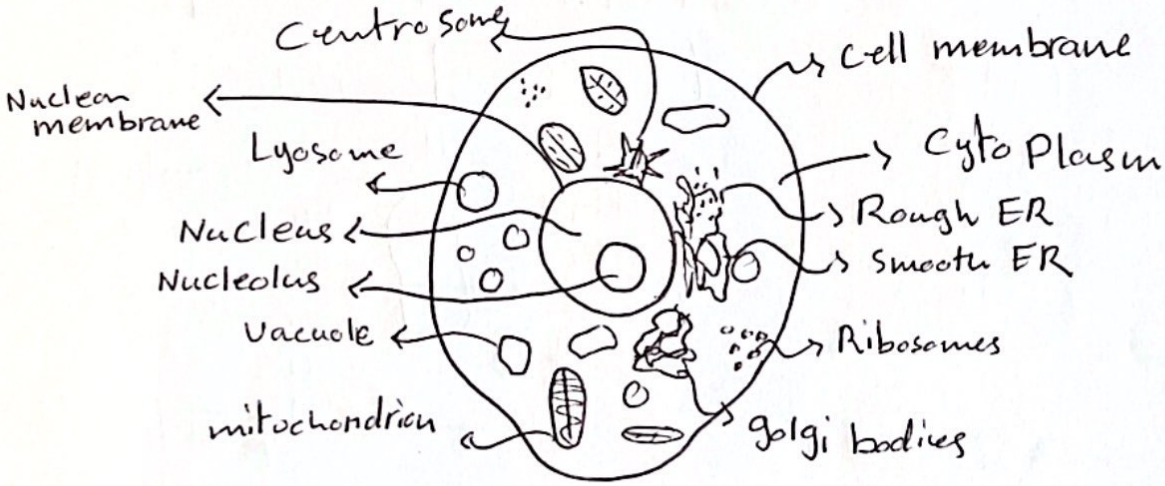
Keytone



Polar and hydrophilic	non-Polar and hydrophobic
* Hydroxyl (alcohols)	* Hydrocarbons
* carboxylic acid	
* Amines	
* Aldehydes	
* Ketones	

Cell: the unit of structure and functions in living organism

* The chemical composition of the cell in all organisms from bacteria to man is almost similar and mainly involving organic molecules



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* usually there are 2 types of biochemical molecules:

1. micromolecules (small size):

such as: monosaccharides sugars,
- Amino Acids
- fatty acids
- Nucleotides

2. Macromolecules (big or large size):

such as:
- Polysaccharides → multiple mones
- Proteins → multiple Amino acids
- some lipids → = fatty acids
- Nucliec acids → = Nucleotides

* Macro and micro molecules are present in a dynamic state :

Converting from :

* micro → macro — anabolism — called Synthesis

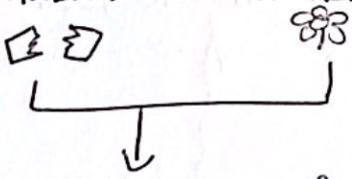
Requires Energy

* macro → micro — called Break down → catabolism

Produces / Libenates Energy

* this alternating process is called **Metabolism**

involves a series of chemical reactions according to groups Catabolism or anabolism



* Selection of either is based on the state of cell activity

→ * if growth and development is needed its (anabolism)

→ * if doing physical activity like moving muscles its (Catabolism)

So Biomolecules :

① Micromolecules

* inorganic compounds Like : water & minerals
* organic compounds like : ① Monosaccharides
② Amino Acids
③ fatty Acids
④ Nucleotides

② Macromolecules

① Protiens
② Polysaccharides
③ nucleic acids
④ Some lipids

Carbohydrates:

- They Provide fast energy (4 Kcal/gram) for humans
- They are classified according to the: number of saccharide (sugar) units they have

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* Monosaccharides:

- composed of 3 to 7 carbon atoms
- Their general formula is $(CH_2O)_n$, ex: glucose $C_6H_{12}O_6$

  n = carbon atoms

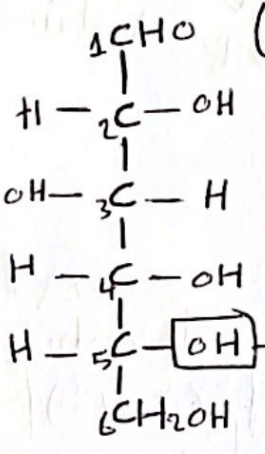
- According to the number of carbon Atoms they are classified into:

  trioses (3), tetroses (4), Pentoses (5), hexoses (6), heptoses (7) respectively

- All monosaccharides contain a hydroxyl groups (OH) and either Aldehyde or Ketone group

- Pentoses and hexoses can Cyclize as the ketone or aldehyde group reacts with a distal OH

ex:



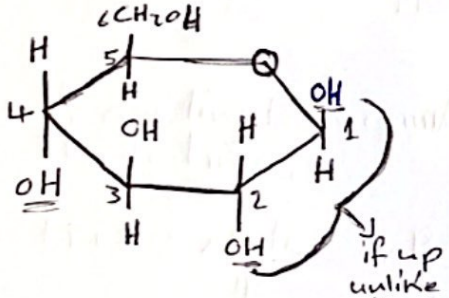
(linear form)

D-glucose

if on the right it is D-g...

if on left it is L-g...

β-D-glucose

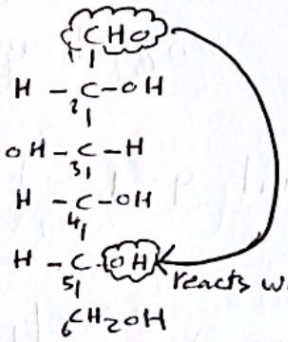


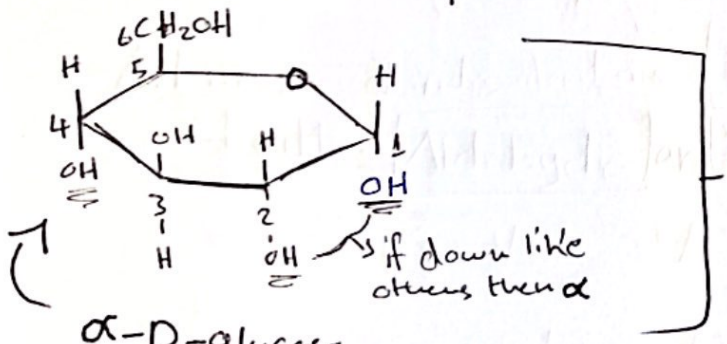
if up unlike others its β

Cyclize

C_1 react C_5

CHO w OH





if down like others then α

α-D-glucose

6-member Pyranose ring

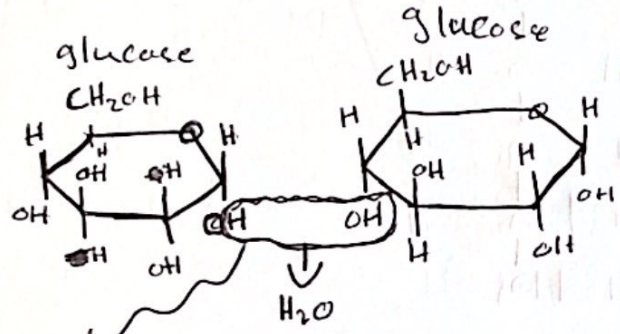
* glucose forms an intra-molecular hemiacetal as the C_1 aldehyde CHO and C_5 hydroxyl OH react to form a (6-member Pyranose ring)

* These representations of the cyclic sugars (⬡) are called: (Haworth Projections)

✱ Disaccharides :

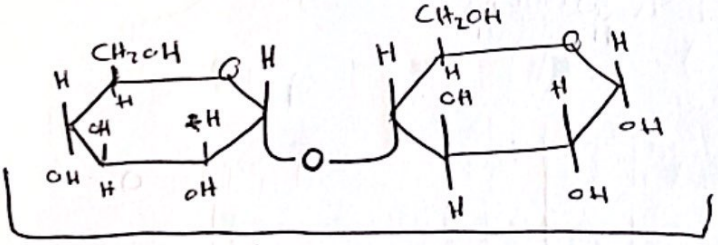
- They are formed when the **hydroxyl group** on the **anumeric** carbon of one sugar molecule interacts
  ↳ $C_{No.1}$
  with **one of several** hydroxyl groups in the other sugar molecule.

ex:



H goes w OH

(Dehydration) reaction / Condensation reaction



Maltose

✱ Polysaccharides :

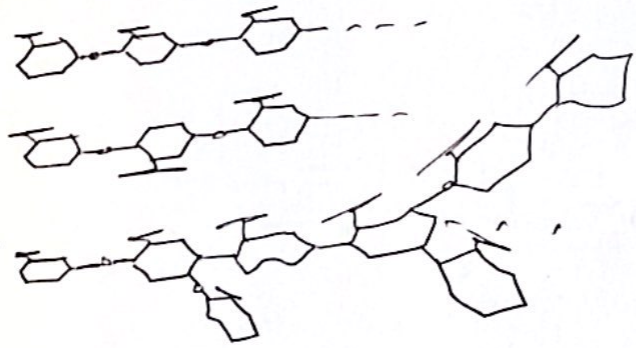
- They are Polymers of monosaccharides
- They are created without a template by the addition of particular monosaccharides residues
- They are long carbohydrate molecules of repeated monomer units joined together by glycosidic bonds
- They range in structure from linear to highly branched
- They differ from each other in :
  1. the identity of their monosaccharide units
  2. their length
  3. the degree of branching

ex :

starch :

cellulose :

glycogen :



*Amino acids and Proteins :

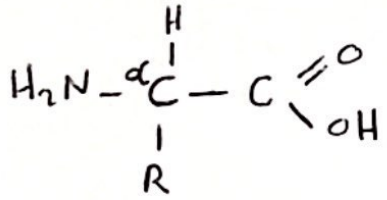
*Amino acids are the building block of Proteins

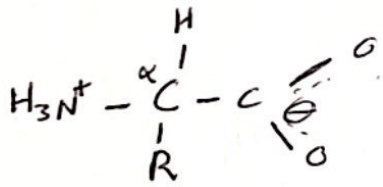
- They are biologically important molecules made from

amine (NH_2) and Carboxylic acid ($COOH$)

functional groups along with a

side chain specific to each amino acid

①  → unIonized form

②  → Ionized (Zwitterionic) form

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*Proteins : are biochemical compounds consisting of one or more

Poly Peptieds

↳ a Polypeptide is a single linear Polymer chain of amino acids bonded together by Peptide bonds between Carboxyl and Amino groups of adjacent amino acid residues

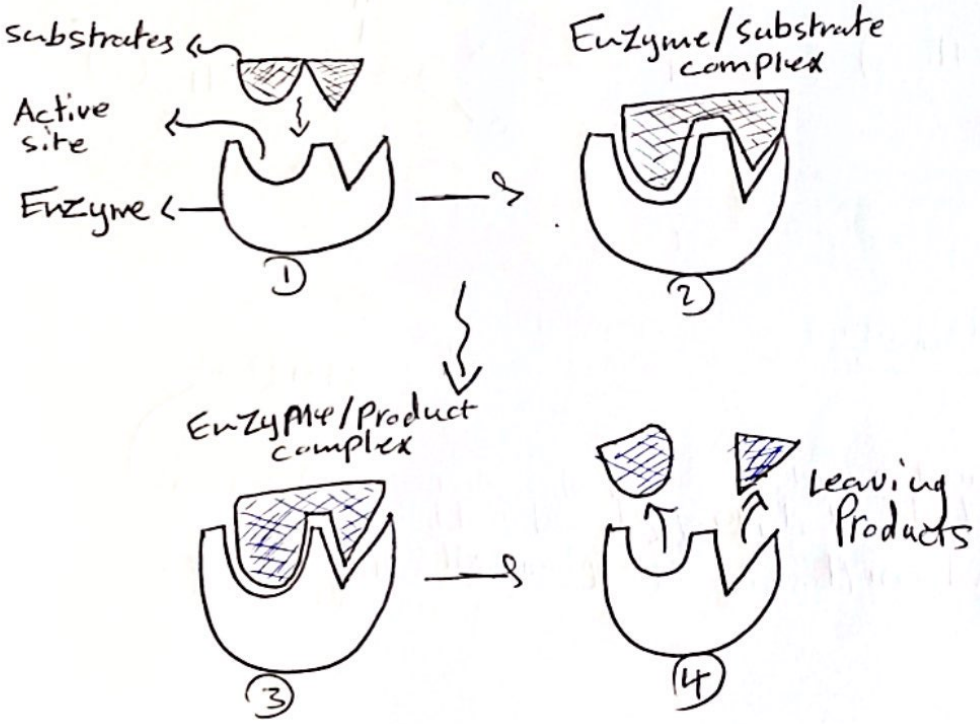
* Enzymes : Biological molecules that **catalize chemical reactions**

* in Enzymic (Enzymatic) reactions the molecules at the begenning of the reactions are called **substrates** then convented to other molecules called **Products**

* **Catalysis** takes place at the **active site** which is a special Pocket or cleft

- The **catalytic activity** of many enzymes depends on the Presence of small molecules termed **cofactors**

ex :



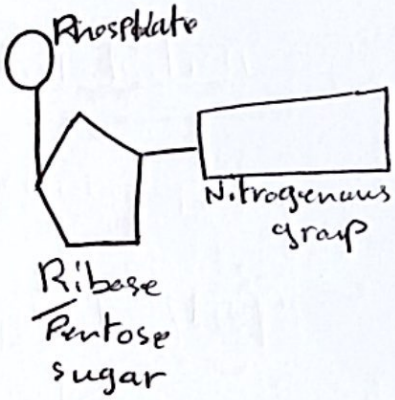
* Classification of Enzymes :

- Enzymes are classified into 6 catagories based on :
  The reaction they catalyze

1. Oxidoreductases : Catalyze oxiditation/reduction reactions
2. Transferases : transfer a functional group
3. Hydrolases : catalyze the hydrolysis of various bonds
4. Lyases : cleave various bonds by means other than hydrolysis and oxidation
5. Isomerases : catalyze isomerization changes within a single molecule
6. Ligases : Join two molecules with covalent bonds

* Nucleotides and Nucleic acids :

* Nucleotides are molecules that when joined make up the individual structual units of the nucleic acids RNA and DNA



- They are made up of :

1. Ribose sugar in RNA and deoxyribose in DNA
2. Phosphate group
3. a Nitrogenous base (A, C, T, G)
   - A: Adenine
   - C: Cytosine
   - T: Thymine
   - G: guanine

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* Nucleic Acids : They include the :

deoxyribonucleic acid (DNA) and ribonucleic acid (RNA)

- together with Proteins they are the most important biological Macromolecules

A bonds w T (2 bonds) $A = T$

C bonds w G (3 bonds) $C \equiv G$

✱ Lipids :

- They provide long term energy storage (9 Kcal/gram) for humans
- Provide padding and insulation
- Store fat soluble vitmins (A, D, E, K ..etc)
- They form the backbone of hormones and cell membranes

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① Fats :- they are 3 Fatty acids bonded to an Ester of glycerol (ester linkage Bond)
- they can be saturated or unsaturated

منهم Essential fatty acids include :
linoleic and linolenic acids

② Waxes :- similar to fats but are composed of much longer fatty acids
- Molecular attractions between fatty acid chains accounts for their higher melting point

gotta breakk em

③ Phospholipids :- similar to fats but one of the fatty acid groups is replaced with a Phosphate group
- The structure gives it interesting characteristics
- the Ester of the glycerol is hydrophilic but the fatty acids chains are hydrophobic

④ steroids :- The least common kind of lipids
- They have a high hydrogen to carbon ratio
- Examples include :
  - cholesterol
  - hormones like testosterone (الذكورة) and estrogen (الأنوثة)

★ Water:
- Has many unique properties that make it essential for all life
- Most of these properties are of the **Hydrogen bonding** between water molecules
- water is an excellent solvent:
  * when **Ionic Compounds** are put in water they Dissociate or seperate (the Ions)

Hydrophilic ←
* **Polar covalent compounds** also dissolve in water be they have charged Poles

Hydrophobic ←
* **Non Polar covalent compound** Do NOT dissolve in water

★ water has high Cohesion ← تَرابُط : individual water molecules tend to "stick" with other water molecules due to:
Hydrogen Bonding

↳ This leads to two characteristics of water:

① high surface tension ← التوتر السطحي

② Strong Capillary action ← الشعرية الخاصية الكبيرة

★ water's high surface tension is what allows some insects to run on water (across the surface)

★ water's strong Capillary action is what allows the liquid level in a straw to be higher than the surronding drink
- bc using hydrogen bonding, water molecules attract others up the sides of the straw

Capillary action
- more noticeable in thinner straws

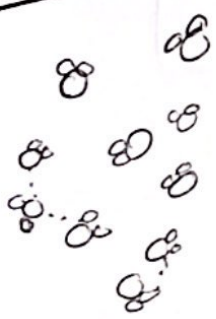
* water has a high specific heat capacity:
  - it takes a lot of energy to change the temp of water

- when you sweat your body is using water as a coolant (The evaporating water removes heat with it)

- At night, oceans are a good insulator, the energy that the sun spent heating water all day is slowly released into the night

* because of hydrogen bonding, when water freezes the water molecules arrange into hollow "cells" shape making it less dense than liquid water
  ↳ bc more volume
  ↓ density = mass / ↑ volume

as liquid



as ice