lec. 2

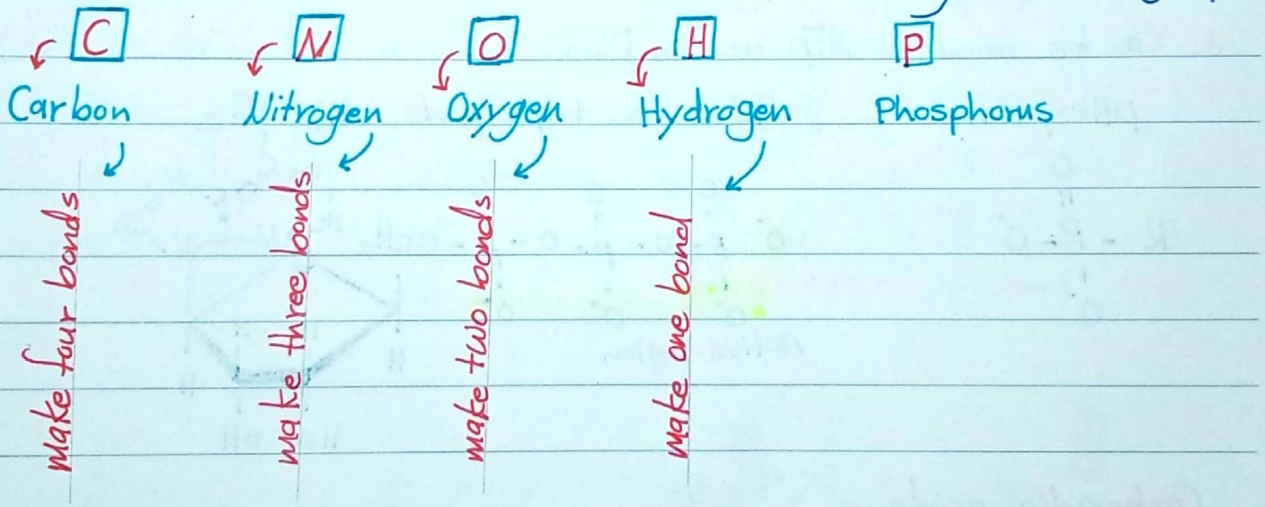
"functional groups"

functional groups:- specific groups of atoms or bonds within molecules that are responsible for the characteristic chemical reactions of those molecules.

The same functional groups undergo the same or similar chemical reactions regardless of the size of the molecule it is a part of.

[acid + base = salt + water]

- A few of the elements involved in forming functional groups



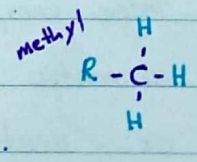
Hydrocarbons

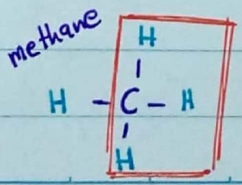
1- long chains of carbon and hydrogen ending with amethyl group ($-CH_3$).

2- hydrophobic [nonpolar molecules]

3- form the backbone of most organic molecules.

4- example:- methane



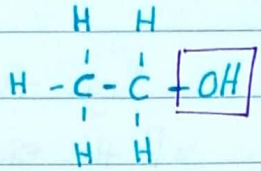


Alcohols

1- Characterized by a hydroxyl group.
2- this group makes the compound polar and hydrophilic. (يحب الماء)
3- Alcohols dissolve in water easily and are good fuels.
4- ex:- ethanol.

Hydroxyl R-OH

Ethanol

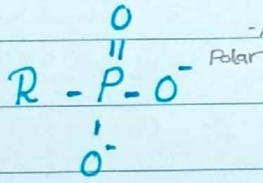


Polar molecules

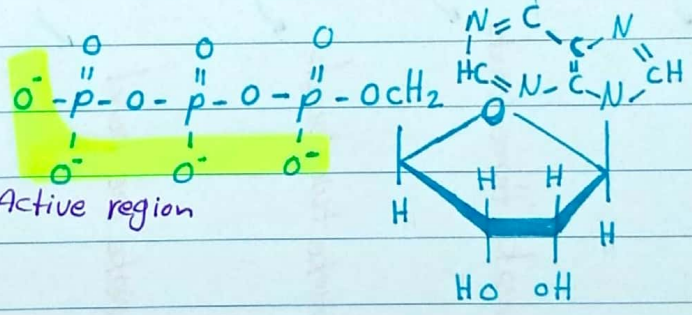
Organic phosphates

1- characterized by a phosphate group.
2- these compounds are usually acidic.
3- Can be found in ATP and in DNA.

pHospHAte

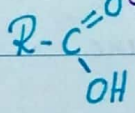


Adenosine triphosphate ATP

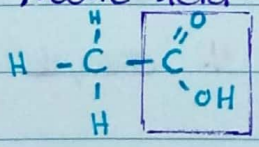


Carboxylic acids

1- characterized by a carboxyl group. hydrophilic.
2- referred (يشار) to as organic acids.
3- these compounds are water soluble weak acids that are often aromatic.
4- ex:- acetic acid [vinegar] (خل). Carboxyl



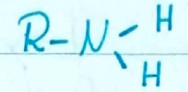
Acetic acid



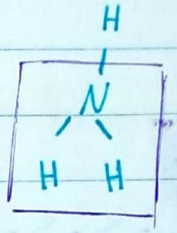
Amines

1- characterized by amino group.
2. water soulble weak bases.
3. ex:- ammonia

AMINO



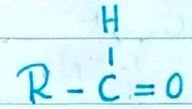
AMMONIA



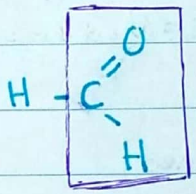
Aldehydes

1- characterized by an aldehyde group.
2- polar and hydrophilic.
3. ex:- formaldehyde.

ALDEHYDE



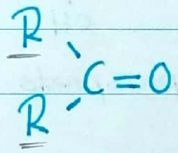
FORMALDEHYDE



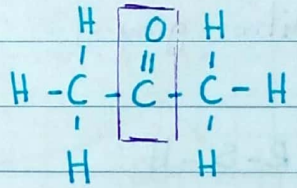
Ketones

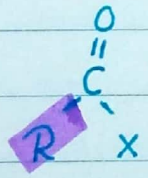
1- characterized by a ketone group.
2- polar and hydrophilic.
3- Many steroids contain ketones.
4- ex:- acetone. ← ketones كيتونات

KETONE



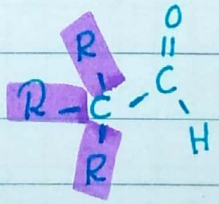
ACETONE



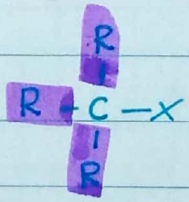


[acyl halides]
[x = f, cl, Br, I]

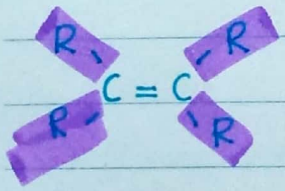
R-O-H
[alcohols]



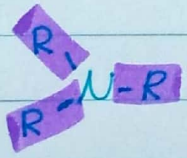
[aldehydes]



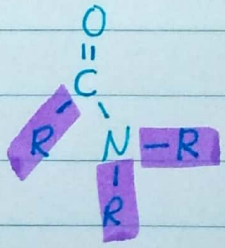
[alkyl halides]
[x = f, cl, Br, I].



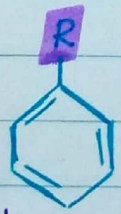
[alkenes]



[amines]

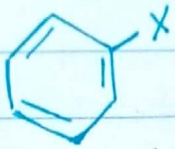


[amides]



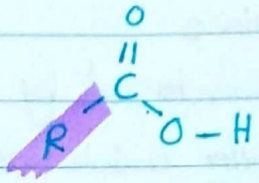
[aromatic rings]

[alkynes]

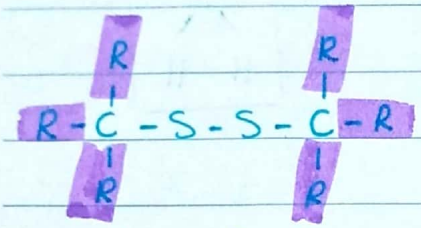


[aryl halides]

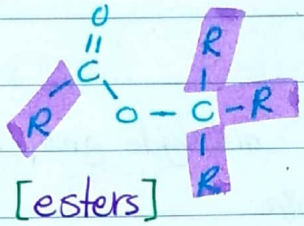
[x = F, Cl, Br, I]



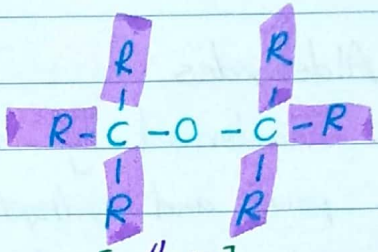
[Carboxylic acids]



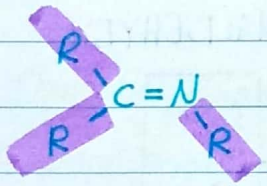
[disulfides]



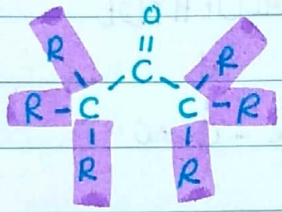
[esters]



[ethers]



[imines]



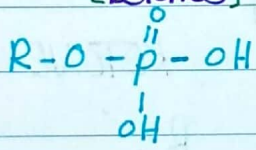
[ketones]

R-C≡N

[nitriles]

R-NO₂

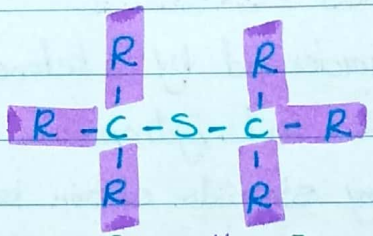
[nitro groups]



[phosphate esters]

R-S-H

[thiols]

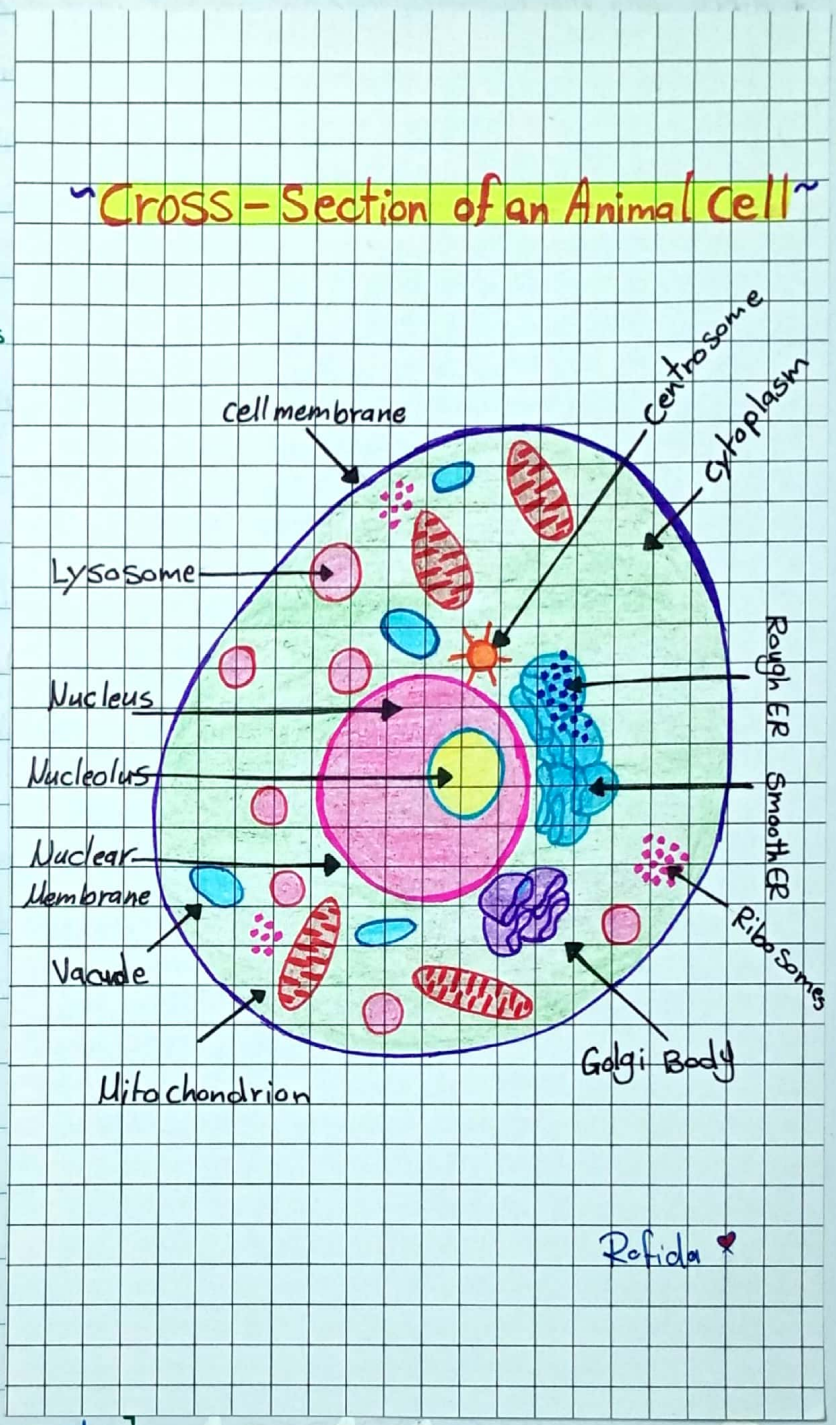


[thioethers]

Cell

the unit of structure and functions in living organism.

[chemical compositions التراكيب الكيميائية of the cell in all organisms (bacteria from simple → man complex) are almost similar and mainly أساسي involving تتضمن organic molecules.



- Two [types] of biochemical molecules.
  - Small size → micro → monomer
  - Large size → macro → Polymer

The micromolecules represented by :-

- monosaccharide sugers
- amino acids
- fatty acids
- nucleotides

[inorganic غير عضوية compounds like water].

[mineral and organic] معدنية عضوية

- micro to → macro [synthesis] بناء.
- macro to → micro [breakdown] هدم.

involve :-

- polysaccharides , - proteins , - Some lipids , - nucleic acids.

* Micro and macro molecules are present in a dynamic state.

- Synthesis :- process requiring energy to converted micromolecules to macromolecules.
- breakdown :- process that hydrolyzed the macromolecules to produce the micromolecules and leads to liberation of energy.

This interconversion process of micromolecules to macromolecules and vice versa is called [metabolism]

- anabolism (synthesis)
- catabolism (breakdown)

note the selection of anabolism or catabolism depends on the state of cell activity.

If cell growth and development are needed the anabolism will be selected while during cell physical activities like muscle movement, then catabolism is favored.

Carbohydrates

- ✓ provide fast energy (4kcal/gram) for the human body.
- ✓ typically classified according to the number of saccharide (sugar) units they have.

• MONOSACCHARIDES

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

* According to the number of carbon atoms, they are classified (respectively) على التوالي

ثلاثية trioses — رباعية tetroses — pentoses — hexoses — heptoses ....

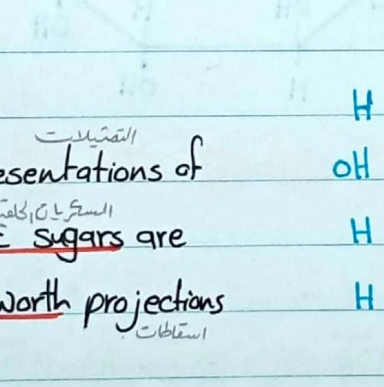
* All monosaccharide/s contain

hydroxyl (-OH) groups. — إما aldehyde أو (or) ketone group.

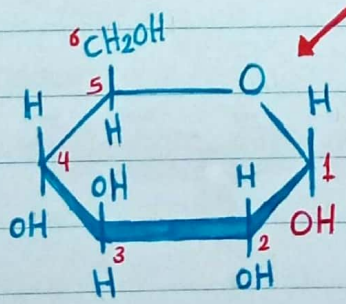
* pentoses and hexoses can (cyclize) تتحلل as the ketone or aldehyde group reacts تتفاعل with a distal بعيدة oH.

* Glucose forms يتشكل an intra-molecular hemiacetal حلقة نصفية مركبية, as the C1 aldehyde & C5 oH react, to form a 6-member pyranose ring.

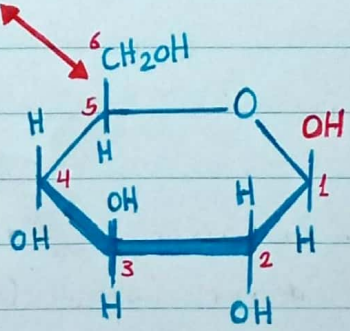
These representations التمثيلات of the cyclic sugars السكريات الحلقية are called Haworth projections إسقاطات



D-glucose (linear form)



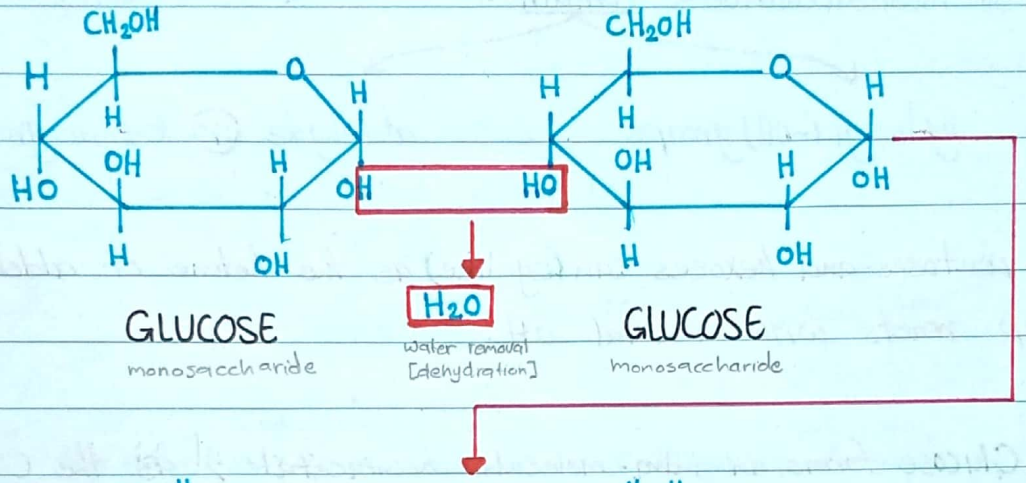
α-D-glucose

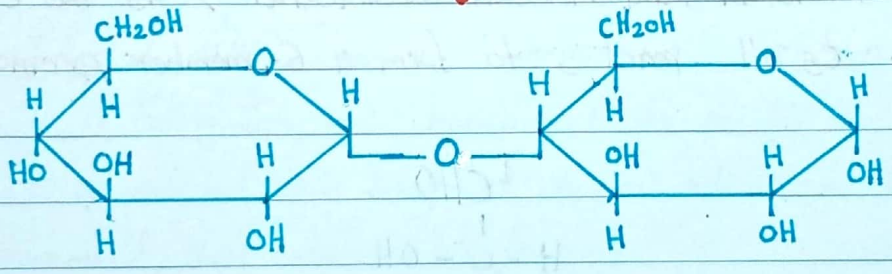


β-D-glucose

• DISACCHARIDES

✓ formed when the hydroxyl group on the anomeric carbon of one suger molecule interacts with one of several hydroxyl groups in the other suger molecule.





MALTOSE

. POLYSACCHARIDES

✓ Polysaccharides are polymers of monosaccharides.

✓ Polysaccharides are created without a template by the addition of particular monosaccharide residues.

✓ Polysaccharides are long carbohydrate molecules of repeated monomer units joined together by glycosidic bonds.

Ex: 1000 ~~poly~~ mono saccharides —(انقص واحد ?!)→ 999 glycosidic ~~linkage~~ bond = عدد water molecules.

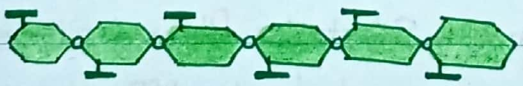
~ They range in structure from linear to highly branched ~

· They differ from each other in

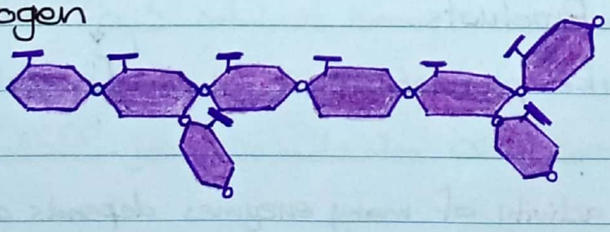
* the identity of their monosaccharide units.
* the length of their chains.
* the degree of branching.

- Starch

- Cellulose

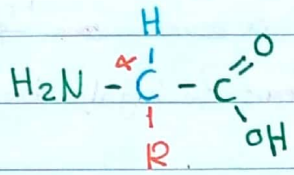


- Glycogen

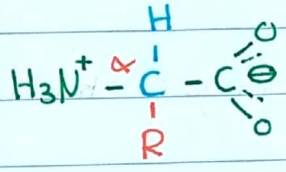


. AMINO ACIDS

- the building blocks of proteins.
- Biologically important molecules made from amino ($-NH_2$) and carboxylic acid ($-COOH$) functional groups,
- along with aside-chain specific to each amino acid.



(1) unionized form



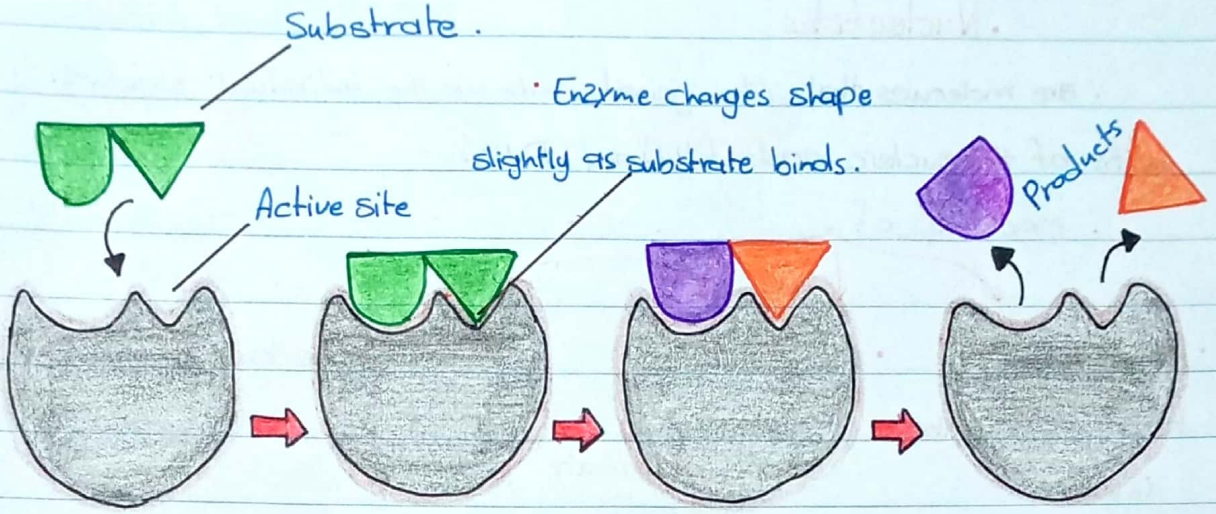
(2) Zwitterionic form

. PROTEINS

- Biochemical compounds consisting of one or more polypeptides.
- A polypeptide is a single linear polymer chain of amino acids bonded together by peptide bonds between the carboxyl and amino groups of adjacent amino acid residues.

. ENZYMES

- Biological molecules that catalyze chemical reactions.
- In enzymatic reactions :- Substrates [the molecules at the begining] of the process are converted into different molecules, called Products.
- Catalysis takes place at the active site [special pocket or cleft].
- The catalytic activity of many enzymes depends on the presence of small molecules termed [Cofactors]



- Substrate entering active site of enzyme.
- Enzyme's - substrate Complex.
- Enzyme's - Products Complex.
- Products leaving active site of enzyme.

~ Classification of enzymes ~

6 categories (فئات) based on the reaction they catalyse.

1- OXIDOREDUCTASES: catalyze oxidation / reduction reactions.

2- TRANSFERASES: transfer a functional group [eg. a methyl or phosphate 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.

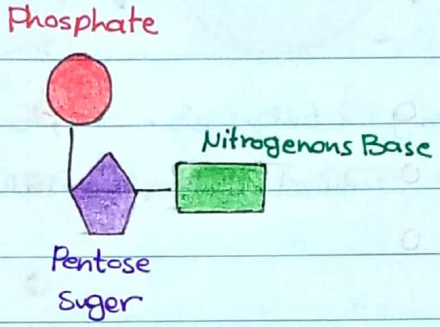
6- LIGASES: join two molecules with covalent bonds.

. Nucleotides

. are molecules that, when joined, make up the individual structural units of the nucleic acids [RNA] and [DNA].

. made up of,

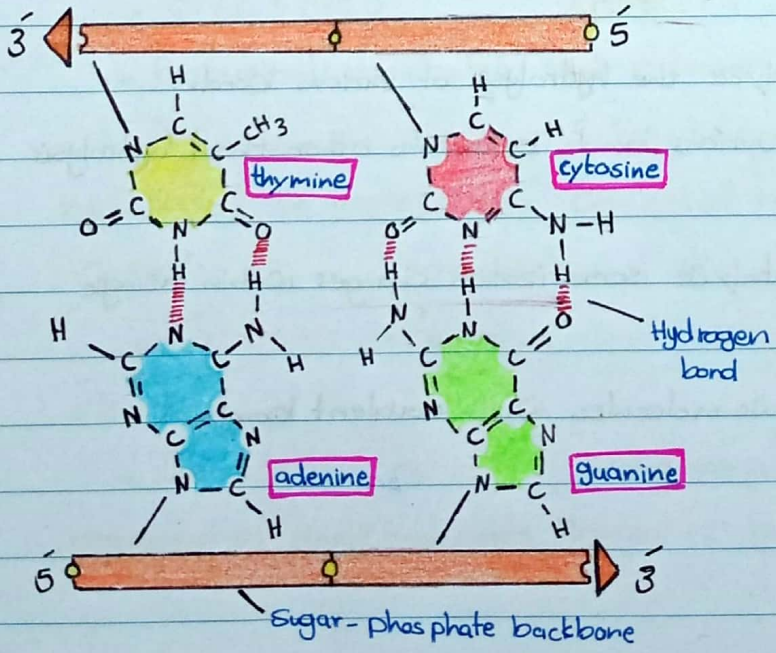
- Ribose Suger in RNA, or deoxyribose in DNA.
- Phosphategroup
- Nitrogenous base [A, C, G, T].



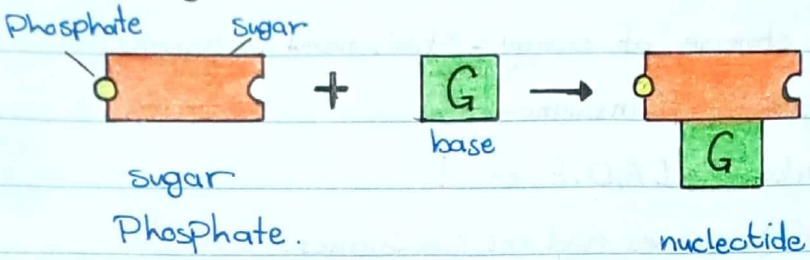
. Nucleic acids

. They include DNA (deoxyribonucleic acid) and RNA (ribonucleic acid).

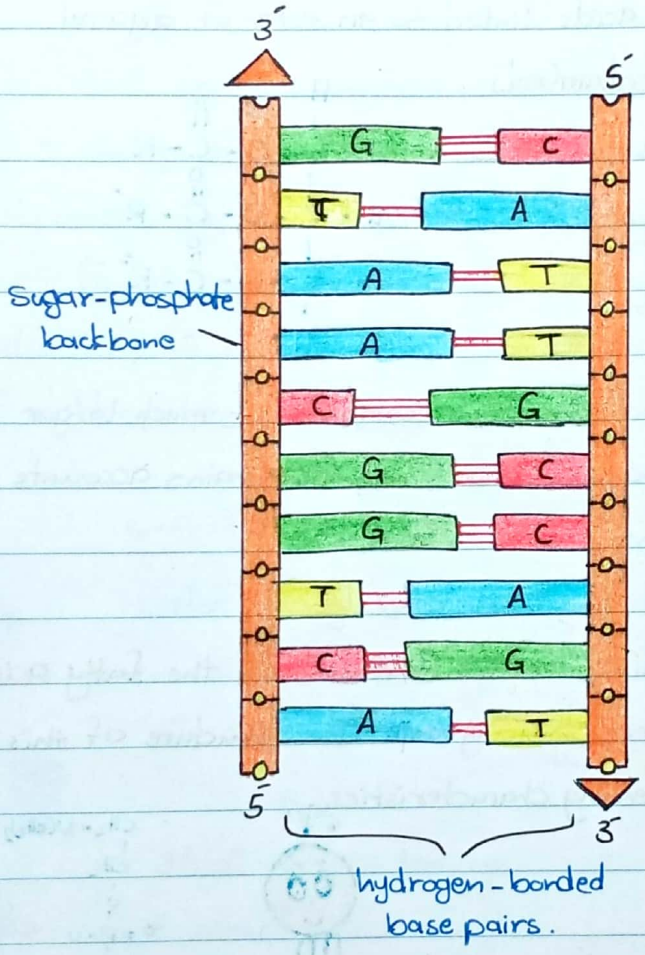
. Together with proteins, nucleic acids are the most important biological [macromolecules].



• building blocks of DNA ~



• double-stranded DNA ~



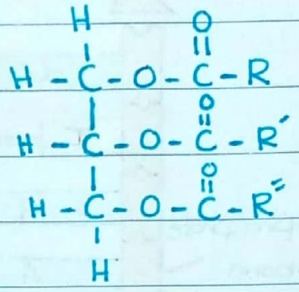
.Lipids

* Provide long-term storage of energy [9 kcal/gram] in humans.
* They also provide padding and insulation,
* Store fat soluble vitamins [A, D, E, etc..].
* F m the backbone of hormones and cell membranes.

1- **Fats** are three fatty acids linked to an ester of glycerol. They can be [saturated] or [unsaturated]

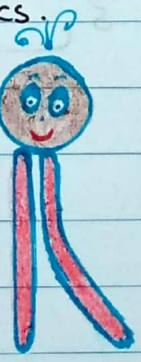
~ Essential fatty acids ~

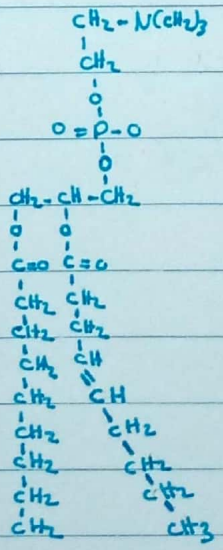
- linoleic acid
- linolenic acid



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

3. **Phospholipids** are similar to fats but one of the fatty acid groups is replaced by a **phosphate group**. The structure of this lipid gives it some interesting characteristics.





* the ester of glycerol is hydrophilic.
* the fatty acid chains are hydrophobic.

4- Steroids are the last common kind of lipids. Steroids have a high hydrogen to carbon ratio.

Ex:- Cholesterol , Hormones → testosterone. / estrogen.

~ Water ~

- water has many unique properties that make it essential to all life.

- hydrogen bonding between water molecules.

- water is an excellent solvent. When ionic compounds are placed into water, the ions dissociate or separate.

- Polar covalent compounds, because they too have charged poles, also dissolve in water. → hydrophilic [water loving ♥].

- Nonpolar covalent compounds, however, do not dissolve in water. → hydrophobic [water fearing :c].

• water has high cohesion :- Individual water molecules tend to "stick" with other water molecules due to hydrogen bonding.

This leads to two characteristics of water

1- a high surface tension (التوتر السطحي).

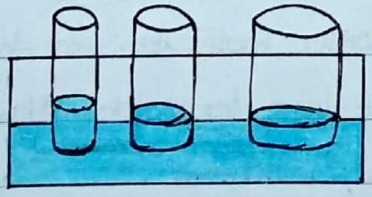
→ is what allows some insects to run across the surface of the water.

2- a strong capillary action.

→ is what allows the liquid level in a straw to be higher than that in the surrounding drink. Using hydrogen bonding, water molecules attract others up the sides of the straw.

+ This effect is the more noticeable in thinner straws.

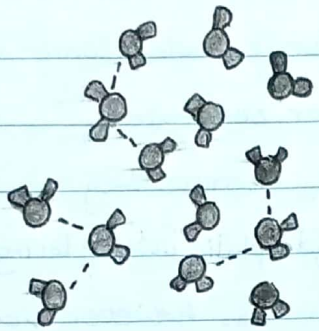
~ CAPILLARY ACTION ~



□ - water

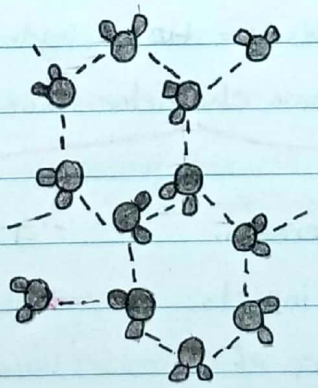
- Water has a high specific heat capacity : It take a lot of energy to change the temperature of water.
- When you sweat, your body is using water as a coolant. The evaporating water removes heat with it.
- At night, oceans are a good insulator. The energy that the sun spent in heating the water all day is slowly released into the night.

~ HYDROGEN BONDING IN WATER ~



-- hydrogen bonds

~ HYDROGEN BONDING IN ICE ~



-- hydrogen bonds

- Hydrogen bonding arranges water molecules into hollow "cells" when water freezes, making it less dense than liquid water.
- Density = mass/volume.