



Charting New Horizons in Education

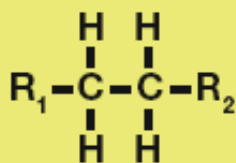
Functional groups

02

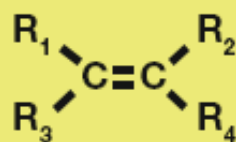
Biochemistry



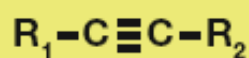
FUNCTIONAL GROUPS



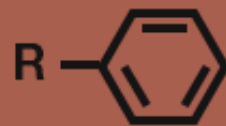
ALKANE



ALKENE



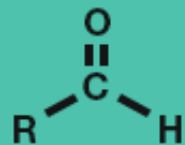
ALKYNE



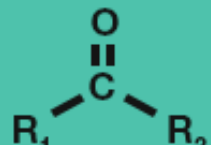
ARENE



HALOALKANE



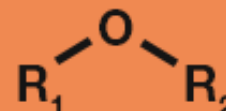
ALDEHYDE



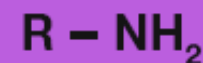
KETONE



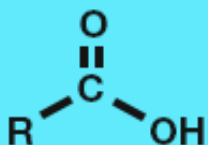
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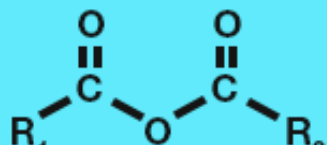
ETHER



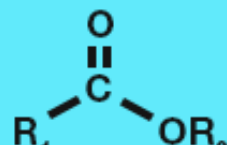
AMINE



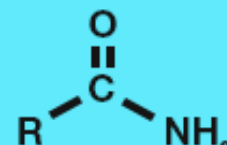
CARBOXYLIC
ACID



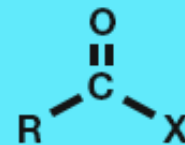
ACID
ANHYDRIDE



ESTER



AMIDE



ACYL
HALIDE

HYDROCARBONS

AROMATICS

OTHER
HETEROATOMICS

SIMPLE OXYGEN
HETEROATOMICS

CARBONYL
COMPOUNDS

CARBOXYLIC ACIDS
AND DERIVATIVES

~ Functional groups



- Functional groups are specific groups of atoms or bonds within molecules that are responsible for the characteristic chemical reactions of those molecules.
- The same functional group will undergo the same or similar chemical reaction(s) regardless of the size of the molecule it is a part of.
- Carbon, nitrogen, oxygen, hydrogen, and phosphorus are a few of the elements involved in forming functional groups.
- Carbon can make four bonds. Nitrogen makes three, oxygen two, and hydrogen one.
- Like dissolves like



٣- المجموعات الوظيفية

المجموعات الوظيفية هي مجموعات محددة من الذرات أو الروابط داخل الجزيئات وتكون مسؤولة عن التفاعلات الكيميائية المميزة لتلك الجزيئات.

• تخضع المجموعة الوظيفية لنفس التفاعل الكيميائي، بغض النظر عن حجم الجزيء الذي هي جزء منه.

• الكربون، النيتروجين، الأكسجين، الهيدروجين، والفوسفور هي بعض العناصر المشاركة في تشكيل المجموعات الوظيفية.

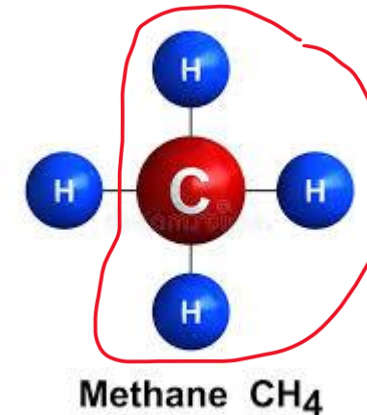
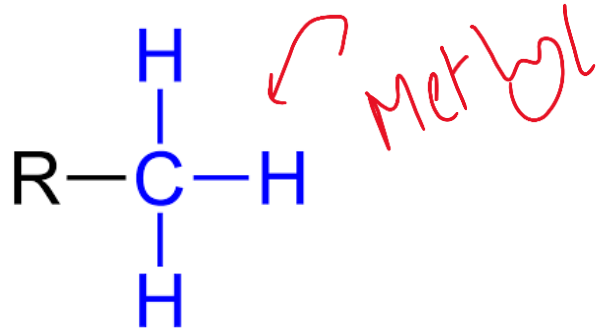
• يمكن أن يشكل الكربون أربع روابط. بينما يشكل النيتروجين ثلاث روابط، والأكسجين رابطتين، والهيدروجين رابطة واحدة.

• المتشابهات تذيب بعضها.

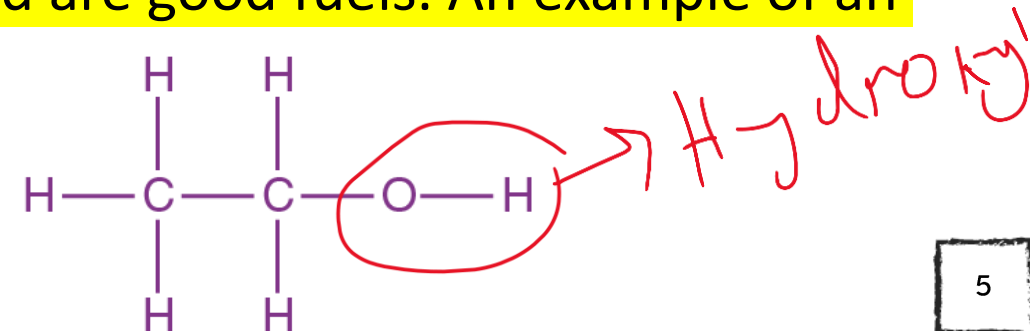
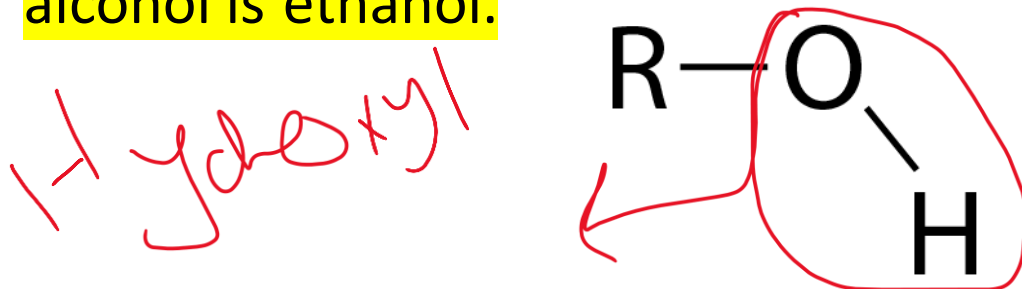
Functional groups



- **Hydrocarbons** are long chains of carbon and hydrogen ending with a methyl group ($-\text{CH}_3$).
- Hydrocarbons are **hydrophobic** and form the backbone of most organic molecules. An example of a hydrocarbon is methane.



- **Alcohols** are characterized by a hydroxyl group. This group makes the **compound polar and hydrophilic**. Alcohols dissolve in water easily and are good fuels. An example of an alcohol is ethanol.



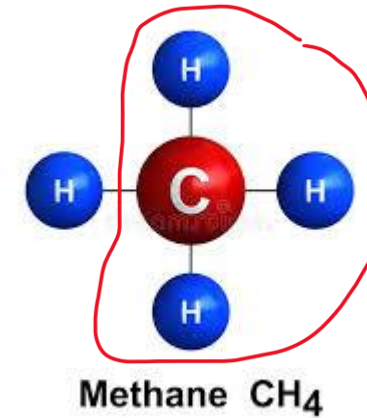
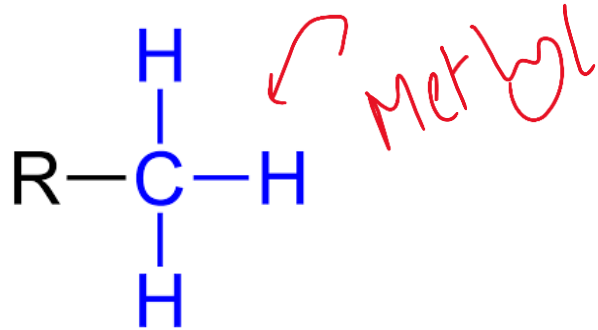
Functional groups



• لهيدروكربونات هي سلاسل طويلة من الكربون والهيدروجين، وتنتهي بمجموعة ميثيل (-CH_3)

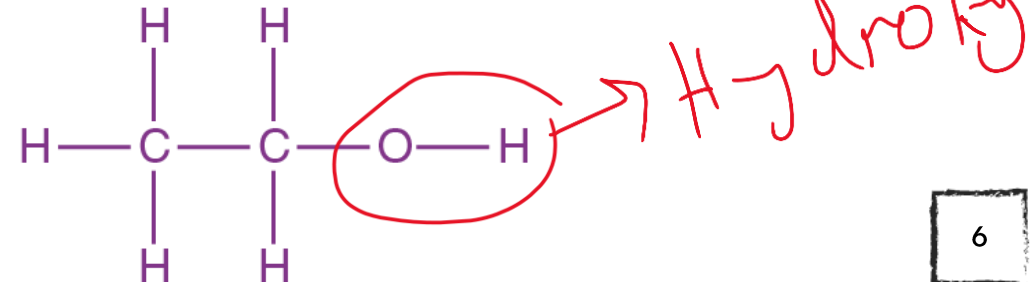
• الهيدروكربونات غير قطبية (غير قابلة للذوبان في الماء) وتشكل العمود الفقري لمعظم الجزيئات العضوية.

• مثال على الهيدروكربون هو الميثان.



Methyl

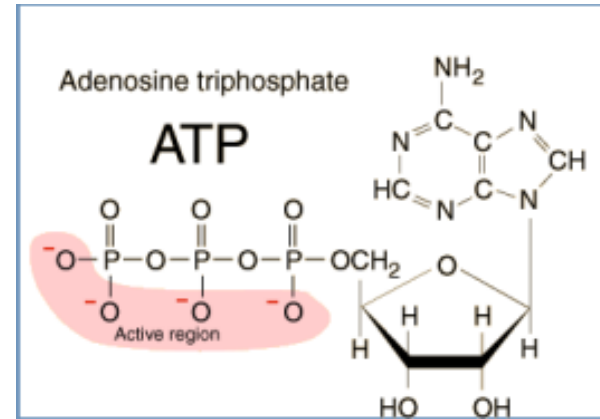
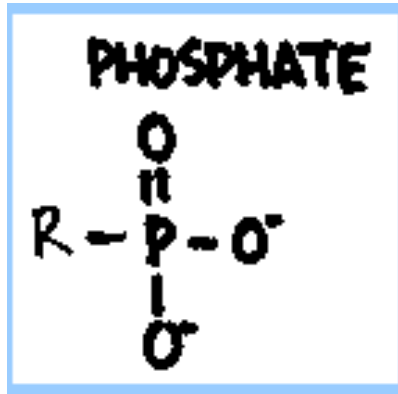
• الكحولات تتميز بمجموعة هيدروكسيل (-OH) تجعل هذه المجموعة المركب قطبيًا وذائبًا في الماء. تذوب الكحولات بسهولة في الماء وتعتبر وقودًا جيدًا. مثال على الكحول هو الإيثانول.



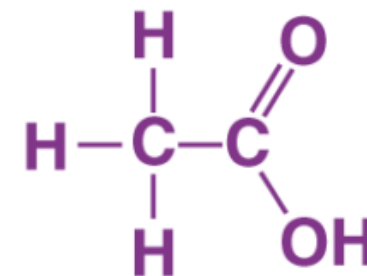
~ Functional groups



- **Organic phosphates** are characterized by a phosphate group.
- These compounds are usually acidic. Organic phosphates can be found in ATP and in DNA.



- **Carboxylic acids** are characterized by a carboxyl group. Also referred to as organic acids, these compounds are **water soluble weak acids** that are often **aromatic (Contain benzene group)**. An example of a carboxylic acid is acetic acid (otherwise known as vinegar).

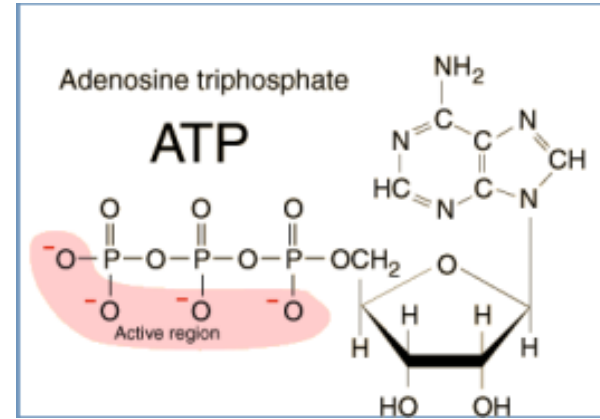
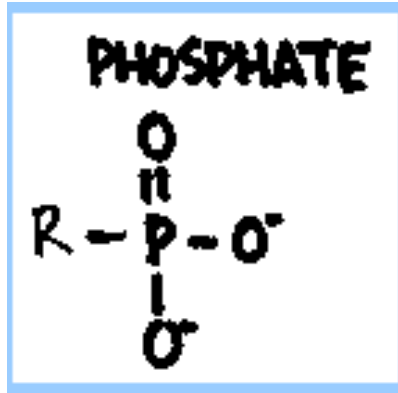


acetic
acid

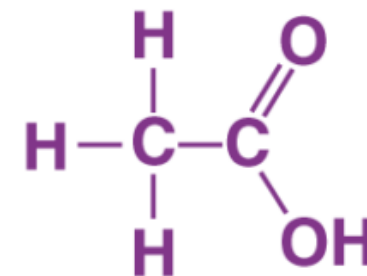
Functional groups



الفوسفات العضوي يتميز بمجموعة فوسفات. هذه المركبات عادةً ما تكون حمضية. يمكن العثور على الفوسفات العضوي في الأدينوزين ثلاثي الفوسفات (ATP) وفي الحمض النووي (DNA).



الأحماض الكربوكسيلية تتميز بمجموعة كربوكسيل (COOH) تُعرف أيضًا بالأحماض العضوية، وهذه المركبات هي أحماض ضعيفة قابلة للذوبان في الماء وغالبًا ما تكون عطرية (تحتوي حلقة بنزين). مثال على الحمض الكربوكسيلي هو حمض الأسيتيك (المعروف أيضًا بالخل).

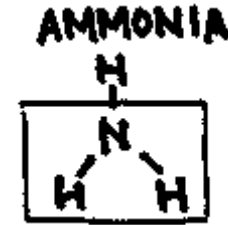
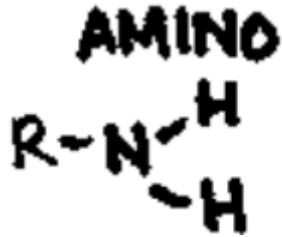


acetic acid

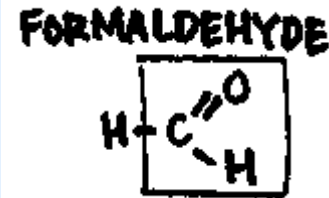
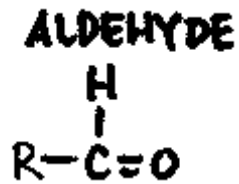
~ Functional groups



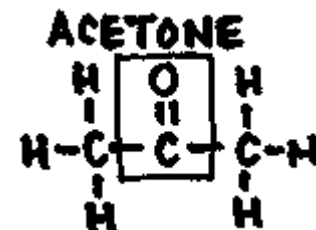
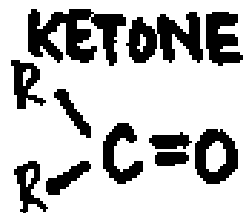
- **Amines** are characterized by an amino group. These compounds are water soluble weak bases. An example of an amine is ammonia.



- **Aldehydes** are characterized by an aldehyde group. These compounds are polar and hydrophilic. An example of an aldehyde is formaldehyde.



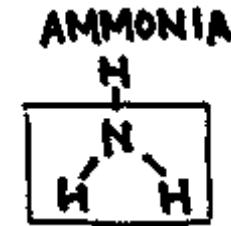
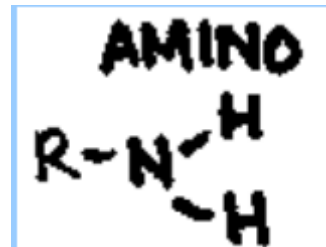
- **Ketones** are characterized by a ketone group. These compounds are polar and hydrophilic. Many steroids contain ketones. An example of a ketone is acetone



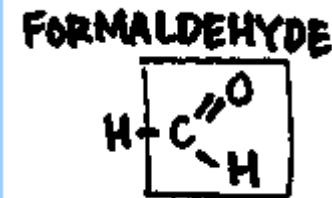
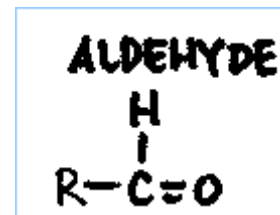
Functional groups



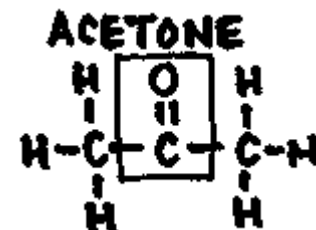
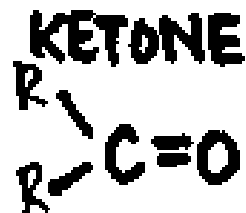
• الأمينات تتميز بمجموعة أمينية (-NH_2) هذه المركبات هي قواعد ضعيفة قابلة للذوبان في الماء. مثال على الأمين هو الأمونيا.

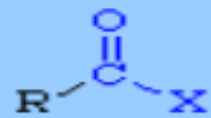


• الألدهيدات تتميز بمجموعة ألدهيد (-CHO). هذه المركبات قطبية وقابلة للذوبان في الماء. مثال على الألدهيد هو الفورمالدهيد.

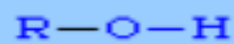


• الكيتونات تتميز بمجموعة كيتون (C=O). هذه المركبات أيضًا قطبية وقابلة للذوبان في الماء. تحتوي العديد من الستيرويدات على كيتونات. مثال على الكيتون هو الأسيتون.

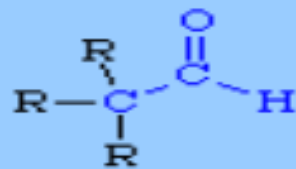




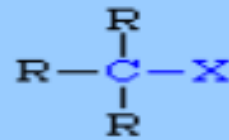
acyl halides
(X = F, Cl, Br, I)



alcohols



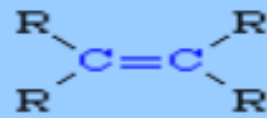
aldehydes



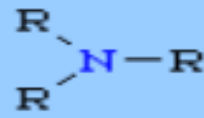
alkyl halides
(X = F, Cl, Br, I)



alkynes



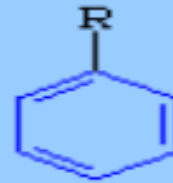
alkenes



amines



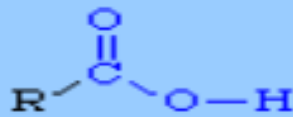
amides



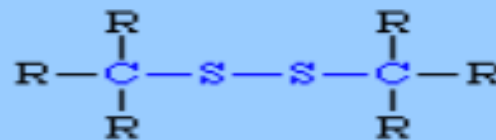
aromatic rings



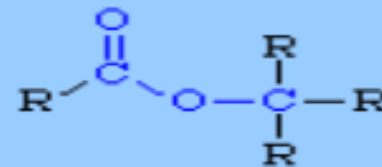
aryl halides
(X = F, Cl, Br, I)



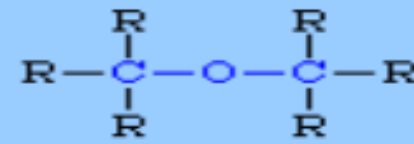
carboxylic acids



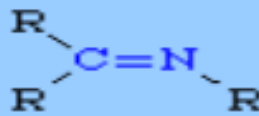
disulfides



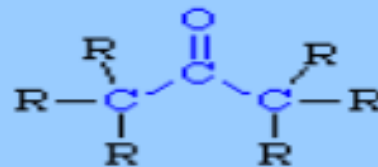
esters



ethers



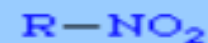
imines



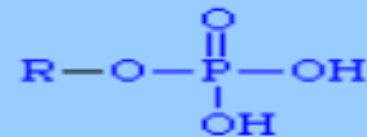
ketones



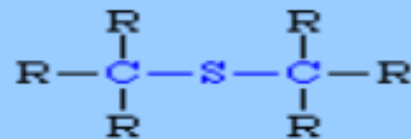
nitriles



nitro groups



phosphate esters



thioethers



thiols

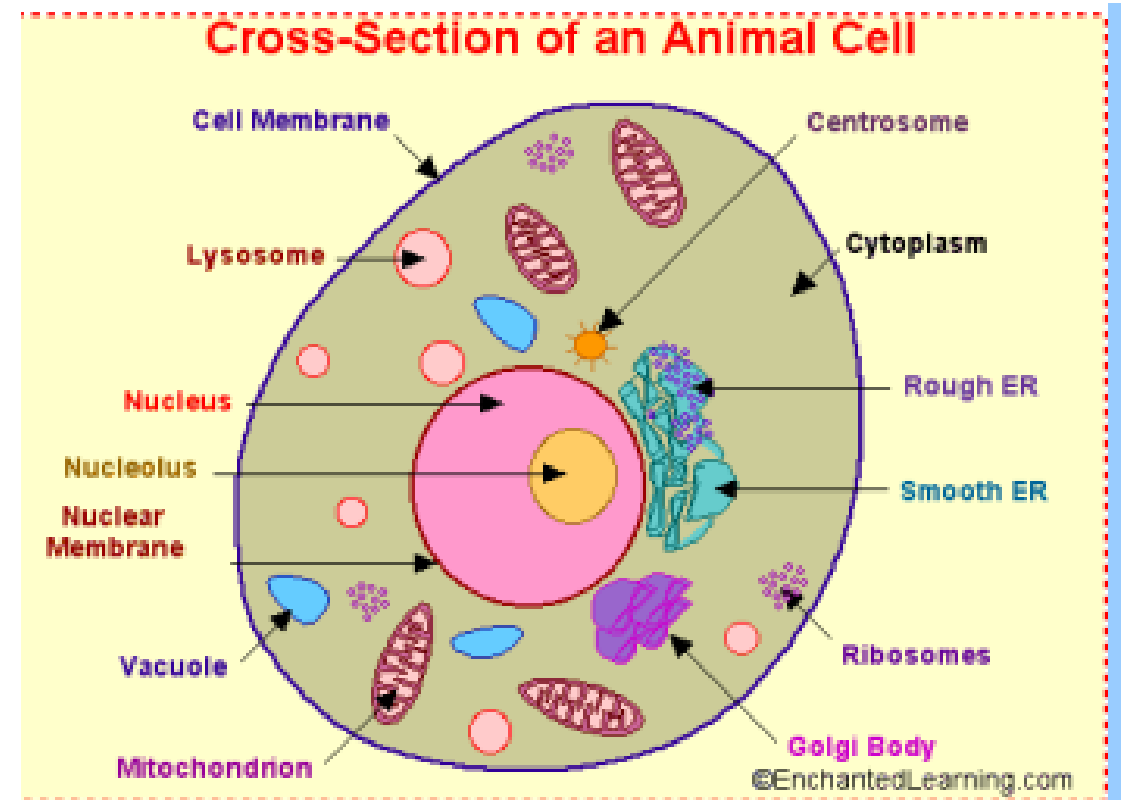
- **Cell: the unit of structure and functions in living organism.**
- Usually there are two types of biochemical molecules:
- **small size (micro) and large size molecules (macro).**

- **The micromolecules**

1. Monosaccharide sugars,
2. Amino acids
3. Fatty acids
4. Nucleotides.

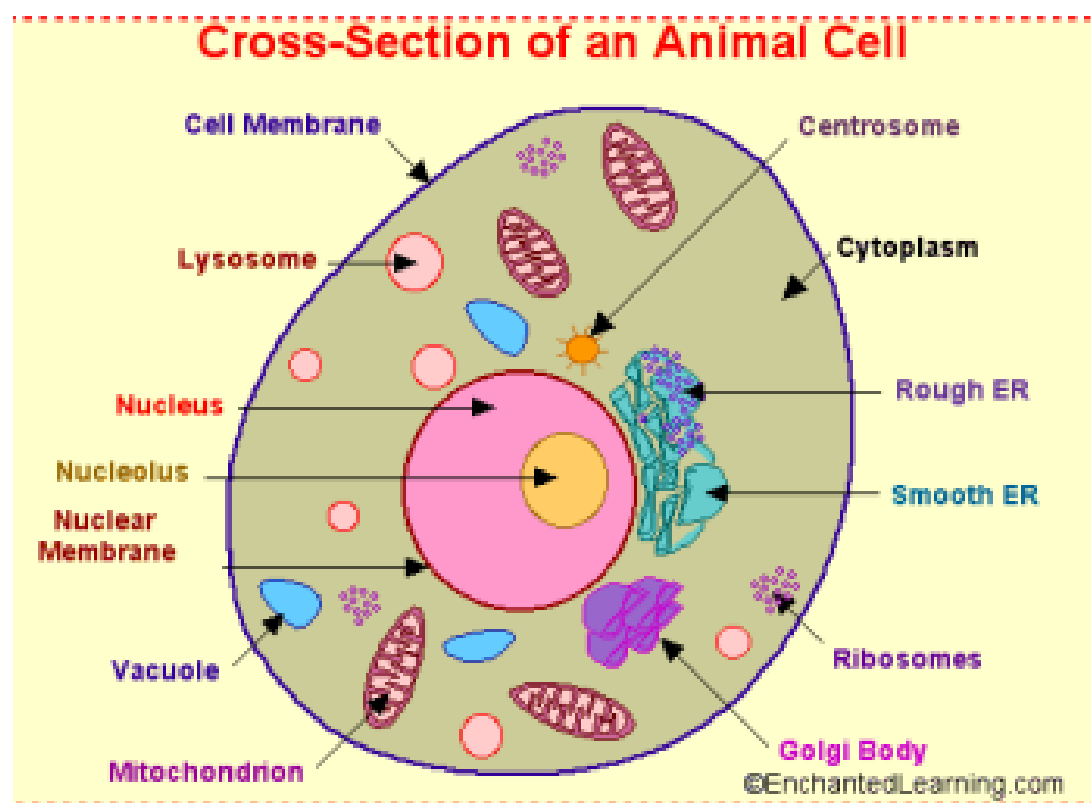
- **The macromolecules:**

1. Polysaccharides
2. Proteins
3. Some lipids
4. Nucleic acids.



• الخلية: هي وحدة التركيب والوظائف في الكائنات الحية.

• عادةً ما توجد نوعان من الجزيئات البيوكيميائية: جزيئات صغيرة (ميكرو) وجزيئات كبيرة (ماكرو).



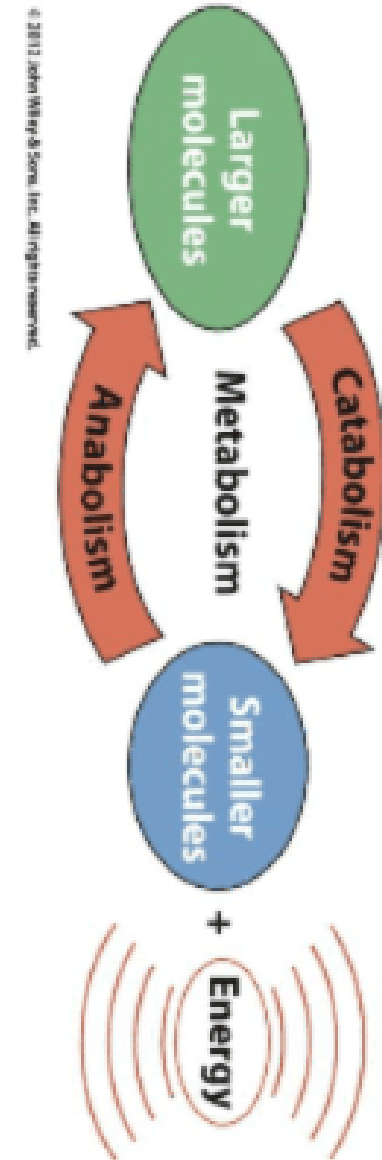
• الجزيئات الصغيرة (الميكرو):

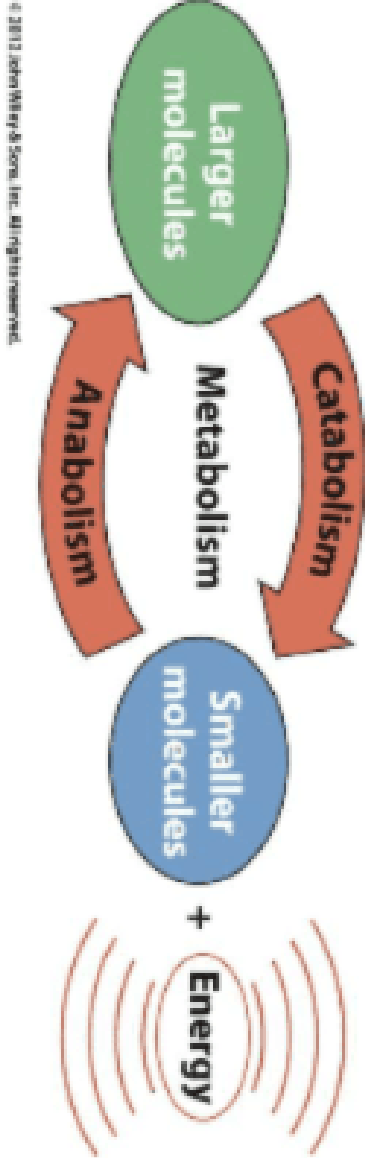
1. السكريات الأحادية
2. الأحماض الأمينية
3. الأحماض الدهنية
4. النيوكليوتيدات

• الجزيئات الكبيرة (الماكرو):

1. السكريات المتعددة
2. البروتينات
3. بعض الدهون
4. الأحماض النووية.

- The micromolecules are converted to macromolecules in an energy requiring process called **synthesis**.
- Also the macromolecules are hydrolyzed to produce micromolecules in a process of breakdown that leads to liberation of energy.
- This interconversion process of micromolecules to macromolecules and vice versa is called **metabolism**.
- **Metabolism involves series of chemical reactions that are grouped either in anabolism (synthesis) or catabolism (breakdown) branches of metabolism.**
- 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.





- الميكرو تتحول إلى الماكرو في عملية تتطلب الطاقة تُعرف بالتركيب كذلك، تُهدم الماكرو لإنتاج الميكرو في عملية هدم تؤدي إلى إطلاق الطاقة.
- تُعرف هذه العمليات المتبادلة بين الميكرو والماكرو باسم عمليات الأيض، وتتضمن سلسلة من التفاعلات الكيميائية التي تُقسم إلى فرعين: الهدم والبناء.
- والاختيار بين البناء أو الهدم يعتمد على حالة نشاط الخلية: إذا كانت الخلية تحتاج إلى النمو والتطور، فسيتم اختيار البناء، بينما خلال الأنشطة الجسدية مثل حركة العضلات، يتم تفضيل الهدم.

- Micromolecules: represented by inorganic compounds like water and minerals and organic compounds like monosaccharides, amino acids, fatty acids and nucleotides.
- Macromolecules: represented by proteins; nucleic acids; polysaccharides, and some lipids Amino acids and Proteins
- Amino acids classes and properties:
 - ✓ Polypeptides structure and functions
 - ✓ Proteins Structure , types , physical and chemical properties.
 - ✓ Structural functions relationship:
 - ✓ Examples of fibrous proteins function, collagen , keratin and motor proteins.
 - ✓ Examples of globular proteins function, myoglobin and hemoglobin.
 - ✓ Clinical examples on protein abnormalities.

Carbohydrates :

Monosaccharides and polysaccharides

Structure and functions

Nutritional significance to the body.

lipids :

Types, structure and functions.

Lipid profile

Classes of lipoproteins

Clinical significance of lipids

Enzymes:

Catalytic functions, Specificity and Classifications.

Factors affecting enzyme activity.

Enzyme kinetics .

Enzyme inhibitions and regulations.

Isozymes and enzyme cofactors.

Application of enzymes in medicine.

Carbohydrates

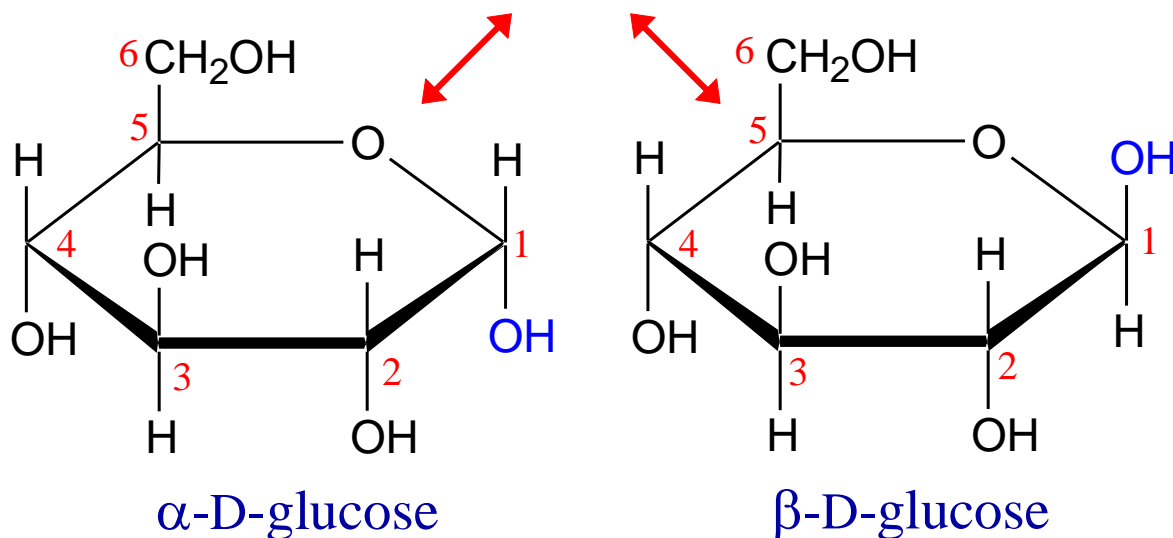
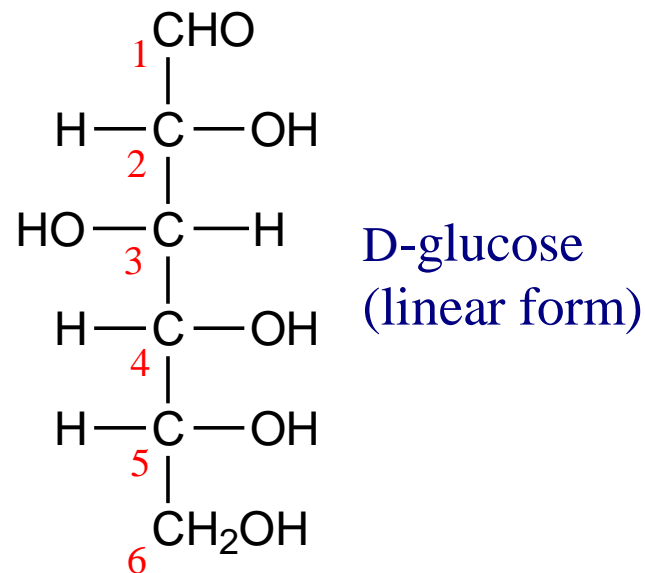
Carbohydrates provide fast energy (4 kcal/gram) for the human body.

Carbohydrates are typically classified according to the number of saccharide (sugar) units they have

- Monosaccharides are composed of 3 to 7 carbon atoms
- They have the general formula $(CH_2O)_n$ (example: glucose $C_6H_{12}O_6$).
- According to the number of carbon atoms, they are classified into trioses, tetroses, pentoses, hexoses and heptoses respectively.
- All monosaccharide's contain hydroxyl (-OH) groups and either an aldehyde or ketone group

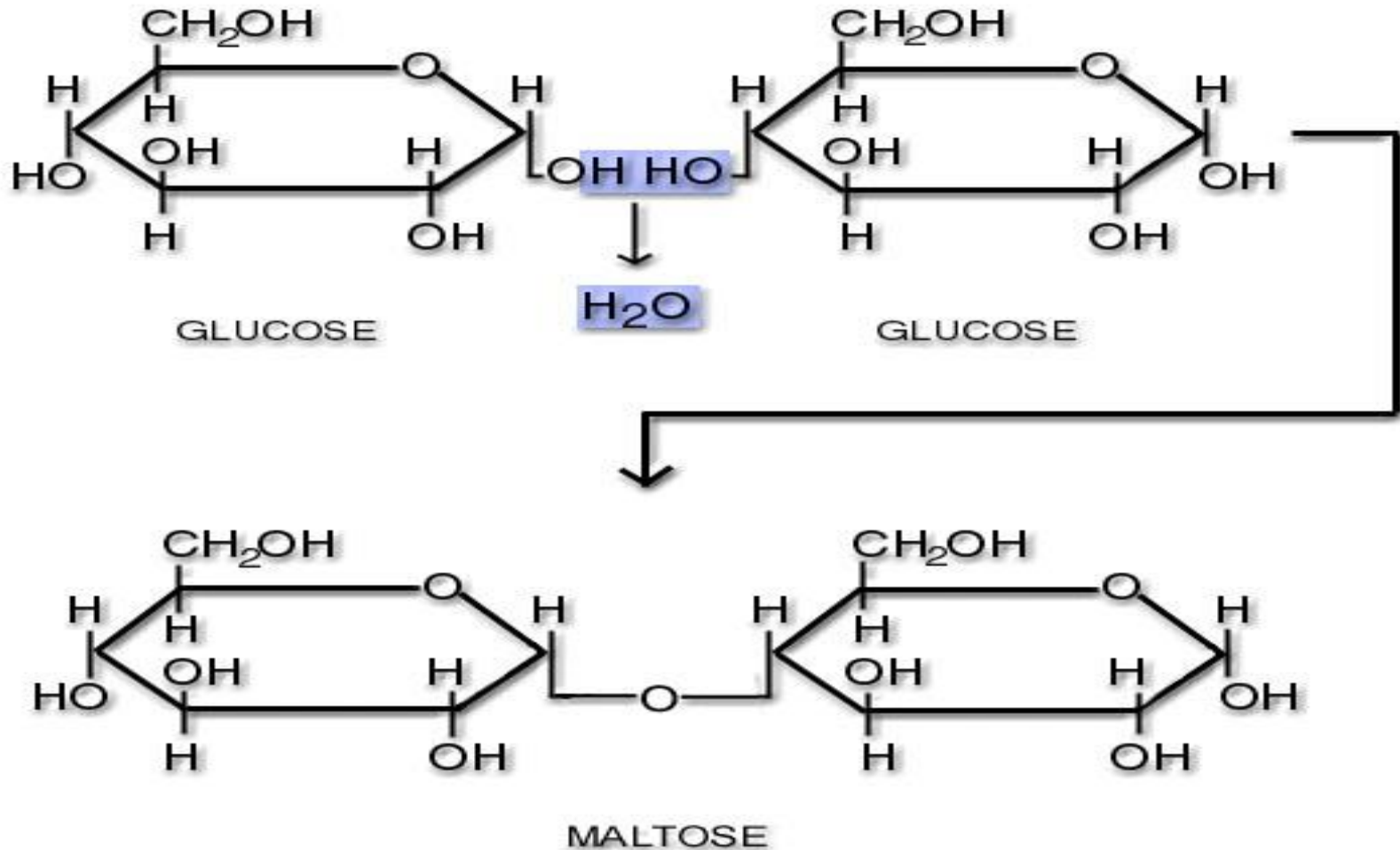
Pentoses and hexoses can **cyclize** as the ketone or aldehyde group reacts with a distal OH.

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



These representations of the cyclic sugars are called **Haworth** projections.

Disaccharides : are formed when the hydroxyl group on the anomeric carbon of one sugar molecule interacts with one of several hydroxyl groups in the other sugar molecule



-réaction de condensation du maltose

Polysaccharides

Polysaccharides are polymers of monosaccharides

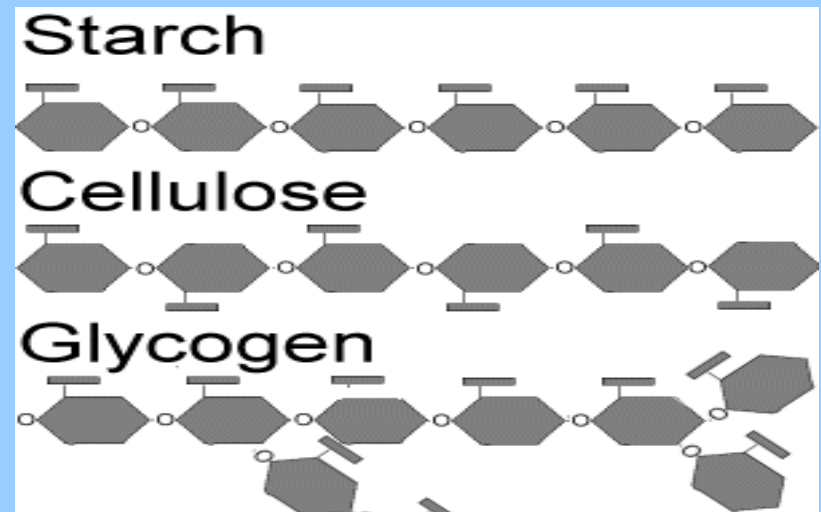
Polysaccharides are created without a template by the addition of particular monosaccharide residues

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

They range in structure from linear to highly branched.

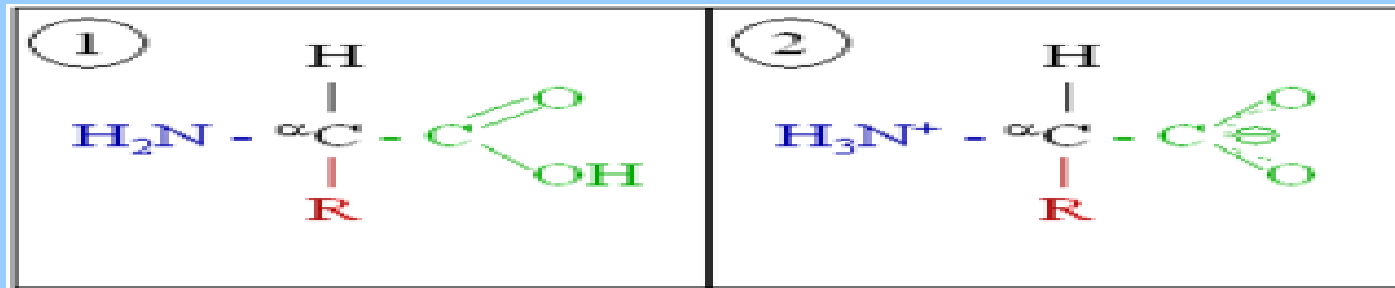
They differ from each other in

- 1- the identity of their monosaccharide units;
- 2- the length of their chains;
- 3- the degree of branching.



Amino acids, and Proteins

- Amino acids are the building blocks of proteins. They are biologically important molecules made from amine (-NH₂) and carboxylic acid (-COOH) functional groups, along with a side-chain specific to each amino acid.



An amino acid in its (1) unionized and (2) zwitterionic forms

- Proteins

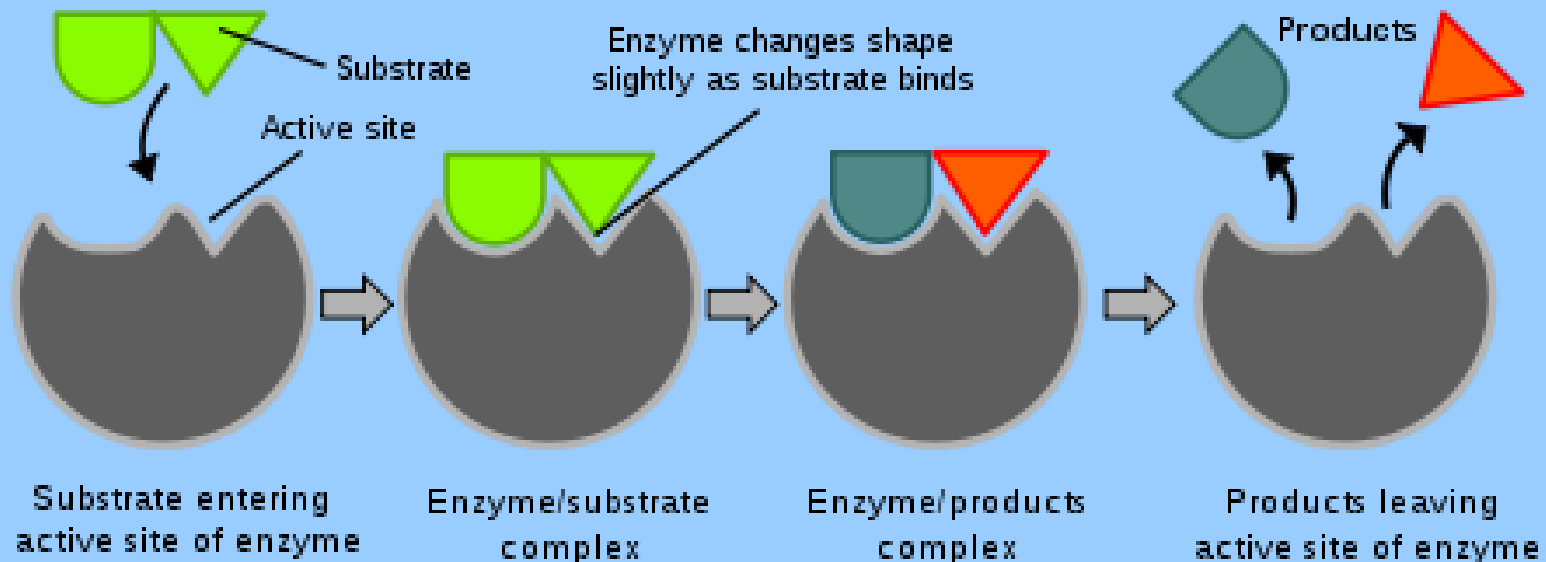
Are biochemical compounds consisting of one or more polypeptides

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

- Are biological molecules that catalyze chemical reactions.
- In enzymatic reactions, the molecules at the beginning of the process, called substrates, are converted into different 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.



- **Classification of enzymes:**

- Enzymes are classified into about 6 categories based on the reaction they catalyse.

1- Oxidoreductases: catalyze oxidation/reduction reactions

2- Transferases: transfer a functional group (e.g. 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 and Nucleic acids

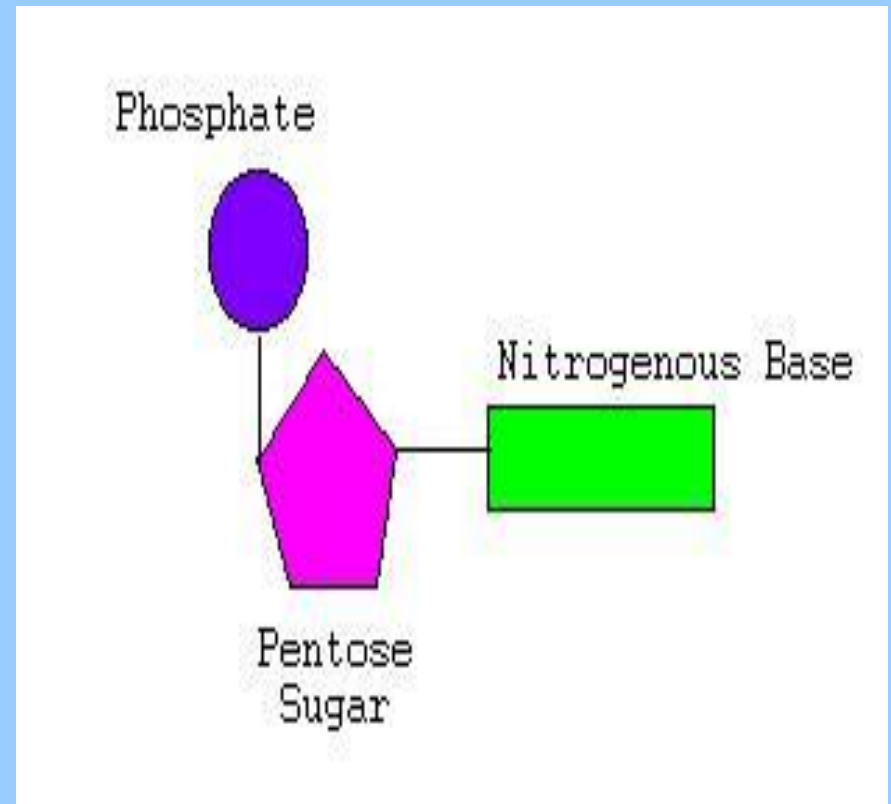
- **Nucleotides**: are molecules that, when joined, make up the individual structural units of the nucleic acids RNA and DNA

Nucleotides are made up of :

1- Ribose sugar in RNA, or deoxyribose in DNA

2- Phosphate group

3- 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

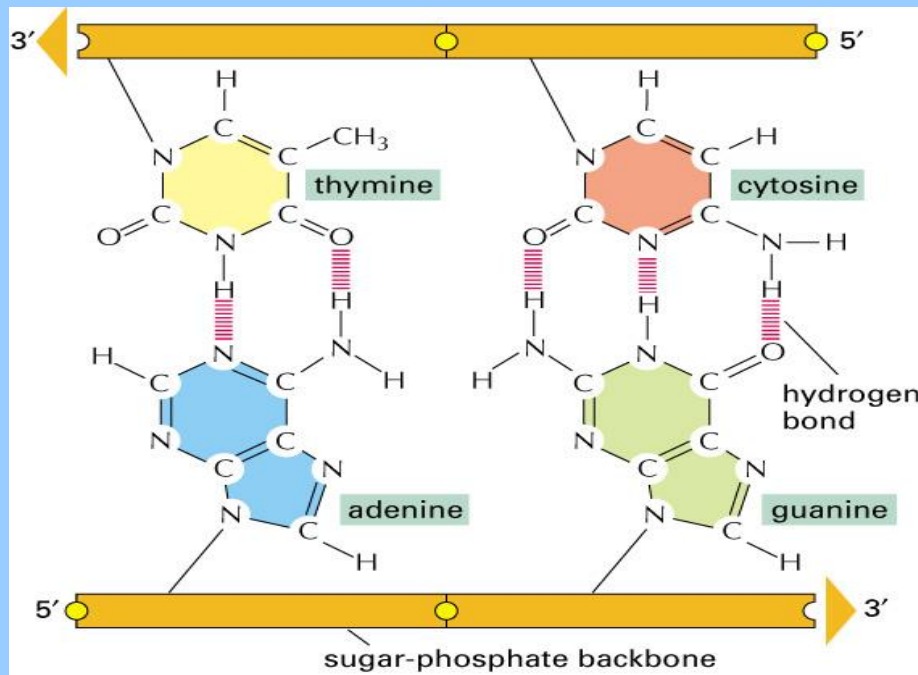


Figure 4-4. Molecular Biology of the Cell, 4th Edition.

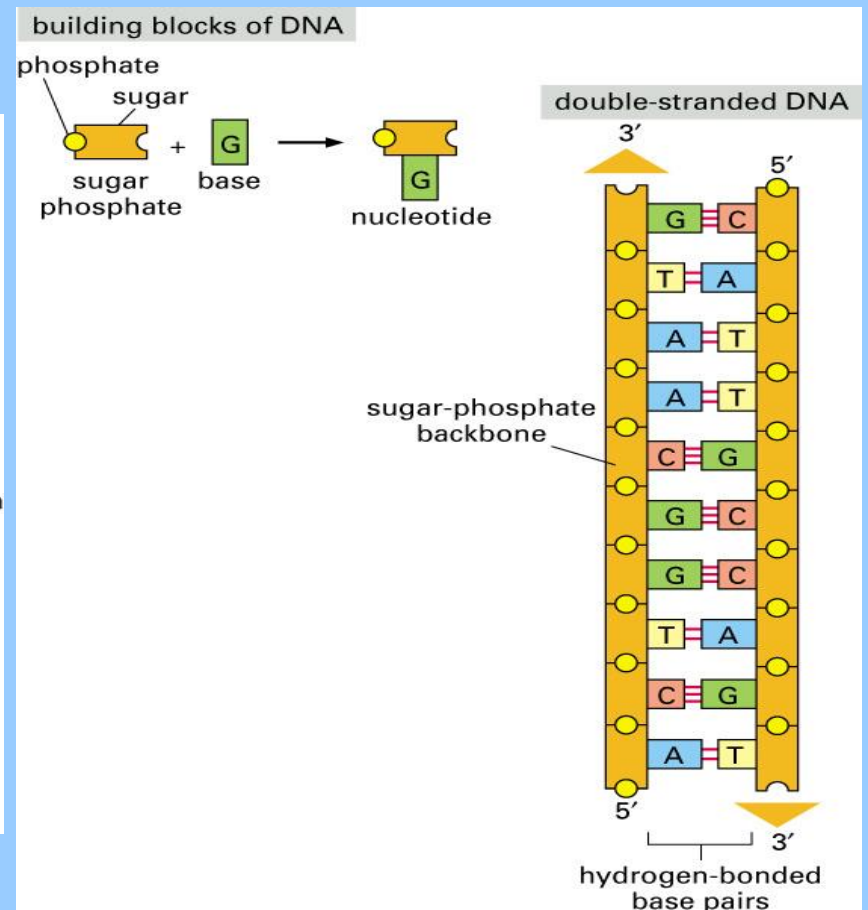


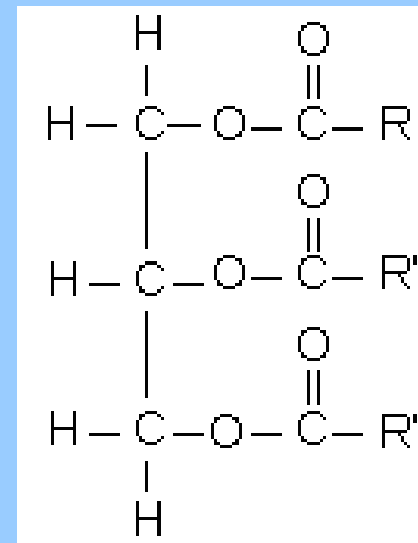
Figure 4-3 part 1 of 2. Molecular Biology of the Cell, 4th Edition.

Lipids

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.), and form 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.

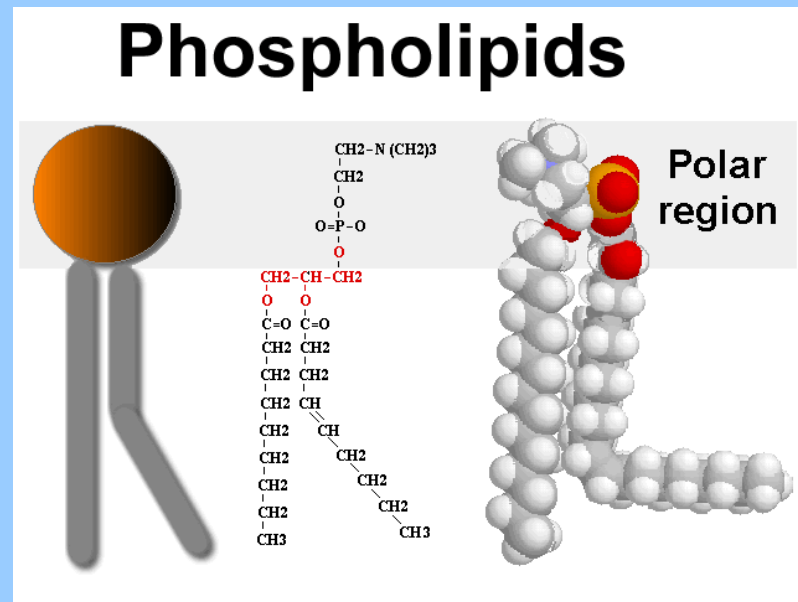
Essential fatty acids include linoleic and linolenic acid.



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** but the **fatty acid chains** are **hydrophobic**.



4- Steroids are the last common kind of lipids. Steroids have a high hydrogen to carbon ratio. Examples of steroids include cholesterol and hormones like testosterone and estrogen.

Water

Water has many unique properties that make it essential to all life. Most of water's unique properties are a result of the **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.

Nonpolar covalent compounds, however, do not dissolve in water.

Thus polar covalent compounds are hydrophilic (water loving) while nonpolar covalent compounds are hydrophobic (water fearing).

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

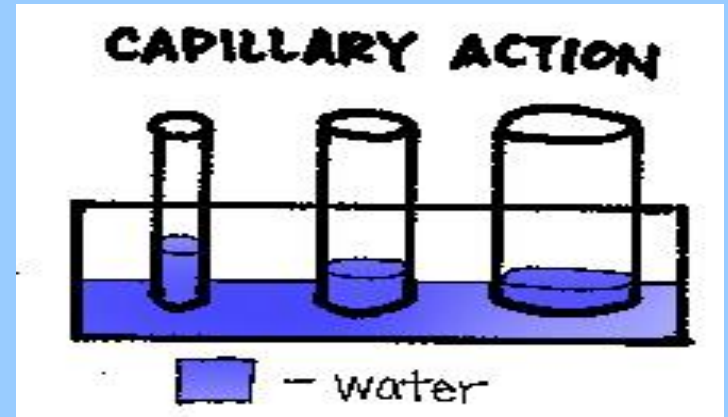
This leads to two characteristics of water:

1- a high surface tension and 2- a strong capillary action.

Water's high surface tension is what allows some insects to run across the surface of the water.

Water's 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.

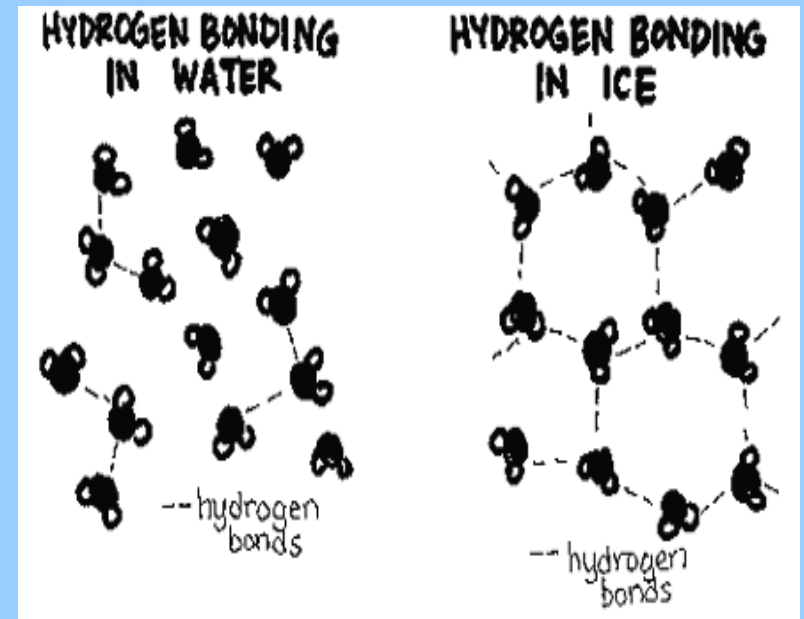


Water has a high specific heat capacity: It takes a lot of energy to change the temperature of water.

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 arranges water molecules into hollow "cells" when water freezes, making it less dense than liquid water.



$$\text{Density} = \text{mass} / \text{volume}$$



«Education is the passport to the future, for tomorrow
belongs to those who prepare for it today»

- Maclom X-