Generality

I. Organic compounds :

Organic chemistry describes the structures, properties, preparation, and reactions of a vast array of molecules that we call **organic compounds**. There are many different types of organic compounds, but all have **carbon** as their principal constituent atom with the exception of simple compounds *e.g.* carbonates (CO_3^{2-}), carbon dioxide (CO_2) and carbon monoxide (CO). These carbon atoms form a **carbon skeleton** or **carbon backbone** that has other bonded atoms such as H, N, O, S, and the halogens (F, Cl, Br, and I).

All organic molecules contain carbon (C), virtually all of them contain hydrogen (H), and most contain oxygen (O) and/or nitrogen (N) atoms. Many organic molecules also have halogen atoms such as fluorine (F), chlorine (Cl), bromine (Br), or iodine (I). Other atoms in organic compounds include sulfur (S), phosphorous (P), and even boron (B), aluminum (Al), and magnesium (Mg).

Organic compounds can be classified into **families** according to their **structural features**. Which the members of each family often **have similar chemical behavior**.

- **Atome de carbone :** carbon is found in period (row) 2, making it a relatively small element, and in group (column) 14,. It is a part of the reactive non-metals category of elements.

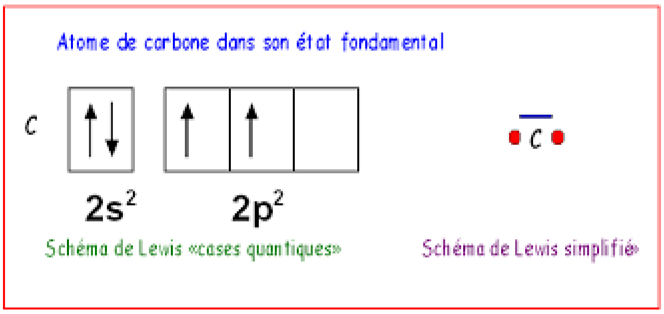
Familles → / périodes ↓	I	II	III	IV	V	VI	VII	VIII
1	1,008 $_1H$							4 $_2He$
2	6,94 Li 3	9,01 Be 4	10,81 B 5	12,01 C 6	14,01 N 7	16 O 8	19 F 9	20,18 Ne 10
3	22,99 Na 11	24,31 Mg 12	26,98 Al 13	28,09 Si 14	30,97 P 15	32,06 S 16	35,45 Cl 17	39,95 Ar 18

masse atomique

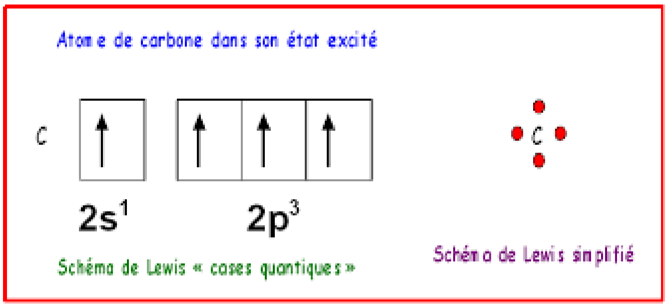
12,01
$_6C$

n° atomique (Z) : nombre d'électrons
qui gravitent autour du noyau de l'atome

its atomic number is 6 and its chemical symbol is C. In its base form, carbon has 6 protons and 6 neutrons, making its atomic mass 12. It also has 6 electrons to balance out its 6 neutrons in its uncharged state. Carbon with atomic number 6(Z=6), has got following ground state electronic configuration of 1 s^2 2 s^2 2 p2



Since carbon is short of 4 electrons to nearest noble gas Neon (Z=10), it forms 4 bonds in order to satisfy Octet configuration of Neon(8 electrons in valence shell). meaning that it has 4 electrons in its outermost electron shell



I.1. chemical bonds :

There are two major types of chemical bonds: **ionic bonds** and **covalent bonds**.

- Ionic bond *:* Ionic bonds result from the transfer of electrons from one element to another. such as sodium chloride : CH_3COO^-,Na^+
- Covalent bond *:* Covalent bonds result from the sharing of electrons

between two nuclei, eg : C-H, C-C

The number of pairs of electrons shared between two atoms determines the type of the covalent bond formed between them.

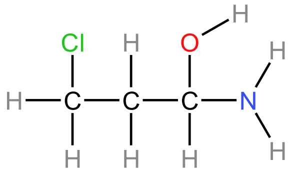
A single bond (δ) is formed when two atoms share one pair of electrons, whereas a multiple bond (л) (double bond and triple bond) is formed when two atoms share two or three pairs.

I.2. valence of éléments :

The number of bonds that an atom can form as part of a compound is expressed by the valency of the element. A valency is always a whole number.

- An atom, with a valency of one, which thus can form one covalent bond is called **monovalent**. For example, hydrogen (H), Lithium (Li), Sodium (Na), etc. have a valency of one.
- An atom, with a valency of two, which thus can form two covalent bonds is called **divalent**. for example, oxygen (O), magnesium (Mg), etc. have a valency of two.
- An atom, with a valency of three, which thus can form three covalent bonds is called a **trivalent**. For example, nitrogen (N), aluminum (Al), etc. have a valency of three.
- An atom, with a valency of three, which thus can form feur covalent bonds is called a **teravalent**. For example, carbon (C), silisium (Si), etc. have a valency of feur.

Exemple :



II. Structural Representation and classifecation of Organic Compounds:

II.1. Structural Representation of Organic Compounds:

Though an organic compound has only one chemical formula, structurally it can be depicted in numerous ways. The three **Structural Formulas** by which a compound can be represented are;

1.Complete Structural Formula

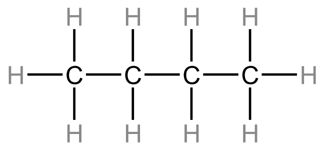
2. Condensed Structural Formula

3. Bond line Structural Formula

- chemical formula : give only the types and numbers of each atom in a molecule. Eg : $C_xH_yO_zN_tX_w$ (X : F, Cl, Br, I)

II.1.1. Complete Structural formulas **:**

· Complete or Expanded Structural formulas show how the atoms in a molecule are arranged « The structural formula of an organic compound shows every bond between every atom in the molecule. Each bond is represented by a line.



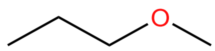
II.1.2. Condensed structural formulas**:**

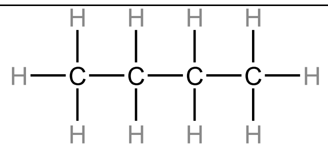
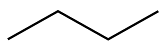
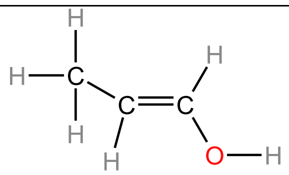
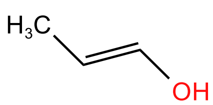
In a condensed structural formula, or semi-structural formula, covalent bonds are not always shown and atoms of the same type bonded to one another are grouped together. Similarly, $CH_3CH_2CH_2CH_2CH_2CH_2CH_2CH_3$ can be further condensed to $CH_3(CH_2)_6CH_3$.

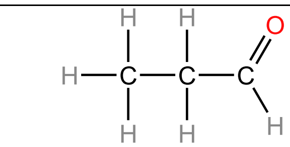
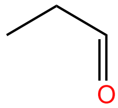
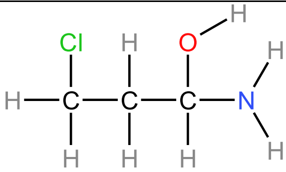
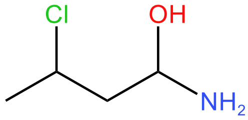
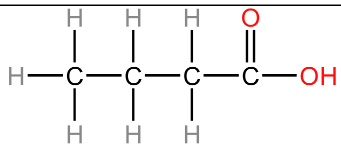
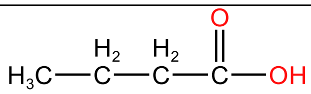
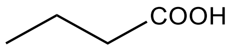
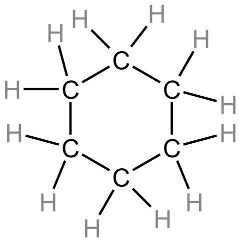
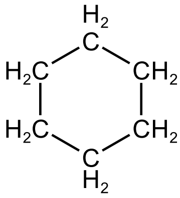
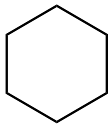
II.1.3. Bond line Structural Formula**:**

in which only lines are used. In this *bond-line structural* representation of organic compounds, carbon and hydrogen atoms are not shown and the lines representing carbon-carbon bonds are drawn in a *zig-zag* fashion. The only atoms specifically written are oxygen, chlorine, nitrogen etc. The terminals denote methyl (–CH3) groups (unless indicated otherwise by a functional group)

Example :



Complete Structural formulas	Condensed structural formulas	Bond line Structural Formula
	$CH_3(CH_2)_2CH_3$	
	$H_3C-\overset{H}{C}=\overset{H}{C}-OH$	

	CH_3CH_2CHO	
	$CH2ClCH_2$	
		
		

II.2. CLASSIFICATION OF ORGANIC COMPOUNDS

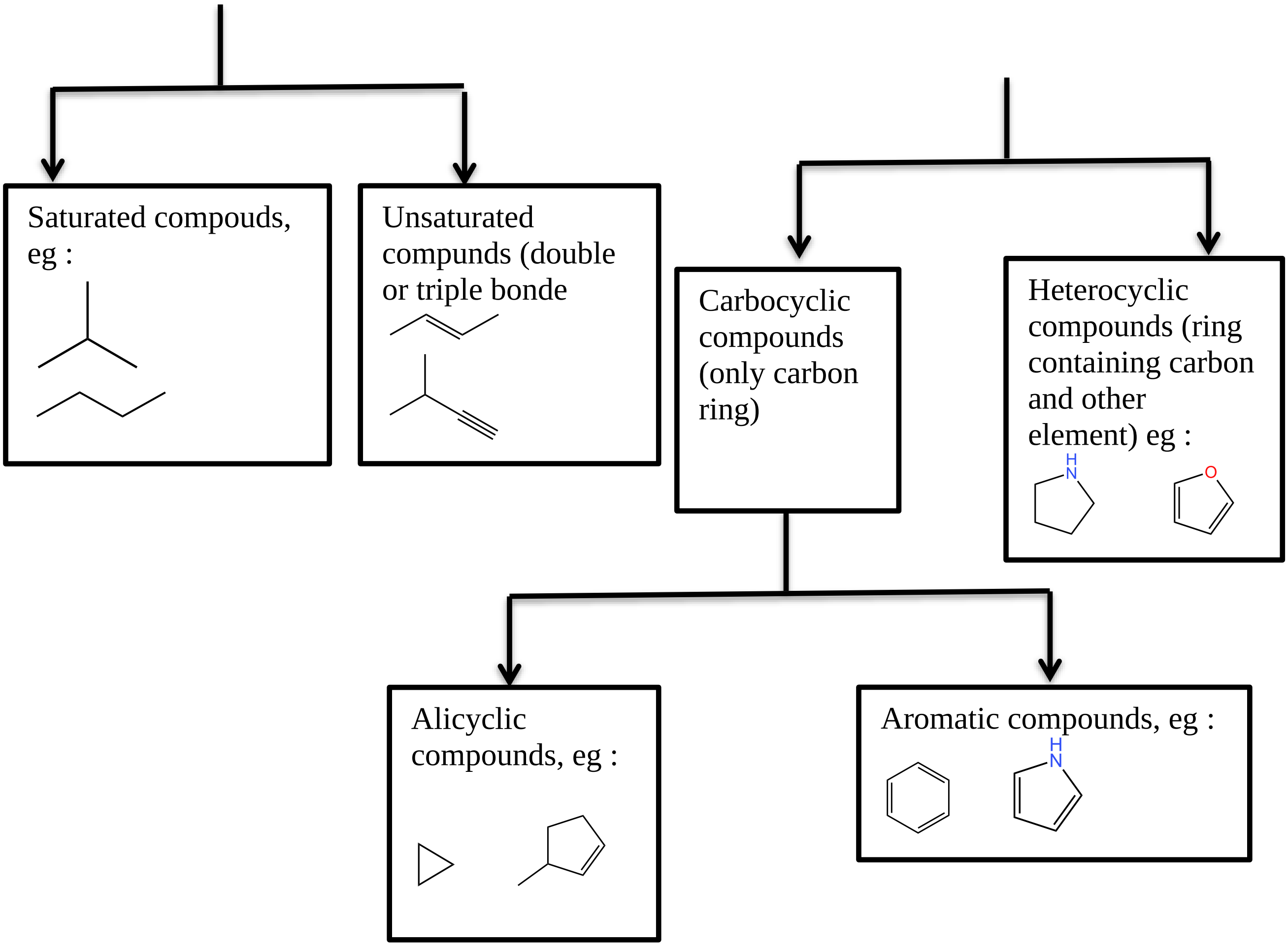
Organic compounds are classified into two main categories based on their structure:

- Acyclic or open-chain compounds
- Cyclic or closed-chain compounds

Organic compounds

Acyclic or open chain compounds : These compounds are also called as **aliphatic** compounds and consist of straight or branched chain compounds

Cyclic or closed-chain compounds : Alicyclic (aliphatic cyclic) compounds contain carbon atoms joined in the form of a ring (homocyclic). Sometimes atoms other than carbon are also present in the ring (heterocylic).



II.2.2. carbon Class:

refer to the number of other carbon atoms attached to the branching carbon atom. There are four possibilities: primary (1°), secondary (2°), tertiary (3°), quaternary (4°) and zero carbone (0°).

Primary carbon: are those which is attached to one carbon atom only

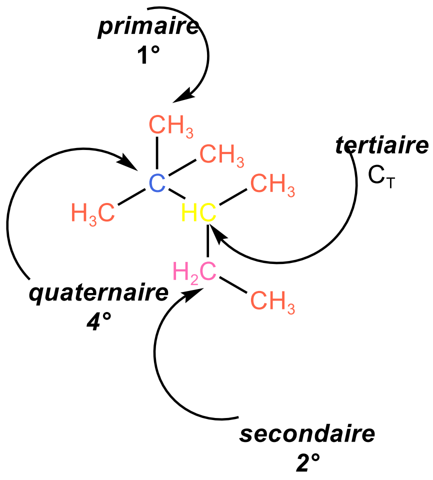
secondary carbon : are those which is attached to two carbon atoms

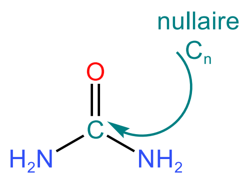
tertiary carbon : are those which is attached to three carbon atoms

quaternary carbon : are those which is attached to three carbon atoms.

Zero carbon : are those not attached with any other carbon atom.

For example :





III. Degrees of Unsaturation **:**

The degree of unsaturation indicates the total number of pi bonds and rings within a molecule which makes it easier for one to figure out the molecular structure :

DU = (number of pi bonds) + (number of rings)

If the molecular formula is given, plug in the numbers into this formula:

$$DU = (2n_C - n_H - n_X + n_N + 2)/ 2$$

- n_C is the number of carbons
- n_N is the number of nitrogens
- n_X is the number of halogens (F, Cl, Br, I)
- n_H is the number of hydrogens

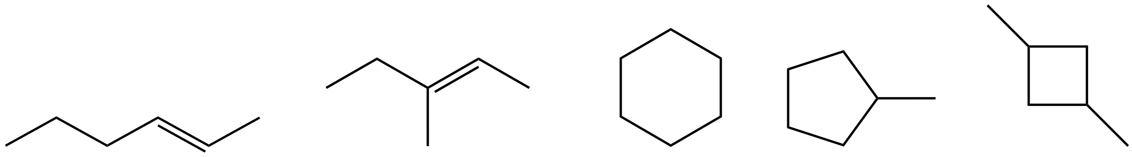
We notice :

- However, the number of oxygen atoms O, or even of sulfur S, does not intervene in this calculation.
- Even a halogen atom F, Cl, Br, I counts as a hydrogen atom.
- or a nitrogen atom, or even phosphorus P.
- Example :

The degree of unsaturation of C_6H_{12} :

- ➢ DU = (2 x 6 – 12 + 2)/ 2 = 1
- ✓ number of pi bonds
- ✓ number of rings

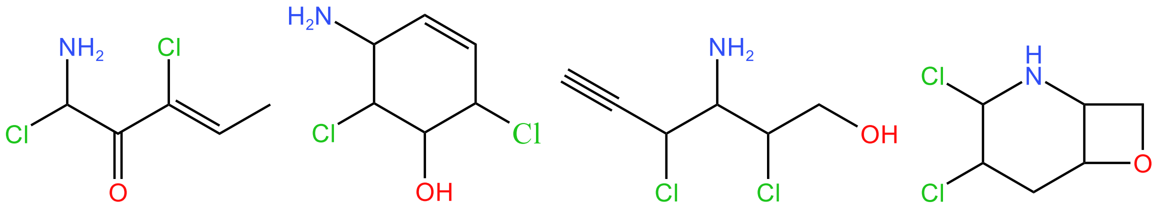
The following structures all have DU of 1 and have the same molecular formula



Degree of unsaturated for $C_6H_9Cl_2NO$: DU = (2 x 6 – 9 - 2 + 1 + 2)/ 2 = 2

- ➢ 2 degrees of unsaturation is equivalent to :
- ✓ 2 double bonds,
- ✓ 1 ring and 1 double bond,
- ✓ 2 rings,
- ✓ or 1 triple bond (2 π bonds). :

The following structures all have DU of 2 and have the same molecular formula



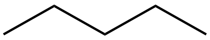
IV. Classification of Organic Compounds

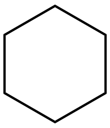
Organic compounds are often classified according to the type (s) of functional groups present. These functional groups are presented in detail in the remaining chapters. The on-sight recognition of functional groups is required for an adequate study of organic chemistry.

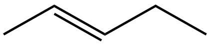
IV.1. Functional Group

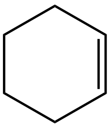
The functional group may be defined as an atom or group of atoms joined in a specific manner which is responsible for the characteristic chemical properties of the organic compounds.

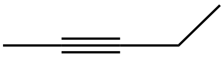
The simplest of the functional groups are the **hydrocarbons**, which include the **alkanes**, **alkenes**, **alkynes**, and **aromatic hydrocarbons**.

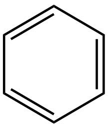

alkane aliphatique


alkane cyclique


alkene aliphatique


alcène cyclique

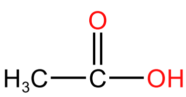
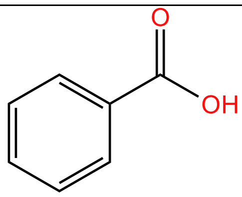

Alkyne

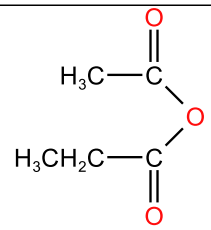
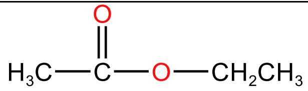
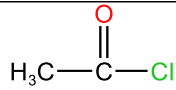
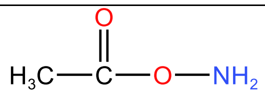
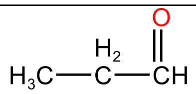
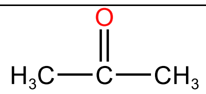
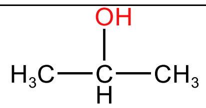
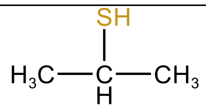
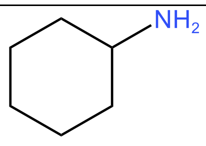
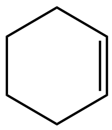
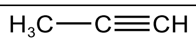
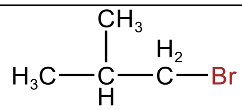
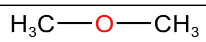
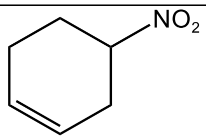
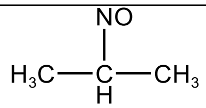
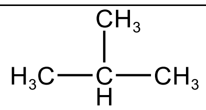

aromatic hydrocarbon

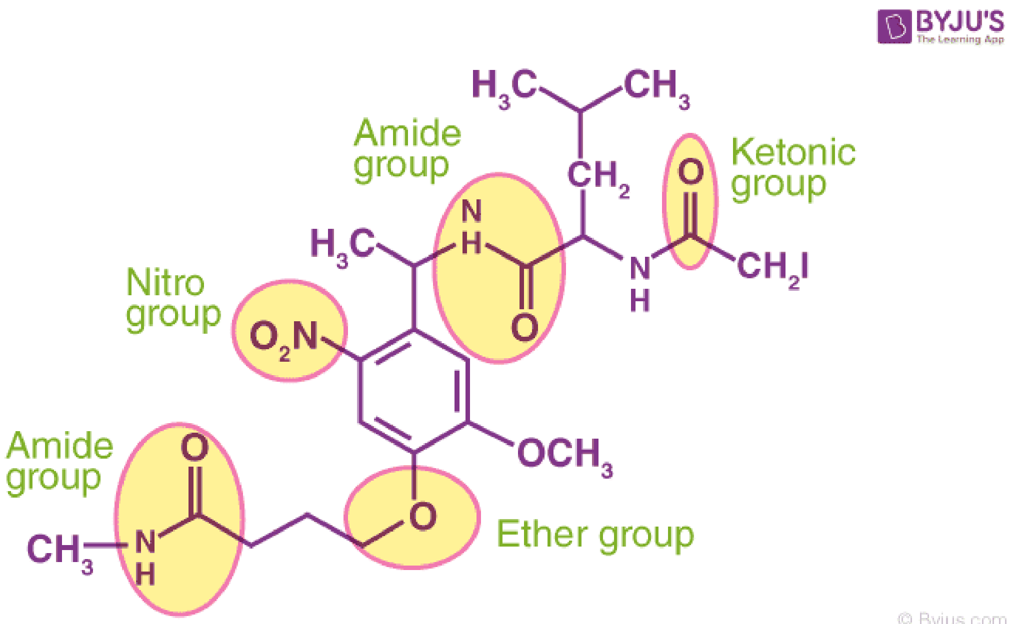
– Many functional groups contain oxygen atoms, such as **alcohols**, **ethers**, **aldehydes**, **ketones**, **carboxylic acids**, and **esters**.

– Some other functional groups contain nitrogen atoms, such as the **amines** and **amides**.

• Molecules with the same functional group tend to share similar chemical and physical properties.

Type of functional groups	**formula**	**Example**
carboxylic acide	R-COOH	 

Anhydride acide	R-CO-O-CO-R'	
Ester	R-CO-O-R'	
Acide halide	R-CO-X	
Amide	R-CO-NH2	
cyanid (nitril)	R-C≡N	$CH_3C≡N$
Aldéhyde	R-CO-H	
Ketone	R-CO-R'	
Alcohol	R-OH	
Thiol alcohol	R-SH	
Amine	R-NH2	
Alkene	C=C	
Alkyne	C≡C	
Halid	R-X	
Ether	R-O-R'	
Nitro compound	R-NO2	
Nitroso	R-NO	
Alkane	C-C	



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