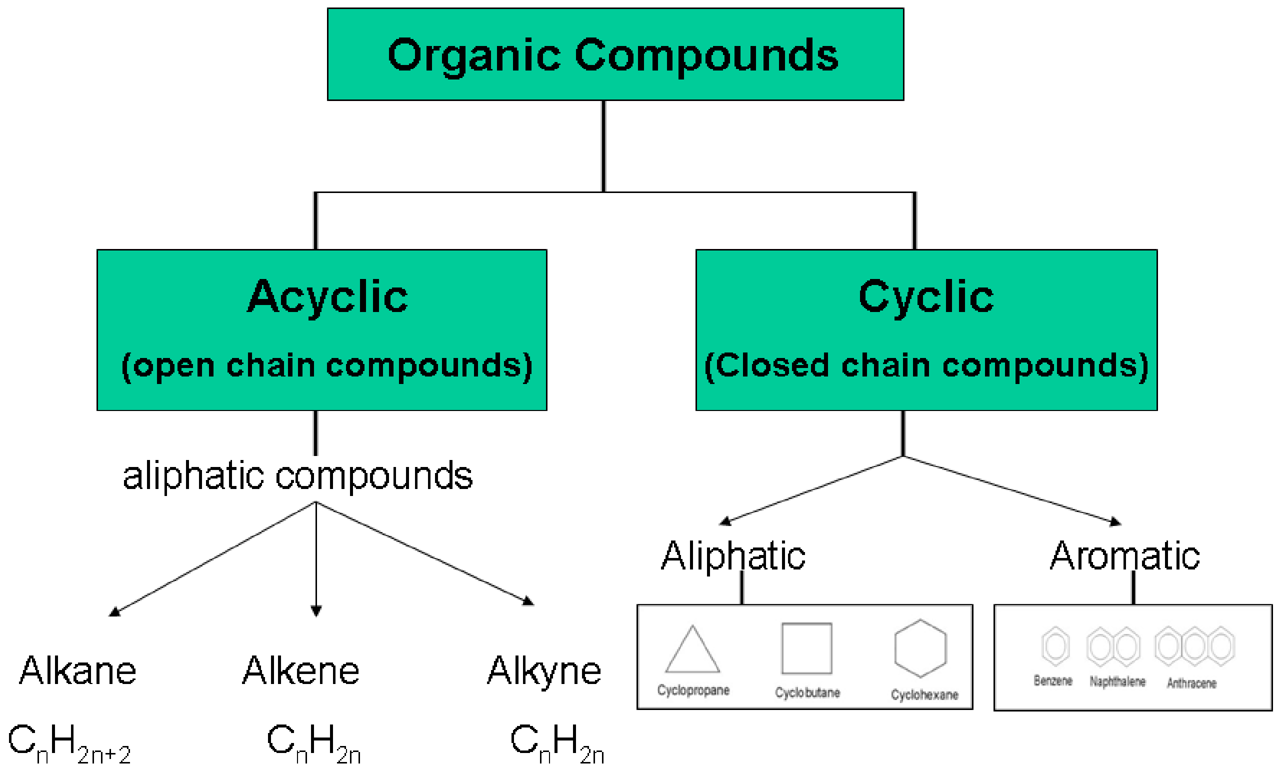
Organic Chemistry
&
Biochemistry

University Chemistry

ORGANIC CHEMISTRY

- Organic chemistry is very important branch of chemistry and it study the compounds which contain carbon (C) and hydrogen (H), in general, and may contains other atoms such as oxygen (O), nitrogen (N), sulfur (S),…etc.

Classification of organic compounds



•DRAWING ORGANIC MOLECULES

Molecular formulae: A molecular formula simply counts the numbers of each sort of atom present in the molecule, but tells you nothing about the way they are joined together.

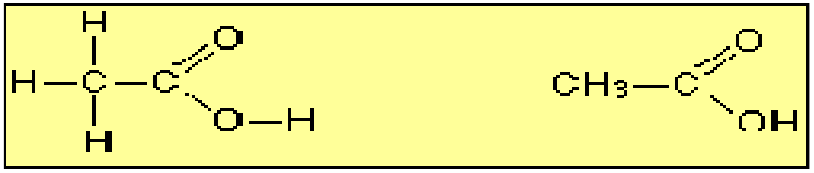
Example:

the molecular formula of butane is C_4H_{10}, and the molecular formula of ethanol is C_2H_6O.

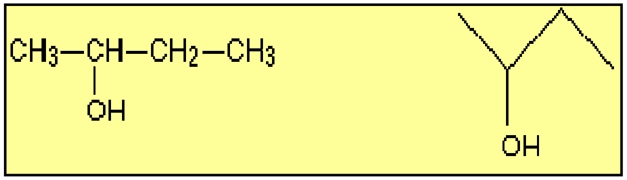
Structural formulae: A structural formula shows how the various atoms are bonded.

Example:

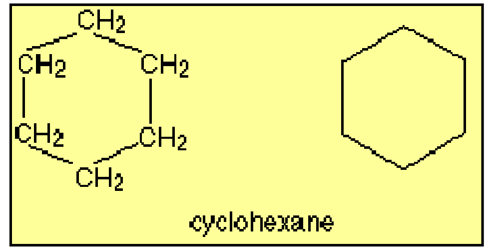
ethanoic acid would be shown in a fully displayed form and a simplified form as:



- **Skeletal formulae:** all the hydrogen atoms are removed from carbon chains, leaving just a carbon skeleton with functional groups attached to it.
- **Example:**
- butan-2-ol



Cyclohexane, C_6H_{12}



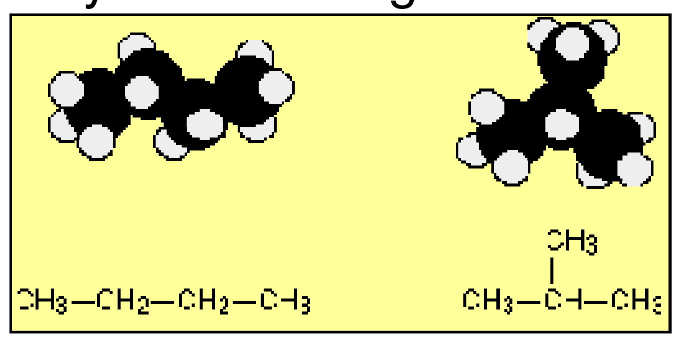
STRUCTURAL ISOMERISM:

Isomers are molecules that have the same molecular formula, but have a different arrangement of the atoms in space.

Types of structural isomerism

(A) Chain isomerism: due to possibility of branching in carbon chains.

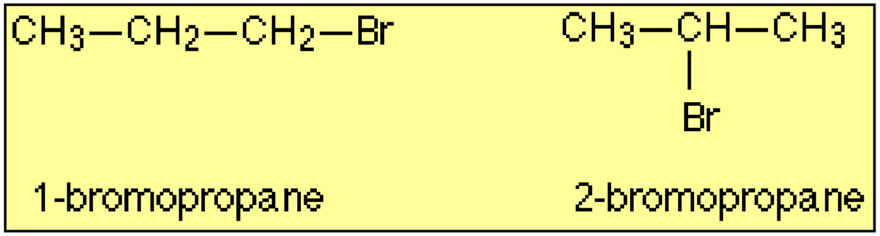
Example:
there are two isomers of butane, C_4H10.



(B) Position isomerism: the basic carbon skeleton remains unchanged, but important groups are moved around on that skeleton.

Example:

there are two structural isomers with the molecular formula C_3H_7Br.

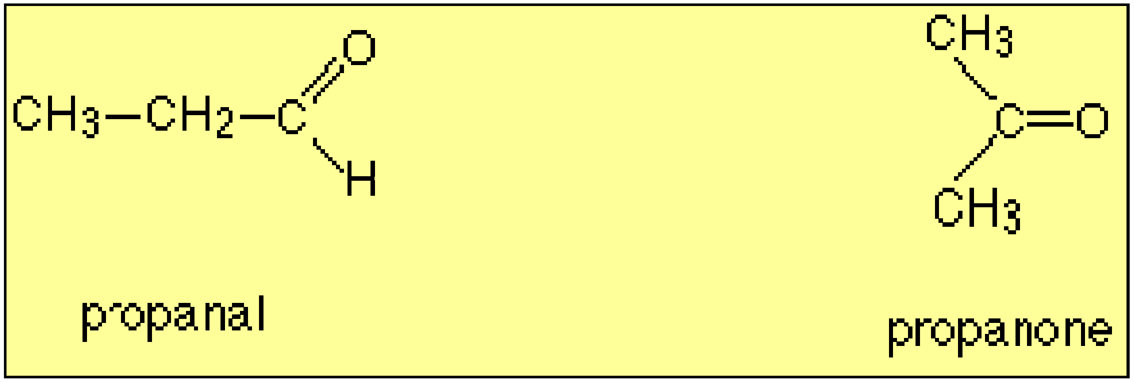


Functional group isomerism

The isomers contain different functional groups, and they belong to different families of compounds

Example

molecular formula C_3H_6O could be either propanal (an aldehyde) or propanone (a ketone).



University Chemistry
Dr. Mohamed A. Salam

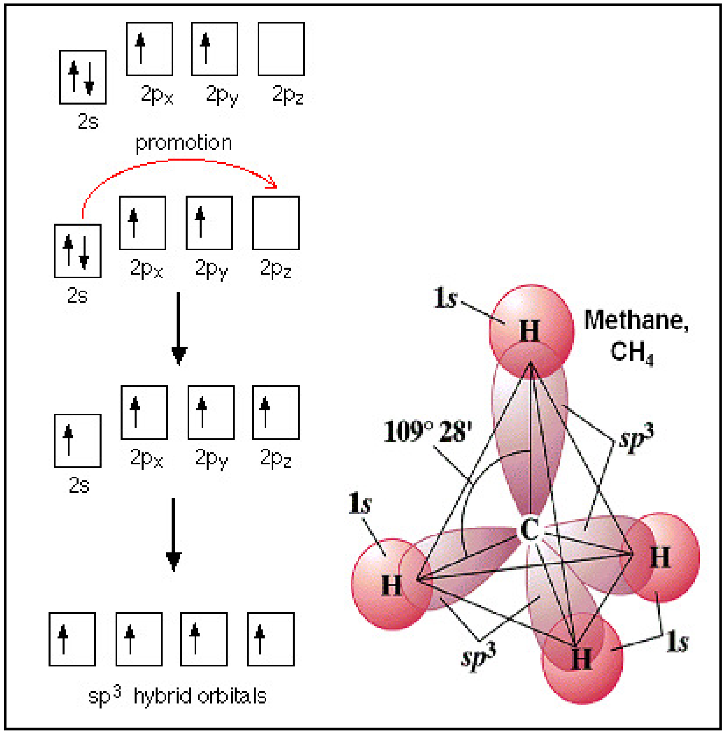
Aliphatic hydrocarbons

- # Alkanes:

- they are saturated hydrocarbons, because all the carbon atoms are bonded with 4 single covalent bonds.
- **General formula: C_nH_{2n+2}**

Bonding in Alkanes

So, alkane (four single bonds) have sp3 hybridization, where four sp3 orbitals are produced which can form sigma (σ) bonds, with an angle of 109º28' between bonds.



- **Nomenclature:** a chemical name has three parts:

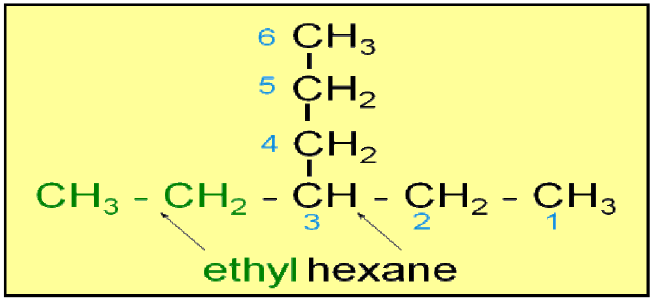
  prefix, **parent**, and **suffix**

- **prefix**: Tells #, types & where side groups attached
- **parent**: Tells # of Cs in longest continuous chain
- **suffix**: Tells which functional group is present
- Straight chain alkanes are named by counting the number of carbon atoms in the longest chain and adding the **suffix *-ane***.

Number of carbon	*Compound*	*Alkane name*	*Application*
1 (Meth)	CH_4	methane	found in natural gas
2 (Eth)	C_2H_6	ethane	used making ethylene
3 (Prop)	C_3H_8	propane	heating and barbecues
4 (But)	C_4H_{10}	butane	lighter fluid
5 (Pent)	C_5H_{12}	pentane	Solvent
6 (Hex)	C_6H_{14}	hexane	part of gasoline
7 (Hept	C_7H_{16}	heptane	part of gasoline
8 (Oct)	C_8H_{18}	octane	
9 (non)	C_9H_{20}	nonane	
10 (dec)	$C_{10}H_{22}$	decane	

How to name open chain compounds?

- **To name alkanes and any other organic compounds:**



- 1. Find the longest continuous chain of carbon atoms; this is a ***hexane*** (6 crabo atoms)*.*

- 2. Alkane groups as substituent's are named as follows:
- - CH3 meth**yl**
- - CH2CH3 eth**yl**
- - CH2CH2CH3 prop**yl**

- 3. Number the long chain so that the substituents are at the lowest numbers,and the substituent at carbon number 3.

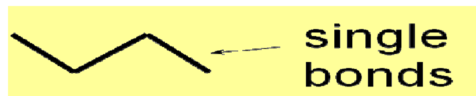
The name for this alkane is: 3-ethylhexane

Draw the structures for n-butane and isobutene

n-butane

n means normal chain (straight), and but means 4 carbon atoms.

put 4 carbon atoms beside each other and make each one connected to 4 single bonds:

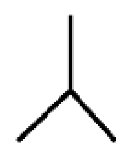
$CH_3CH_2CH_2CH_3$ or 

isobutane

iso means branched chain, and but means 4 carbon atoms.

put 3 carbon atoms beside each other and connect the forth C atom to the middle carbon, and make each one connected to 4 single bonds:

$$\begin{array}{c} CH_3 \\ | \\ CH_3 - CH - CH_3 \end{array}$$

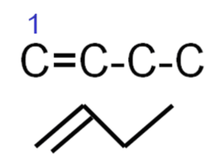


Aliphatic hydrocarbons

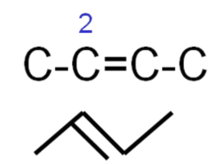
- **Alkenes:**
- Alkenes are unsaturated hydrocarbons (contain at least one C=C double bond)
- **General formula: C_nH_{2n}**

C_2H_4	ethene (ethylene)
C_3H_6	propene (propylene)
C_4H_8	butene

•**Naming Alkenes:** count the number of the carbon atoms in the longest chain, and add the suffix **-*ene*** at the end.



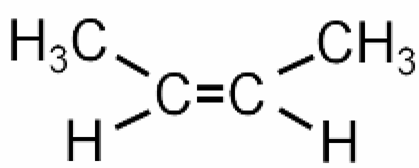
1-butene



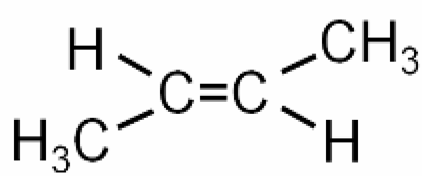
2-butene

***cis-trans* isomerism**

Alkenes have two different geometrical isomerism, *cis* and *trans*.



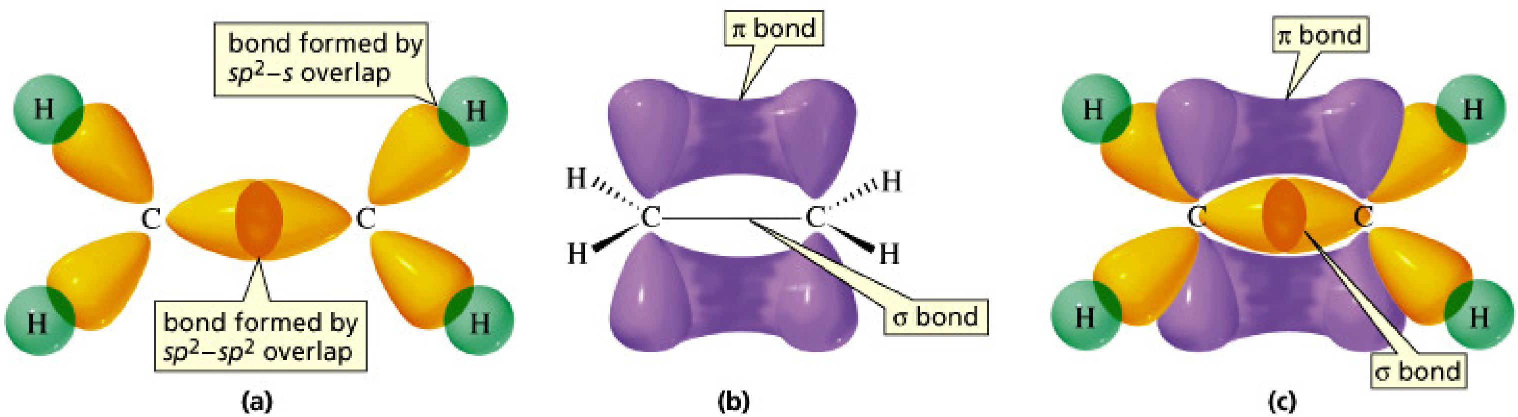
cis-2-butene



trans-2-butene

Bonding in alkene

In alkene (one double bond and two single bonds) have sp^2 hybridization, where three sp^2 orbitals are produced which can form three sigma (σ) bonds, with an angle of 120° between bonds, and one pi (π) bond from the pure p orbitals.



Aliphatic hydrocarbons

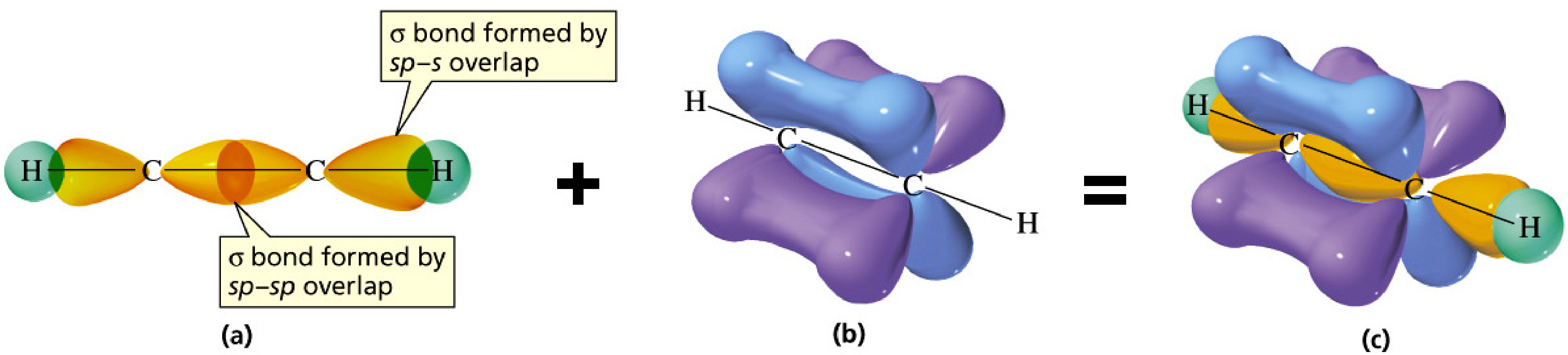
- **Alkynes:**
- Alkynes are unsaturated hydrocarbons (contain at least one C≡C triple bond)
- **General formula: C_nH_{2n-2}**

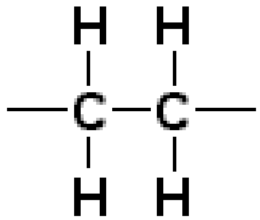
•**Naming Alkynes:** count the number of the carbon atoms in the longest chain, and add the suffix **-*yne*** at the end.

C_2H_2	C≡C	ethyne (acetylene)
C_3H_4	C–C≡C	propyne
C_4H_6	C–C≡C–C	butyne

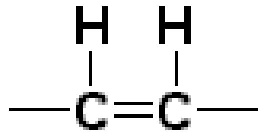
Bonding in alkyne

In alkyne (one triple bond and one single bonds) have sp hybridization, where two sp orbitals are produced which can form two sigma (σ) bonds, with an angle of 180° between bonds, and two pi (π) bond from the pure p orbitals.

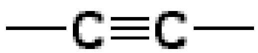




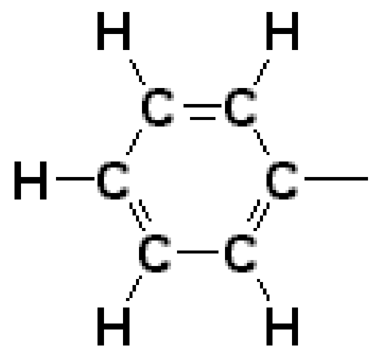
alkane



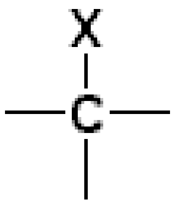
alkene



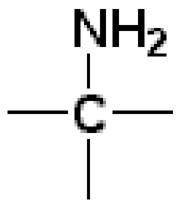
alkyne



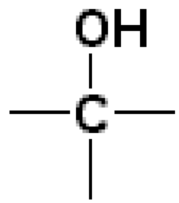
phenyl



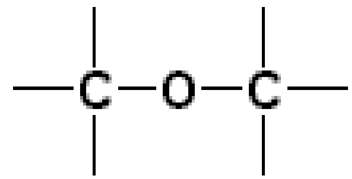
alkyl halide
(X = F, Cl, Br, I)



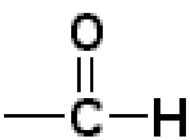
amine



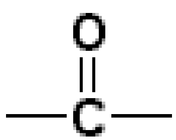
alcohol



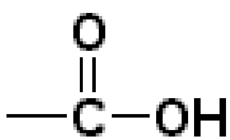
ether



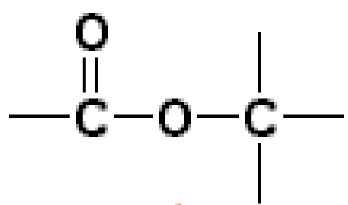
aldehyde



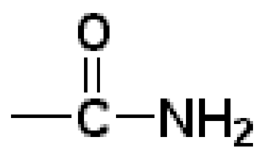
ketone



carboxylic acid



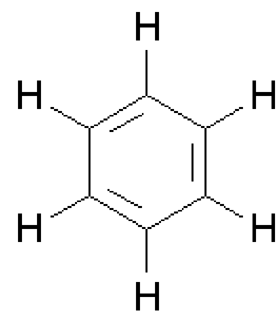
ester



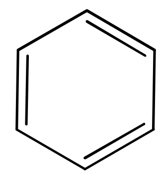
amide

Aromatic Hydrocarbons and their Nomenclature

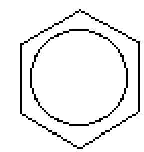
Benzene is the most common aromatic parent structure



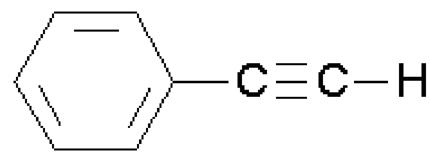
OR



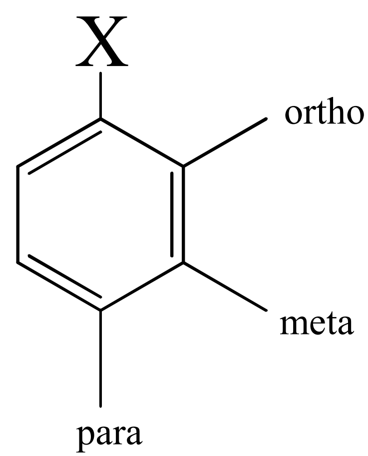
OR



The benzene ring is named as a phenyl group when it is a substituent.

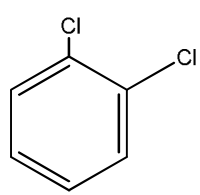


phenylethyne



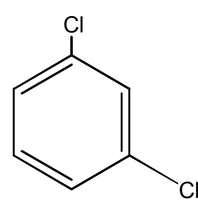
Multiple substituent's on a benzene ring:

1,2-dichlorobenzene



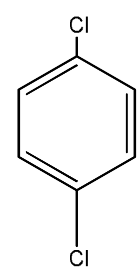
ortho *o*-dichlorobenzene

1,3-dichlorobenzene



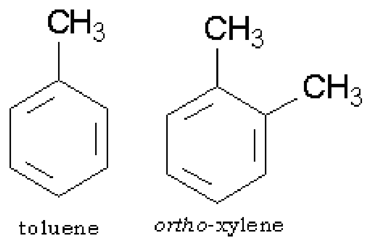
meta *m*-dichlorobenzene

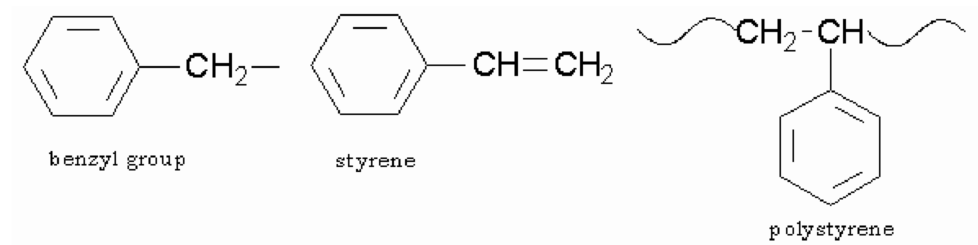
1,4-dichlorobenzene



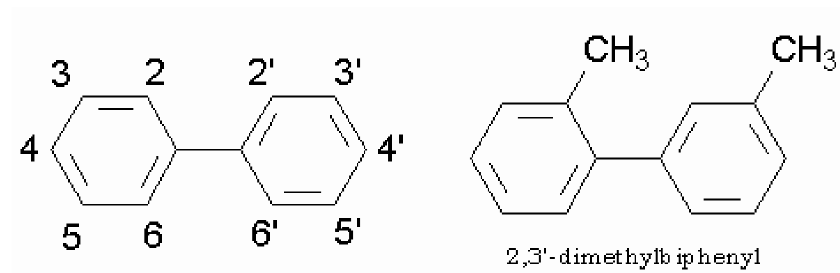
para *p*-dichlorobenzene

Some common names involving benzene rings

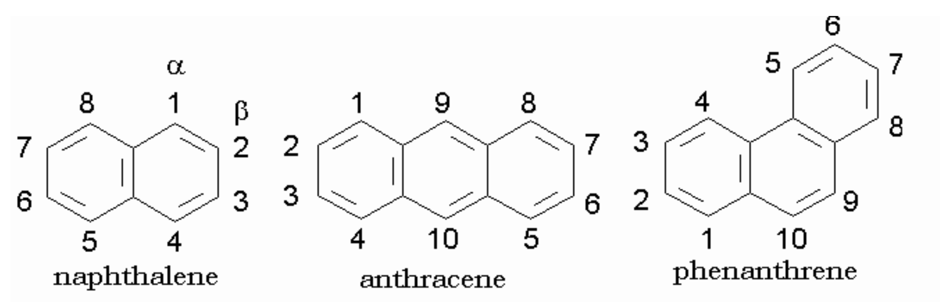




Biphenyl: involve two benzene rings bonds together and follow the numbering system.



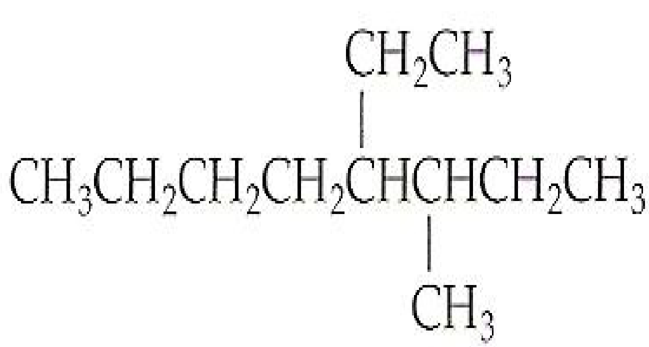
Polycyclic aromatic hydrocarbons, which contains fused benzene rings



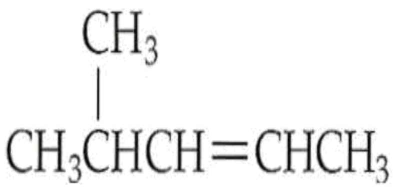
Number of bonds

For each single bond count one sigma bond, for each double bond count one sigma bond and one pi bond, and finally for each triple bond count one sigma bond and two pi bonds.

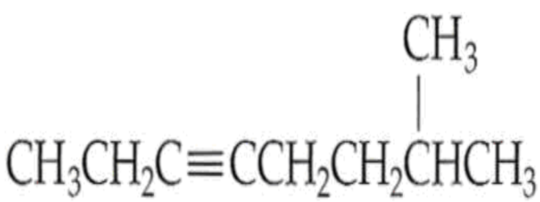
Name the following compounds and count the total number of bonds:



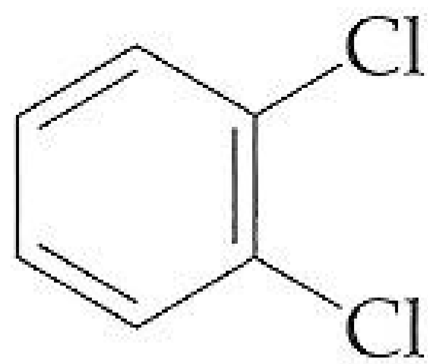
The longest chain contains 8 carbons, so it is oct
All single bonds, so it is octane
Ethyl branch at carbon number 4, and methyl branch at carbon number 3, so its name is: 4-ethyl- 3- methyl-octane
Bond: all are single bonds, 34 sigma bonds.



The longest chain contains 5 carbons, so it is pent
One double bond = at carbon number 2, so it is 2-pentene.
Methyl branch at carbon number 4, so its name is: 4-methyl-2-pentene
Bond: One double bond =, counts as 1 sigma and 1 pi, 16 other single (sigma). 17 sigma and 1 pi bond, so the total number of bonds is 18.

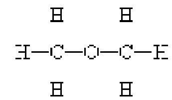
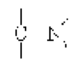
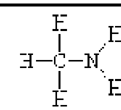
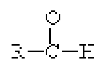
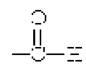
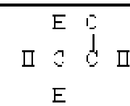
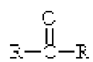
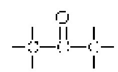
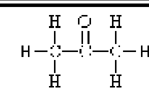
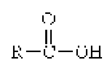
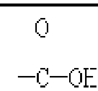
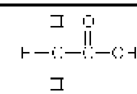
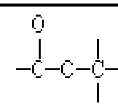
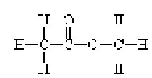
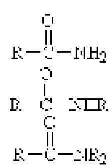
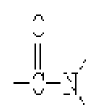
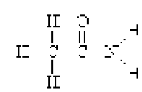


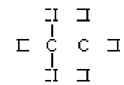
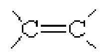
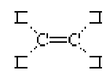
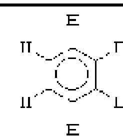
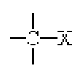
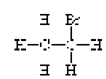
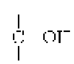
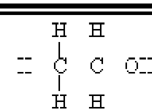
The longest chain contains 8 carbons, so it is oct
One triple bond ≡ at carbon number 3, so it is 3-octyne.
Methyl branch at carbon number 7, so its name is: 7-methyl-3-octyne
Bond: One triple bond ≡, counts as 1 sigma and 2 pi, 23 other single (sigma) bonds. 24 sigma and 2 pi bond, so the total number of bonds is 26.



It is benzene, with two chloro substitution at position 1, 2.
Its name is 1,2-dichlorobenzene or ortho- dichlorobenzene.

Bond: three double bond =, counts as 1 sigma and 1 pi, 9 other single (sigma) bonds. 12 sigma and 3 pi bond, so the total number of bonds is 15.

Ether	ROR	—C—O—C—		Methoxy methane	Dimethyl ether
Amine	RNH_2 R_2NH R_3N			Methanamine	Methylamine
Aldehyde				Ethanal	Acetaldehyde
Ketone				Propanone	Acetone
Carboxylic Acid				Ethanoic acid	Acetic Acid
Ester				Methyl ethanoate	Methyl acetate
Amide				Ethanamide	Acetamide

Family	General Formula	Functional Group	Example	IUPAC Name	Common Name
Alkane	RH	C-H and C-C bonds		Ethane	ethane
Alkene	$RCH=CH_2$ $RCH=CHR$ $R_2C=CHR$ $R_2C=CR_2$			Ethene or ethylene	ethylene
Alkyne	$RC\equiv CH$ $RC\equiv CR$	$—C\equiv C—$	$H-C\equiv C-H$	Ethyne or acetylene	Acetylene
Arene	ArH	Aromatic Ring		Benzene	Benzene
Haloalkane	RX			Bromo ethane	Ethylbromide
Alcohol	ROH			Ethanol	Ethyl alcohol

Biochemistry

- Biochemistry is the chemistry of living organisms.
- It is the application of chemistry to study the different biological processes at the cellular and molecular level.
- In general, Chemistry deals with objects at the *molecular* scale and the fundamental unit of living organisms is the *cell* (macroscopic scale), so, consequently, biochemistry tries to span *both* of these worlds (molecules and cells).

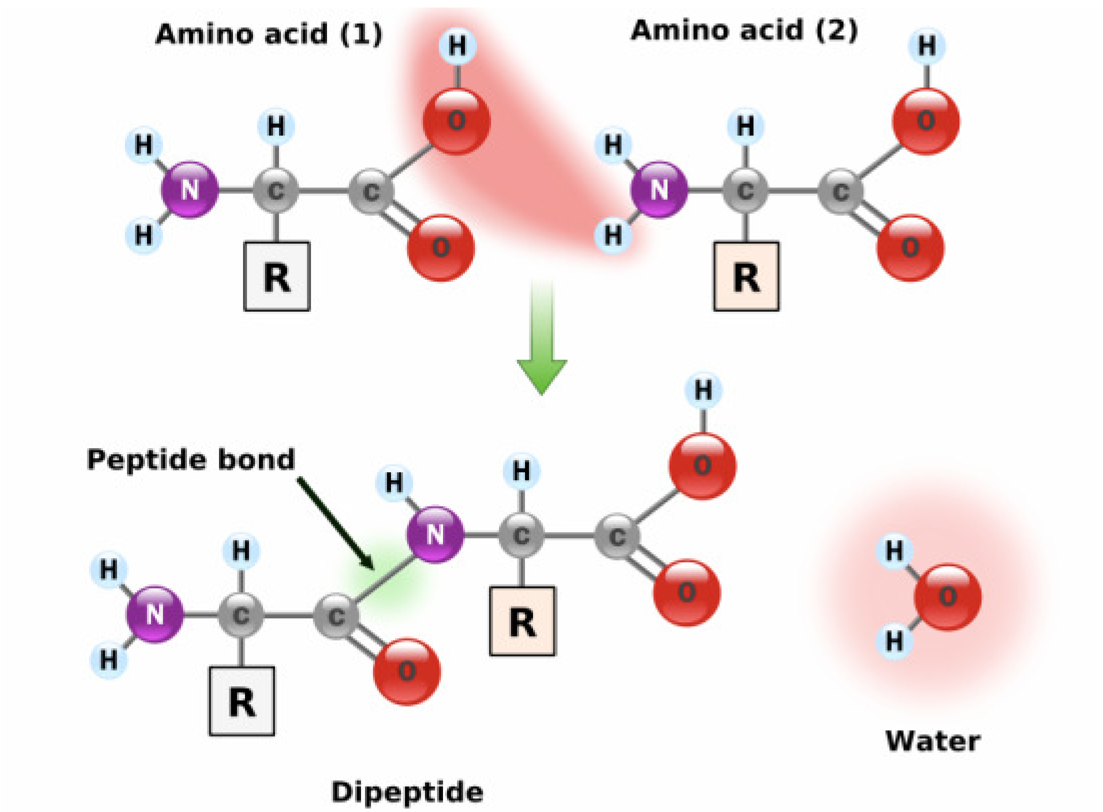
Basic Structures and Mechanisms

The basic structures of biochemistry are *biomolecules, which* are molecules created by living organisms. There are four main categories of biomolecules:

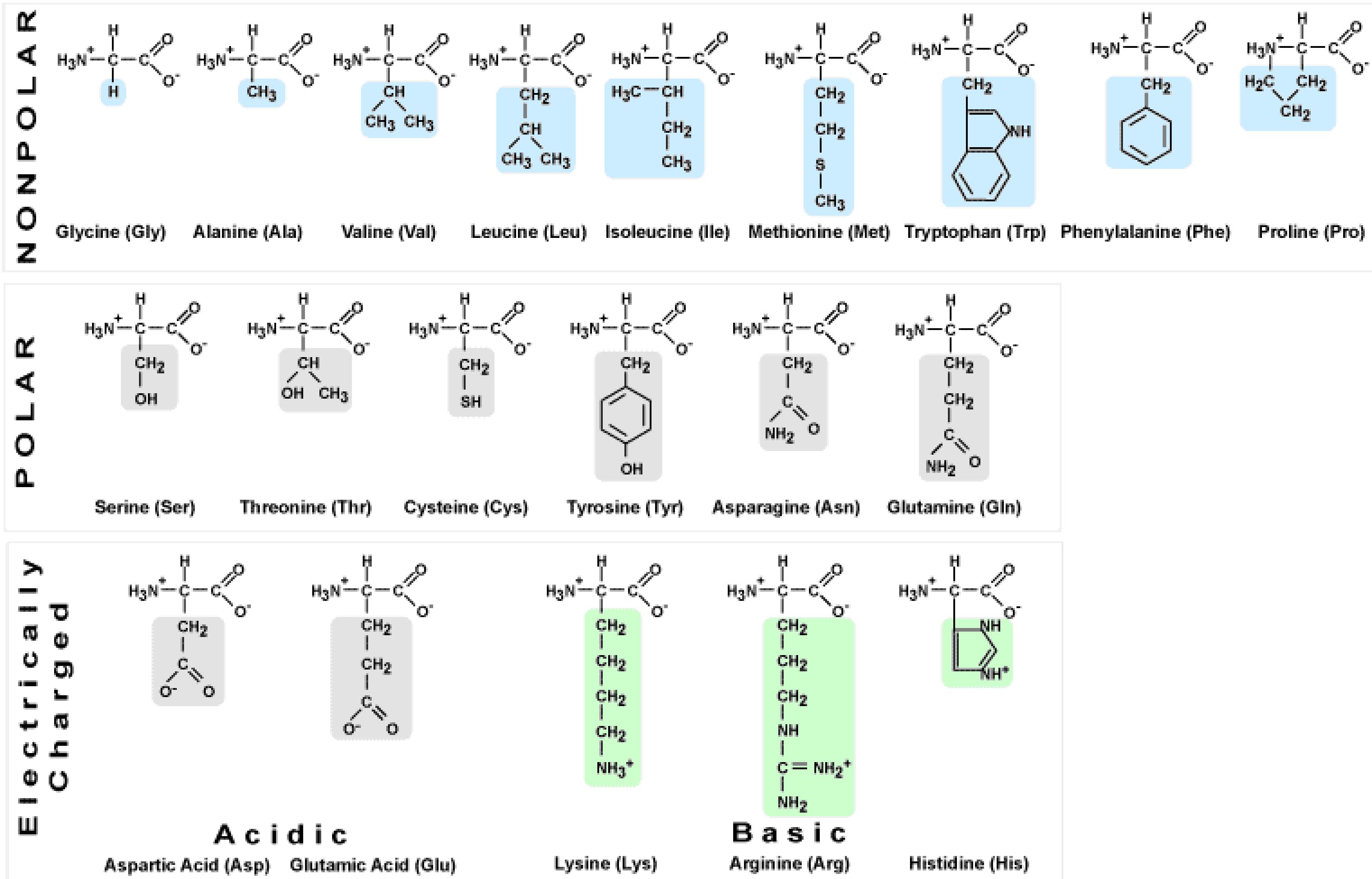
1) Proteins
2) Carbohydrates
3) Lipids
4) Nucleic Acids

Proteins

- Proteins are macromolecules made up of amino acids. Amino acids: consist of an amino group, a carboxyl group, a hydrogen atom and a distinctive R group bonded to a carbon atom.

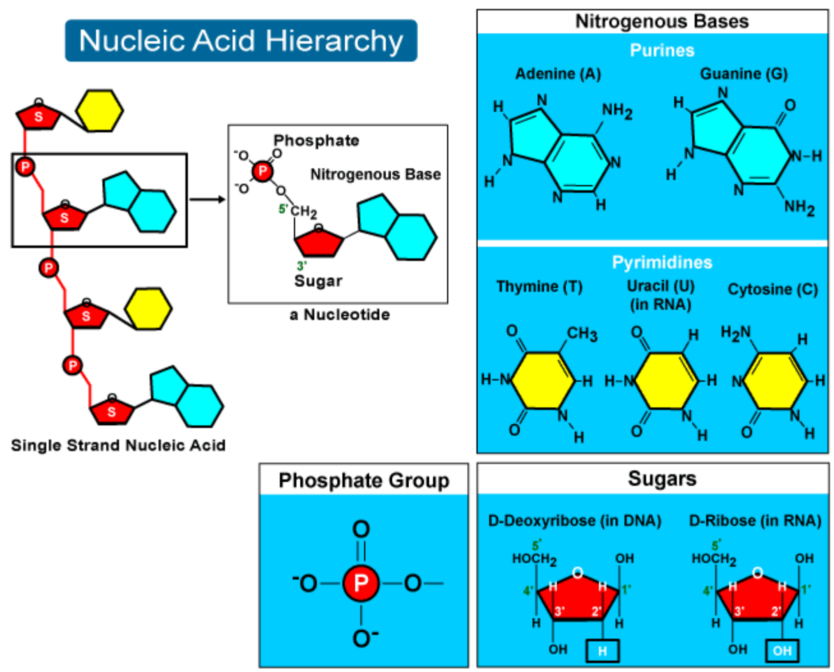


There are twenty different types of side chains (20 amino acids).



- **NUCLEIC ACIDS**

  DNA and RNA are used to direct the activity of cells. Cells look and function a certain way because of directions contained in the DNA. They have 3 Parts: a **Carbohydrate** (pentose, a 5 carbon sugar), a single **Base** (one of five possibilities), a **Phosphorous** Here is what they look like all put together.



- Nucleic acids are linked together to form long chains, and DNA is made of ***two parallel*** chains. These parallel chains have a twist to them so DNA is often called a **Double Helix** making the DNA molecules.

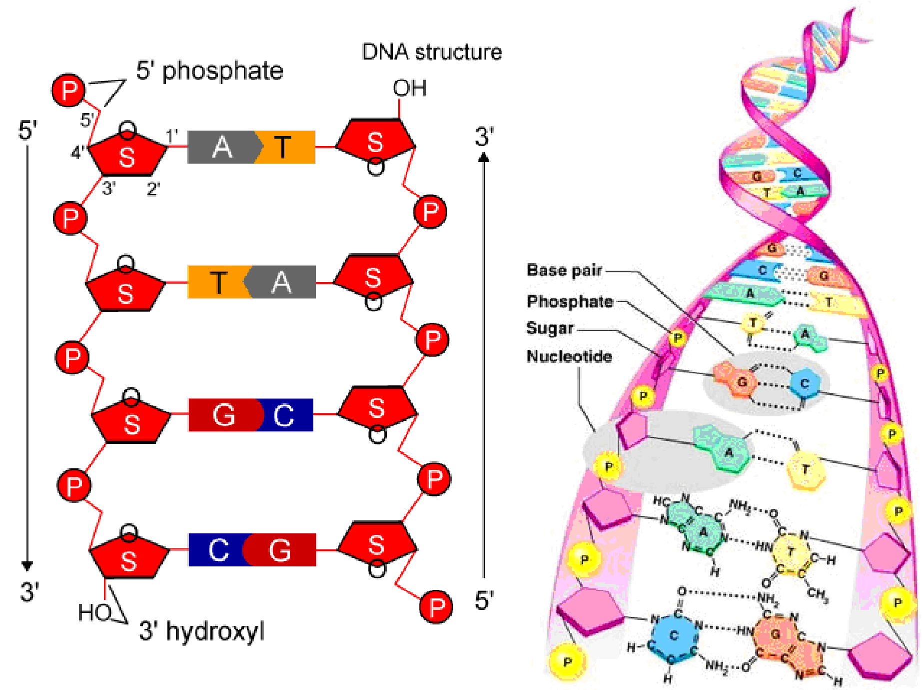


Fig. 8.7 DNA structure and the formation of the double Helix.

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أحصل على نسختك من كتاب
University Chemistry
من مكتبة خوارزم