ORGANIC CHEMISTRY – I

UNIT 1 NOTES

- CLASSIFICATION OF ORGANIC COMPOUNDS
- IUPAC NOMENCLATURE
- STRUCTURAL ISOMERISM

Rx Pharma Education

ORGANIC CHEMISTRY

Hydrocarbons : Those covalent compound which contain Carbon & Hydrogen are called Hydrocarbons.

Organic Compounds : Hydrocarbons and their derivatives are called Organic compounds.
Main Elements : C, H, O, N, X (Halogens)

Organic Chemistry : Study of Organic compounds is known as Organic Chemistry.

Special Properties of Carbon

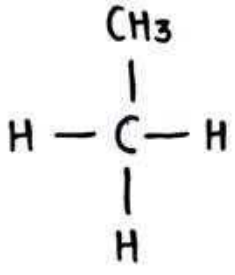
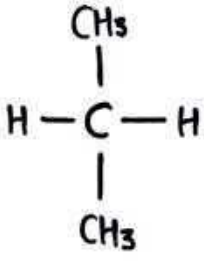
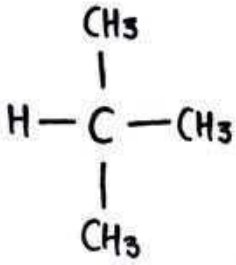
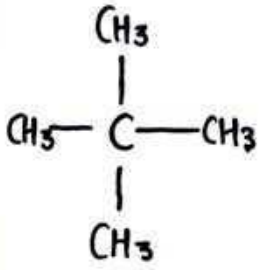
The two major properties of carbon due to which it is needed to study separately are :
① Tetravalency
② Catenation (Self Linking)

Elements	C	H	O	N	X
L·D·S·					
Valency	4	1	2	3	1
Structure					

DEGREE OF CARBON

According to the number of carbons, a carbon is directly attached with, it can be classified into 4 categories :

① Primary Carbon (1°)
② Secondary Carbon (2°)
③ Tertiary Carbon (3°)
④ Quaternary Carbon (4°)

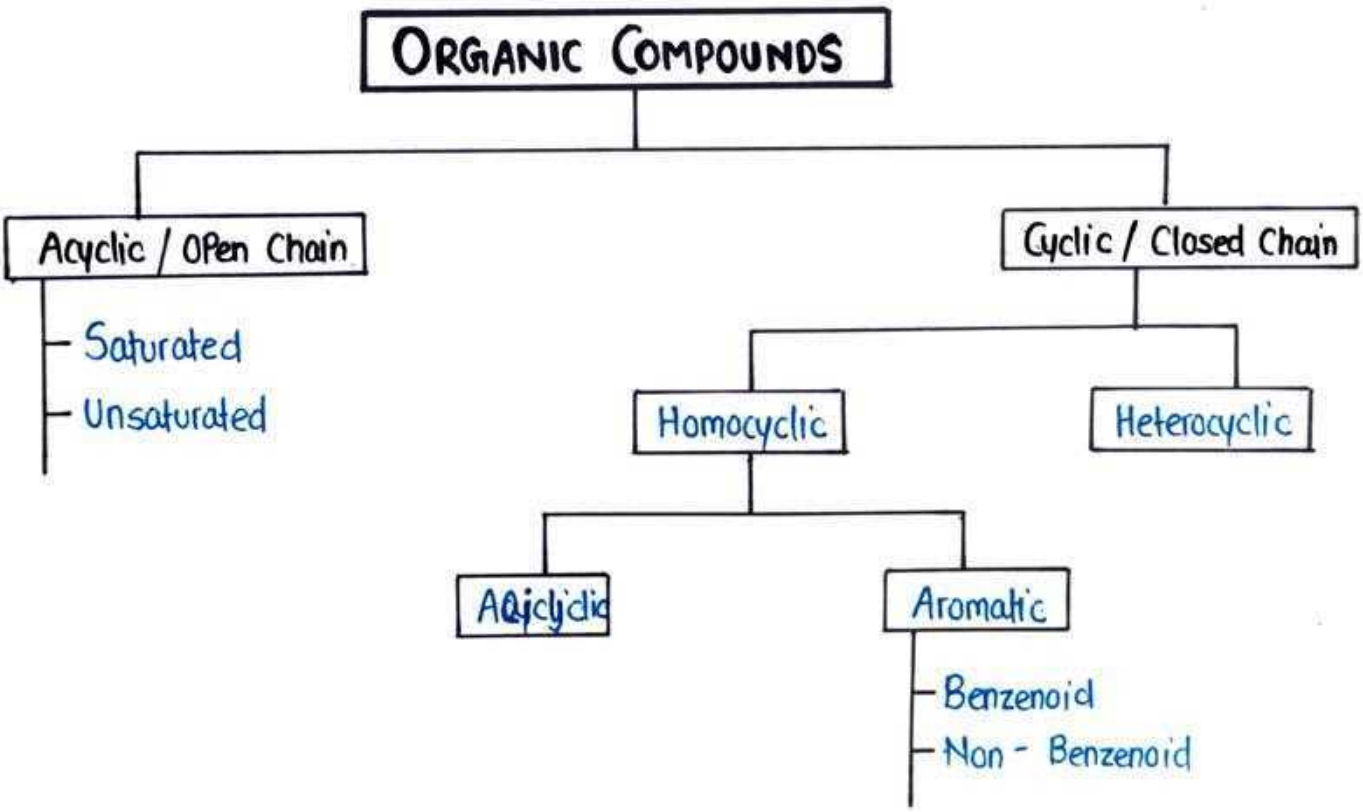
			
PRIMARY	SECONDARY	TERTIARY	QUATERNARY

ORGANIC COMPOUNDS

Compounds containing Hydrocarbons and their derivatives are known as Organic Compounds.

Example : CH_4, C_2H_6, CH_3COOH etc.

Classification of Organic Compounds



Acyclic / Open Chain Compounds

- In these compounds carbon atoms are present in the form of open chain.
- In these compounds, the terminal carbon atoms are completely free they are not linked with each other.
- Initially, they were known as **Aliphatic Compounds** because they were derived from either animal or vegetable fats.

Types of Acyclic Compounds

They are of two types :

① Straight Chain Compounds
② Branched Chain Compounds

Straight Chain Compounds

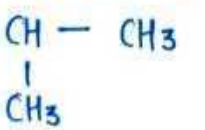
Hydrocarbons is in the form of straight chain.

example : $CH_3 - CH_2 - CH_3$ (n- propane)

Branched Chain Compounds

Hydrocarbons is in the form of branched chain.

example :



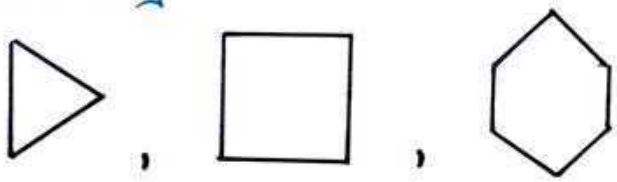
(2 methyl - propane)

Classification on the basis of =/≡ bonds

① Saturated Compounds (only — bond)
② Unsaturated Compounds (=/≡ bond)

Cyclic / Closed Chain Compounds

- These compounds contain one or more closed chains or rings of atoms in their molecules.
- In cyclic compounds terminal carbon atoms are linked with each other and form a closed ring.
- example :



Classification of Cyclic Compounds

They are further classified into two types :

① Homocyclic Compounds
② Heterocyclic Compounds

Homocyclic Compounds

- The rings in these compounds are entirely made up of carbon atoms.
- There is no other atom is present in the closed chain.
- They can be further divided into two sub-categories :

(1) Alicyclic Compounds
(2) Aromatic Compounds

Alicyclic Compounds

These are carbocyclic compounds which resembles properties of Aliphatic compounds. Example : Cyclopropane , Cyclobutane. etc.

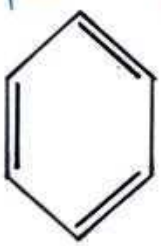
Aromatic Compounds

- These are the carbocyclic compounds which contain alternate single and double bonds between the carbon atoms.
- The word 'Aromatic' is derived from greek word 'Aroma' which means smell (because most of aromatic compounds have a pleasant smell)
- They can be further divided into two sub-types :

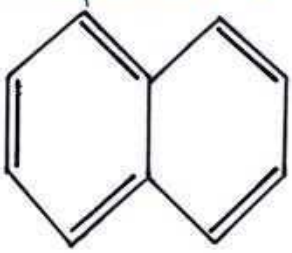
① Benzenoid Aromatic Compounds.
② Non-benzenoid Aromatic Compounds

Benzenoid Aromatic Compounds

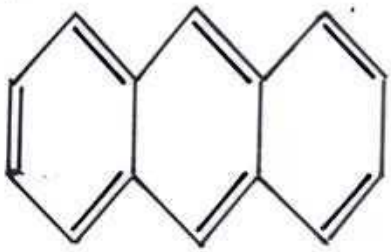
These compounds contain one or more fused benzene rings :
Example : Benzene, Napthalene, Anthracene etc.



Benzene



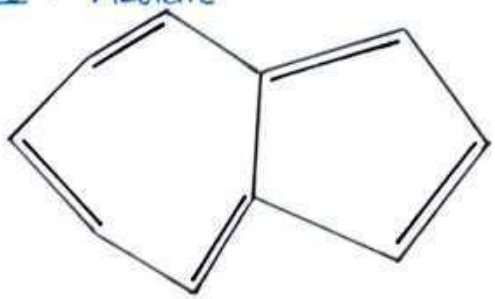
Napthalene



Anthracene

Non-Benzenoid Aromatic Compounds

Aromatic compounds that contain other highly unsaturated rings in place of benzene are called Non benzenoid Aromatic compounds.
example : Azulene

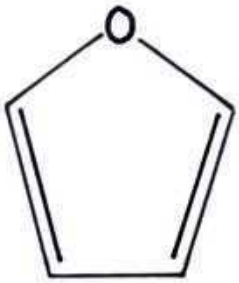


Azulene

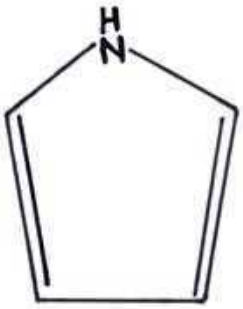
Heterocyclic Compounds

When one or more heteroatoms such as Oxygen, Nitrogen, Sulpher etc. also present in hydrocarbon rings, then such compounds are known as Heterocyclic compounds.

example: Furan, Pyrrole etc.



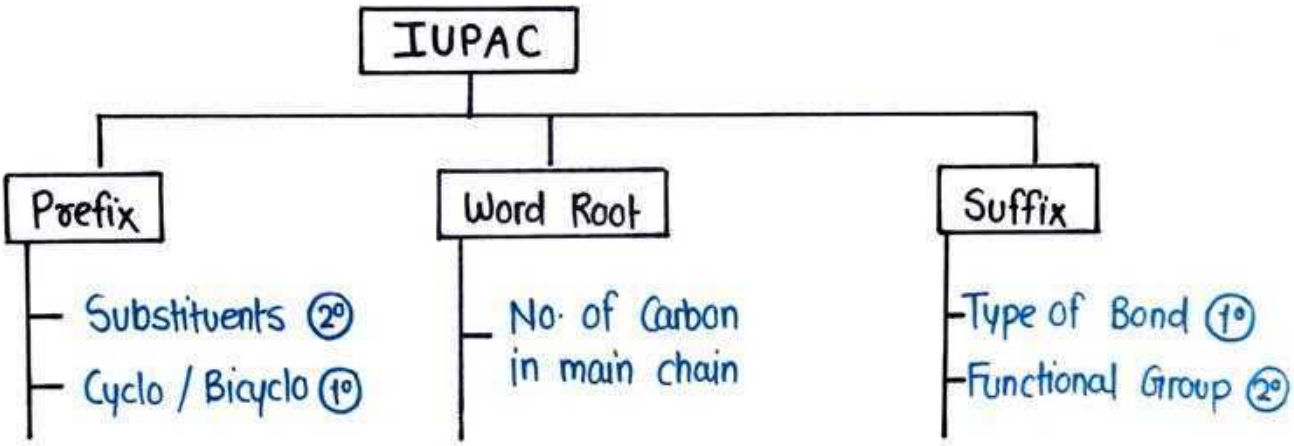
Furan



Pyrrole

IUPAC

- The word IUPAC stands for International Union of Pure and Applied Chemistry.
- The purpose of IUPAC system of nomenclature is to establish an international standard of naming compounds to facilitate communication.



IUPAC : 2° Prefix + 1° Prefix + Word Root + 1° Suffix + 2° Suffix

Note : Here 1° = Primary & 2° = Secondary

SUBSTITUENTS

- $-CH_3$: Methyl
- $-C_2H_5$: Ethyl
- $-C_3H_7$: Propyl
- $-Br$: Bromo
- $-Cl$: Chloro
- $-F$: Fluoro
- $-NO_2$: Nitro
- $-I$: Iodo

TYPES OF BOND

- (—) Bond : ane
- (=) Bond : ene
- (≡) Bond : yne

WORD ROOT

- 1 Carbon : Meth
- 2 Carbon : Eth
- 3 Carbon : Prop
- 4 Carbon : But
- 5 Carbon : Pent
- 6 Carbon : Hex
- 7 Carbon : Hept
- 8 Carbon : Oct
- 9 Carbon : Non
- 10 Carbon : Dec

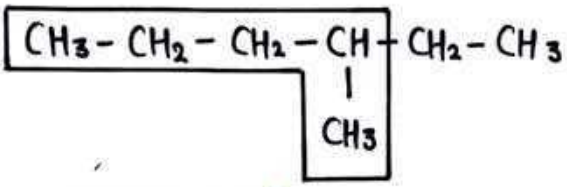
FUNCTIONAL GROUPS

- -OH : Alcohol (ol)
- -CHO : Aldehyde (al)
- $-R-\overset{\overset{O}{\|}}{C}-R_1$: ketone (one)
- -COOH : Carboxylic acid (oic acid)
- $R-\overset{\overset{O}{\|}}{C}-OR_1$: ~~Alkyl Alk~~ Ester (Alkyl Alkanoate)
- R-O-R' Ether (Alkoxy Alkane)

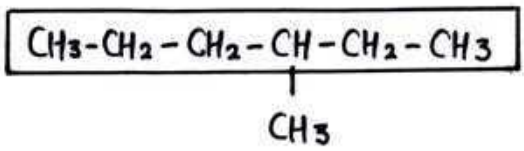
Rules For Iupac Nomenclature

① Longest Chain Rule

- Select the longest C-C chain (May or may not be straight)

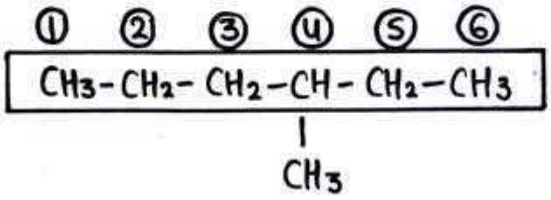


Wrong (X)

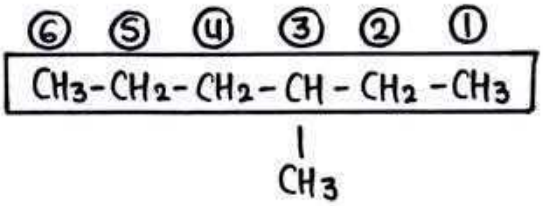


Right (✓)

- Numbering from that side, so that branch (substituents) gets lowest locant

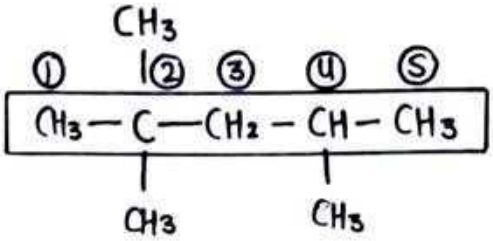


Wrong (X)

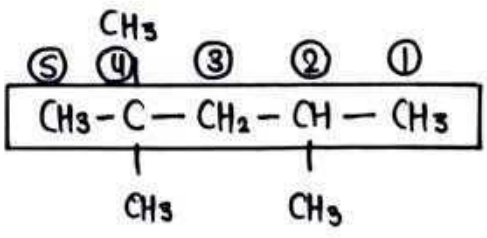


Right (✓)

- When more than 1 branch is present then follow 'lowest sum rule' or 'First Point Of Difference'



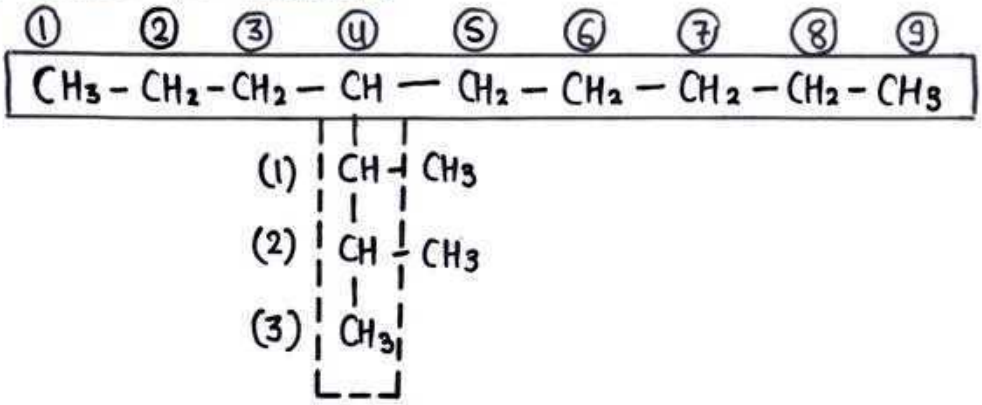
Right [2,2,4]



Wrong [2,4,4]

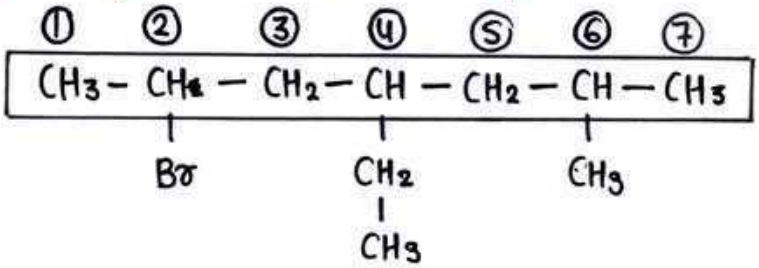
② Naming of Complex Substituents

- While naming of complex substituents, Give 1st no to directly attached carbon from main chain, then follow IUPAC for substituents (Name written in Bracket)



4 (1,2 dimethyl Propyl) Nonane

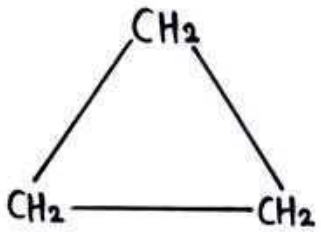
- Naming always done alphabetically



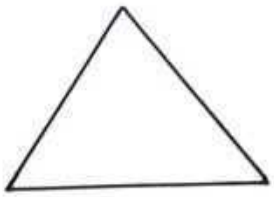
2- Bromo - 4- ethyl - 6- methyl Heptane

③ Naming of Cycloalkanes

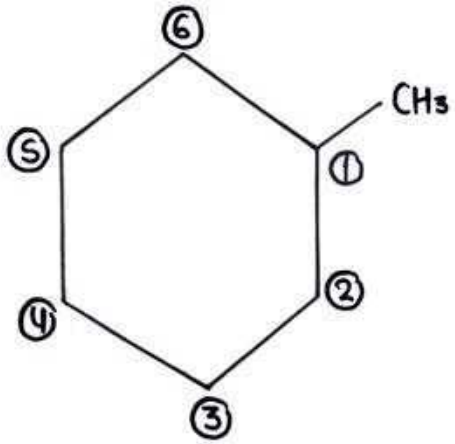
- While naming of carbocyclic compounds, we have to add the prefix 'Cyclo' before the main chain.



or

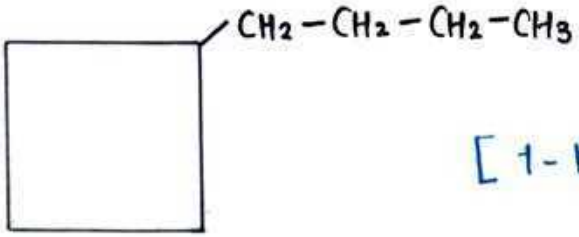


[Cyclopropane]



[1-methyl- Cyclohexane]

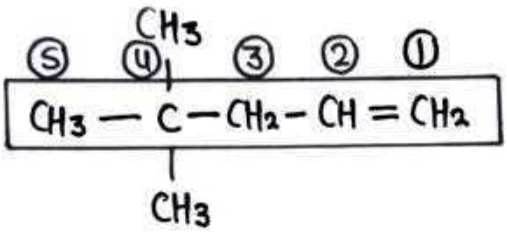
- If ring and chain both have same number of carbons then For main chain Ring > Chain



[1- butyl - Cyclobutane]

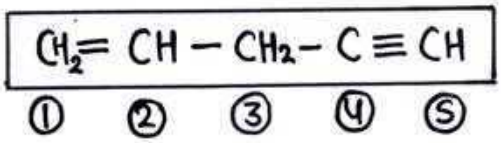
④ Naming of Unsaturated Hydrocarbons (Alkene & Alkyne)

- Select longest C-C chain with maximum number of =/≡ bonds
- Numbering in such a way that =/≡ bond gets lowest locant.
- =/≡ > Substituents



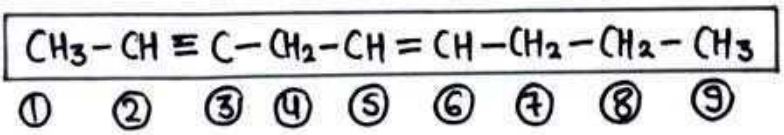
[4,4-dimethyl-pent-1-ene]

- Normally both = and ≡ bond have same priority, but in case of tie = > ≡



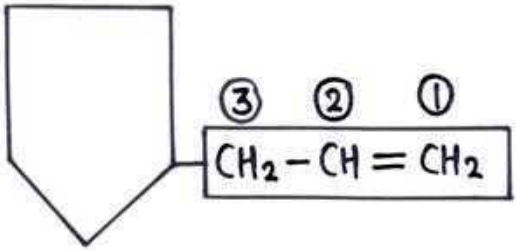
[Pent-1-en-4yne]

- While naming if a, e, i, o, u, y comes after one another then previous one deleted



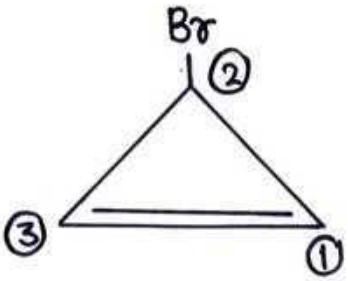
Non-5-en-2-yne → [Non-5-ene-2yne]

- If both ring and chain present simultaneously, select one with maximum =/≡ bonds (irrespective of no. of carbons)

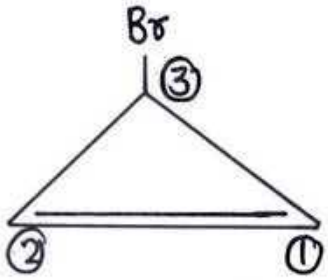


[3- Cyclopentyl - Prop-1-ene]

- In cycloalkenes and cycloalkynes both ≠ 1st and 2nd position is obtained by =/≡ bonds.



Wrong (X)

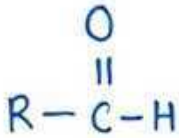
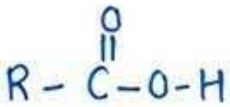
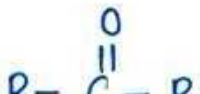
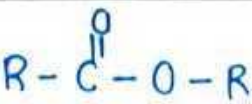


Right (✓) [3-Bromo-Cycloprop-1-en

⑤ Naming of Functional Group

Functional groups are the atoms or group of atoms which gives all properties to a compound.

Some Commonly Used Functional Group in IUPAC Nomenclature

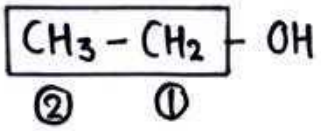
Functional Group	Structure	Secondary Suffix
• Alcohol	R – O – H	'ol'
• Aldehyde		'al'
• Carboxylic Acid		'oic acid'
• Amine	$R - NH_2$	'amine'
• Ketone		'one'
• Ether	R – O – R'	'Alkoxy Alkane'
• Ester		'Alkyl Alkanoate'

Biggest and Final Rule For IUPAC Naming

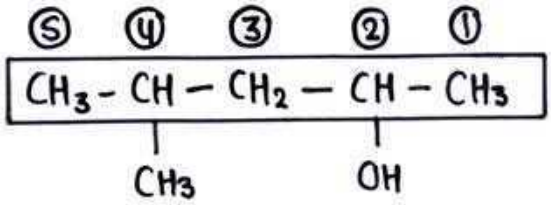
- Select longest C-C Chain containing functional group
- Numbering from that side so that functional group lowest locant
- Functional Group > =/≡ > Substituents.

ALCOHOLS

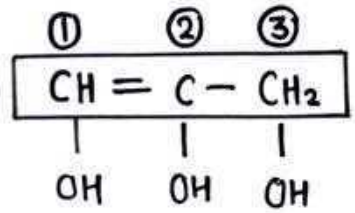
For functional group 'Alcohol' we use secondary suffix **'ol'**

- 

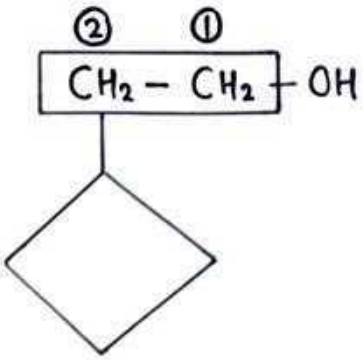
[Ethan-1-ol] or [Ethanol]

- 

[-4-methyl- Petan-2-ol]

- 

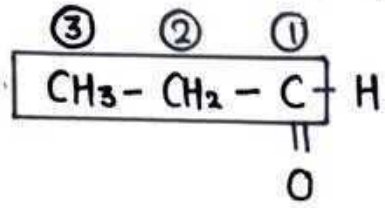
[~~Prop~~ - ~~1~~ - ~~en~~ Prop-1-ene-1,2,3 triol]

- 

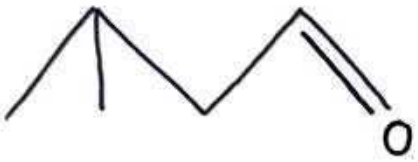
[-2-cyclobutyl- Ethan-1-ol]

ALDEHYDE

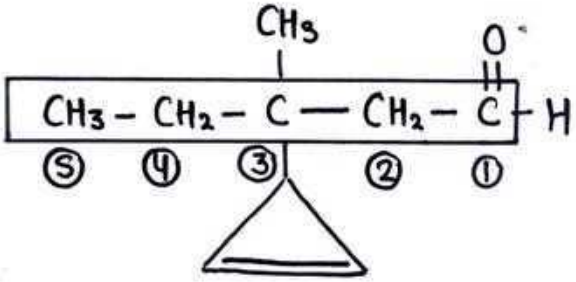
For functional group aldehyde, we use secondary suffix 'al'

- 

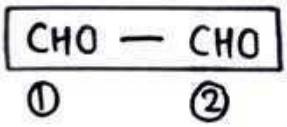
[Propan-1-al] or [Propanal]

- 

[3-methyl-Butan-1-al]

- 

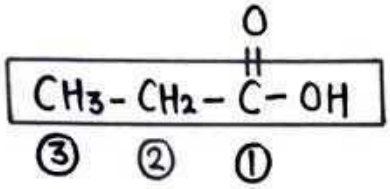
[3-Cycloprop-2enyl, 3-methyl pentan-1-al]

- 

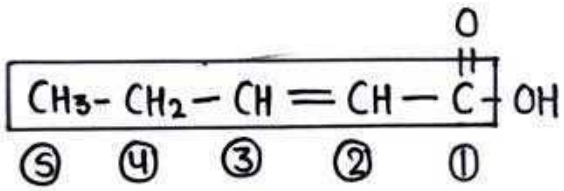
[Ethane-1,2 dial]

CARBOXYLIC ACID

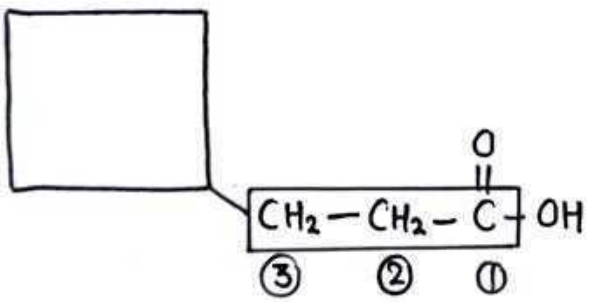
- Carboxylic acid is also can be known as king of all the functional groups.
- For functional group 'Carboxylic acid', we use secondary suffix 'oic acid'

- 

[Propane-1-oic acid] or [Propanoic Acid]

- 

[Pent-2-en-1-oic acid]

- 

[3-cyclobutyl-propan-1-oic acid]

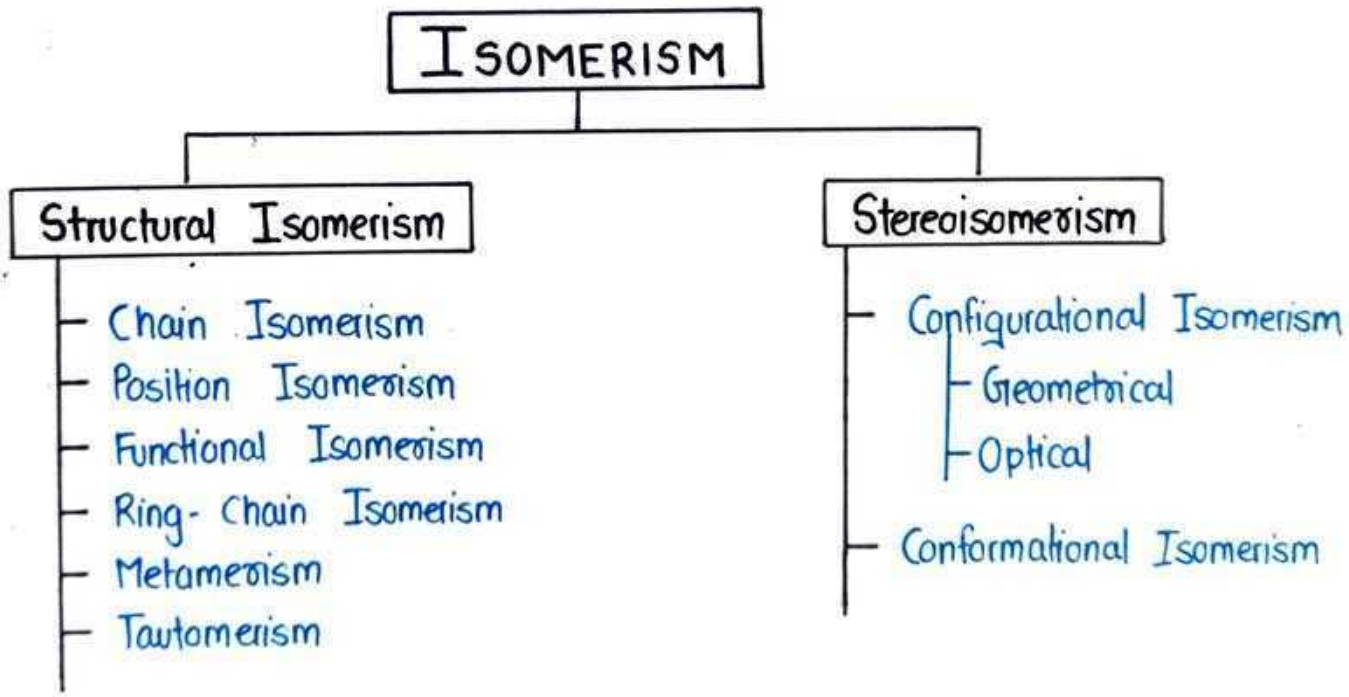
ISOMERISM

The organic compounds having the same molecular formula but having different structural formula or we can say having different physical and chemical properties are called **Isomers** and the phenomenon is known as **Isomerism**.

Classification of Isomerism

Isomerism are classified into two categories :

- Structural Isomerism
- Stereoisomerism



Chain Isomerism

When the compounds having same molecular formula but they have different principle carbon chain then this type of isomerism is known as Chain Isomerism.

$CH_3 - CH_2 - CH_2 - CH_3$ (Butane)	$CH_3 - CH(CH_3) - CH_3$ (2-methyl-propane)

Position Isomerism

When the compounds having same molecular formula ~~but they~~ and same principle carbon chain but they have different positions of substituents, $=/\equiv$ bond or functional group, then this type of isomerism is known as Position Isomerism.

$CH_2 = CH - CH_2 - CH_3$ (But-1-ene)	$CH_3 - CH = CH - CH_3$ (But-2-ene)

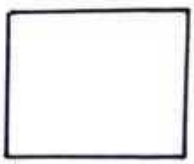
Functional Isomerism

When the compounds having the same molecular formula but they contains different functional group, then this type of isomerism is known as Functional Isomerism.

$CH_3 - CH_2 - OH$ (ethanol)	$CH_3 - O - CH_3$ (dimethyl ether)

Ring Chain Isomerism

When the compounds having the same molecular formula but they have different mode of linkage of carbon atoms (means one is in open chain and other is in closed chain) then this type of isomerism is known as Ring chain isomerism.

$CH_3 - CH_2 - CH_2 - CH_3$ (Butane)	 (Cyclobutane)

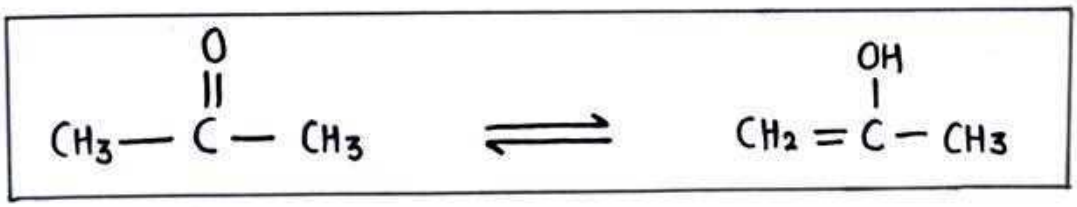
Metamerism

When the compounds having the same molecular formula and same functional group but they have different arrangment of carbon atoms on both side of functional group, then this type of isomerism is known as Metamerism.

$CH_3-CH_2-O-CH_2-CH_3$ (Diethyl ether)	$CH_3-O-CH_2-CH_2-CH_3$ (Methyl propyl ether)

Tautomerism

When two compounds having the same molecular formula exist in two interconvertible different structures (dynamic equillibrium) then this type of isomerism is known as Tautomerism.



keto Form ⇌ Enol Form