Organic Chemistry Some Basic Principles and Techniques Chemistry

Organic Chemistry

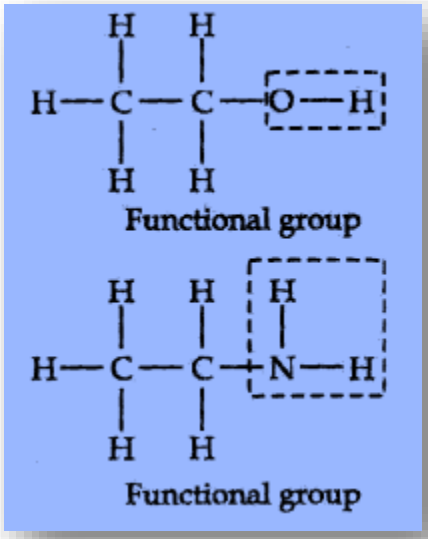
Organic chemistry is the branch of chemistry that deals with the study of hydrocarbons and their derivatives.

The Shapes of Carbon Compounds:

In organic or carbon compounds, s and p orbitals are involved in hybridisation. This leads to three types of hybridisation which are sp^3(in alkanes) – Tetrahedral in shape sp^2(in alkenes) – Planar structure sp(in alkynes) – Linear molecule

Functional Group: The functional group are atom or group of atoms joined in a specific manner which determines the chemical properties of the organic compound. The examples are hydroxyl group (—OH), aldehyde group (—CHO) and carboxylic acid group (—COOH) etc.

Organic compounds = Alkyl group + Functional group



• Homologous Series

A homologous series may be defined as a family of organic compounds having the same functional group, similar chemical properties and the successive members differ from each other in molecular formula by —CH2 units.

The members of a homologous series can be represented by same general molecular

formula.

• Nomenclature of Organic Compounds

Common name (Common system): Before the IUPAC system of nomenclature, organic compounds were named after the sources of origin, for example, urea was so named because it was obtained from the urine of mammals. Formic acid was so named since it was extracted from red ants called formica.

Compound	Common name
CH_4	Methane
$H_3CCH_2CH_2CH_3$	*n*-Butane
$(H_3C)_2CHCH_3$	Isobutane
$(H_3C)_4C$	Neopentane
$H_3CCH_2CH_2OH$	*n*-Proply alcohol
HCHO	Formaldehyde
$(H_3C)_2CO$	Acetone
$CHCl_3$	Choloroform
CH_3COOH	Acetic acid
C_6H_6	Benzene
$C_6H_5OCH_3$	Anisole
$C_6H_5NH_2$	Aniline
$C_6H_5COCH_3$	Acetophenone
$CH_3OCH_2CH_3$	Ethyl methyl ether

• IUPAC (International Union of Pure and Applied Chemistry) System

According to IUPAC system, the name of an organic compound contains three parts: (i) word root, (ii) suffix, (iii) prefix.

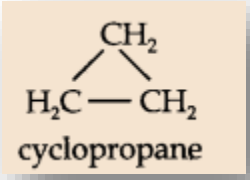
(i) Word root: Word root represents the number of carbon atoms present in the principal chain, which is the longest possible chain of carbon atoms.

For special word roots		for
meth	——	C_1
eth	——	C_2
Prop	——	C_3
but	——	C_4

(ii) Suffix: Suffix are of two types, primary suffix, secondary suffix.
(a) Primary Suffix: It indicates the type of bond in the carbon atoms.

For example: Primary suffix ane for C–C bond
ene for C=C bond
yne for C≡C bond

(b) Secondary Suffix: Secondary suffix is used to represent the functional group.
(iii) Prefix: Prefix is a part of IUPAC name which appears before the word root. Prefix are of two types:
(a) Primary prefix: For example, primary prefix cyclo is used to differentiate cyclic compounds.



cyclopropane

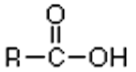
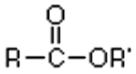
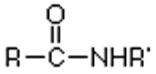
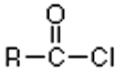
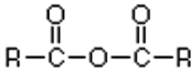
(b) Secondary prefix: Some functional groups are considered as substituents and denoted by secondary prefixes.
For example:

Substituted Group	Secondary prefix.
— F	Fluoro
— Cl	Chloro
— Br	Bromo
— NO	Nitroso
— NO_2	Nitro
— CH_3	Methyl
— OCH_3	Methoxy

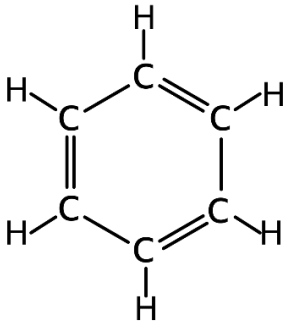
Naming of Compounds Containing Functional Groups: The longest chain of carbon atoms containing the functional group is numbered in such a manner that the functional group is attached at the carbon atoms possessing lowest possible number in the chain. In case of polyfunctional compounds, one of the functional group is selected as principal functional group and the compound is named on that basis. The choice of principal functional group is made on the basis of order of preference.
The order of decreasing priority for the functional group is

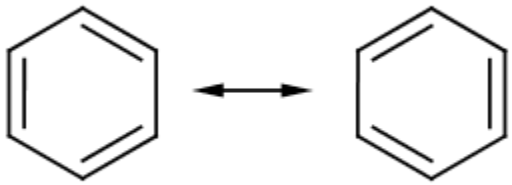
Functional grp	Symbol	Prefix	Suffix	IUPAC
Alcohol	-OH R-OH	Hydroxy	ol	Alkanol
Aldehyde	-CHO H-CHO or R-CHO	Formyl	al	Alkanal
Carboxylic acid	-COOH H-COOH or R-COOH	Carboxy	oic	Alkanoic acid
Derivatives of acids Acyl halide	-COX H-COX or R-COX X – halide	Haloformyl or Halocarbonyl	oyl	Alkanoyl halide
Amides	-$CONH_2$ H-$CONH_2$ or R-$CONH_2$	Carbamoyl	amide	Alkanamide
Esters	-COOR’			Alkyl alkanoate

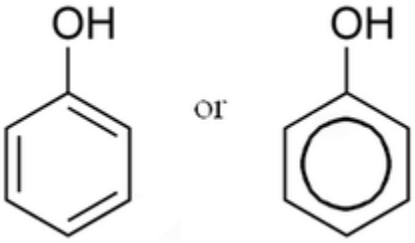
	R-COOR’	Alkoxy carbonyl	oate	
Acid anhydride	-$(COO)_2O$		oic	Alkanoic Anhydride
Ketones	-C=O | R-C=O | R	Keto or Oxo	one	Alkanone
Ether	R-O-R’	Alkoxy	----	Alkoxy alkane
Amines	-NH_2 R-NH_2	Amino	amine	Alkanamine
Cyanide or Nitrile	-CN R-CN	Cyano	nitrile	Alkane nitrile
Isocyanide	-NC R-NC	Isocyano	Isonitrile or Isocyanide or Carbylamine	Alkyl isonitrile or Alkyl isocyanide or Alkyl carbylamine
Nitro	-NO_2	Nitro	------	Nitroalkane
Halide	-X R-X	Halo	-------	Haloalkane
Thioalcohol	-SH	Mercapto	Thiol	Alkane thiol

Name	Structure	Found or Used In:
Carboxylic Acid		Vinegar, Cream of Tartar
Ester		Fats, Cell Membranes
Amide		Nylon, Proteins
Acyl Chloride		Synthesis of Carboxyl Derivatives
Acid Anhydride		Synthesis of Carboxyl Derivatives

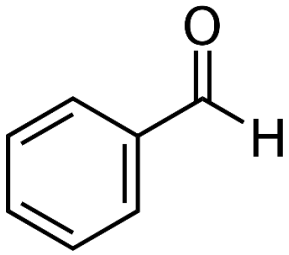
Structure of Benzene



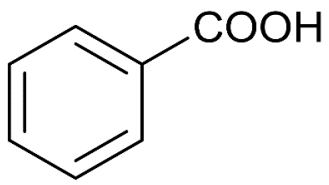




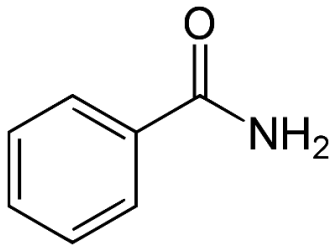
Phenol



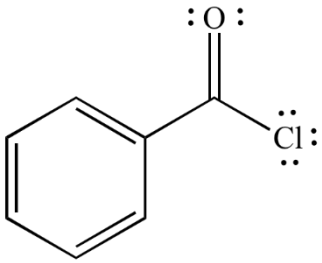
Benzaldehyde



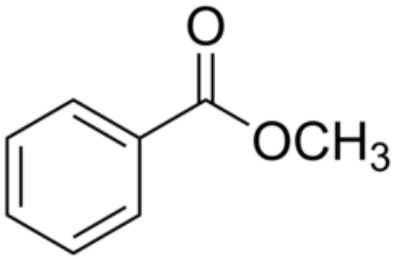
Benzoic Acid



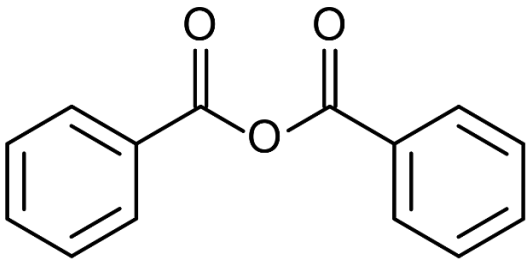
Benzamide



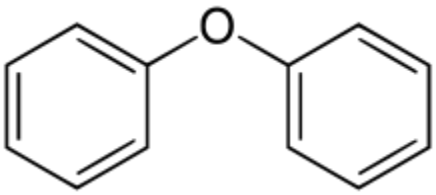
Benzoyl Chloride



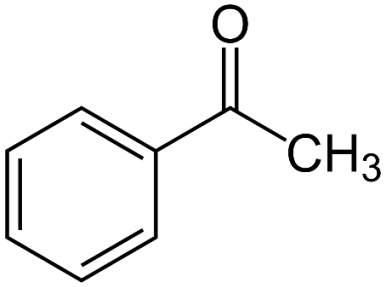
Methyl Benzoate



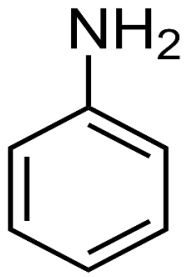
Benzoic anhydride



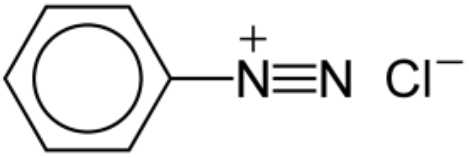
Diphenyl Ether



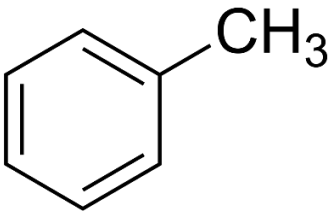
Acetophenone



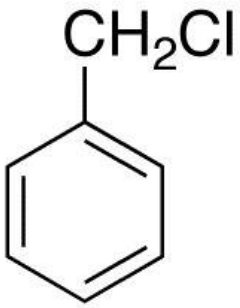
Aniline



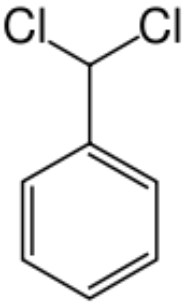
Benzene diazonium chloride



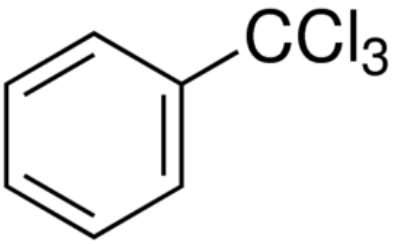
Toluene



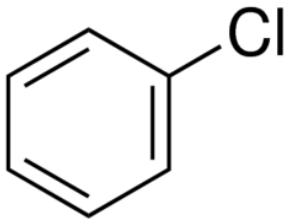
Benzyl Chloride

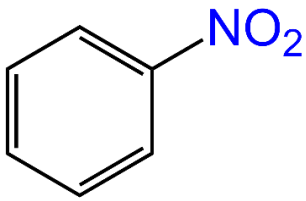


Benzyl Chloride



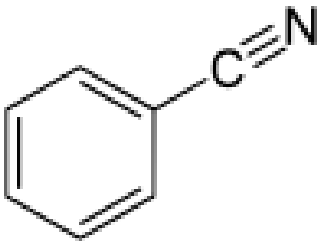
Benzo Chloride





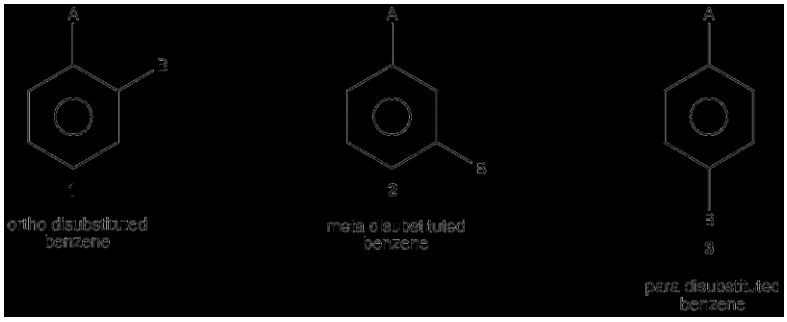
Chlorobenzene

Nitrobenzene



Benzonitrile

Sites of attachments in benzene ring

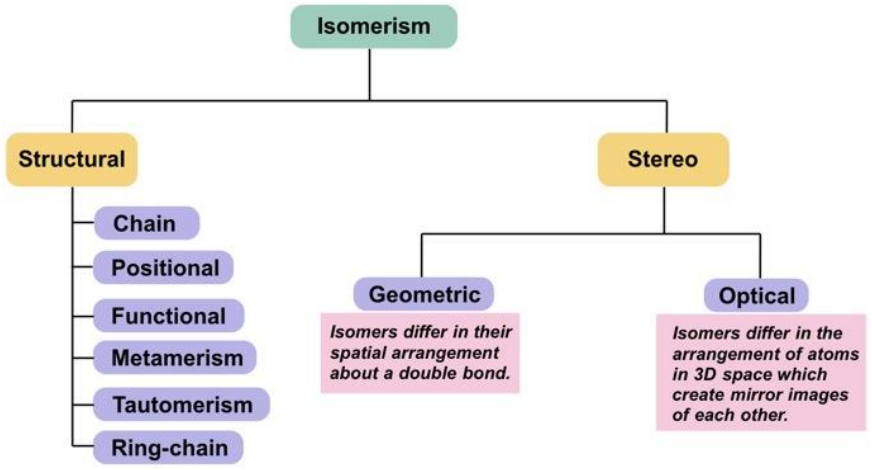


- **Isomerism**

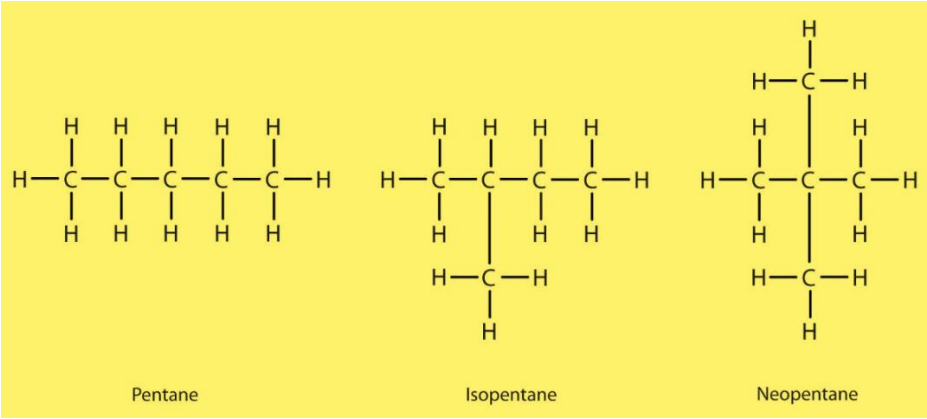
When there are two or more compounds possessing the same molecular formula but different structural formula and different physical and chemical properties, the phenomenon is called isomerism. Such compounds are called isomers.

It is of two types:
(1) Structural Isomerism
(2) Stereoisomerism

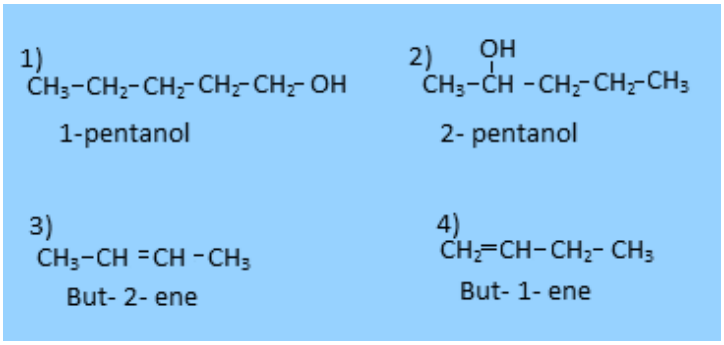
(1) Structural Isomerism: Structural isomerism is shown by compounds having the same molecular formula but different structural formulae differing in the arrangement of atoms.



Example of chain isomerism



Example of position isomerism



Example of functional isomerism

(*i*) C_2H_6O represents two functional isomers.

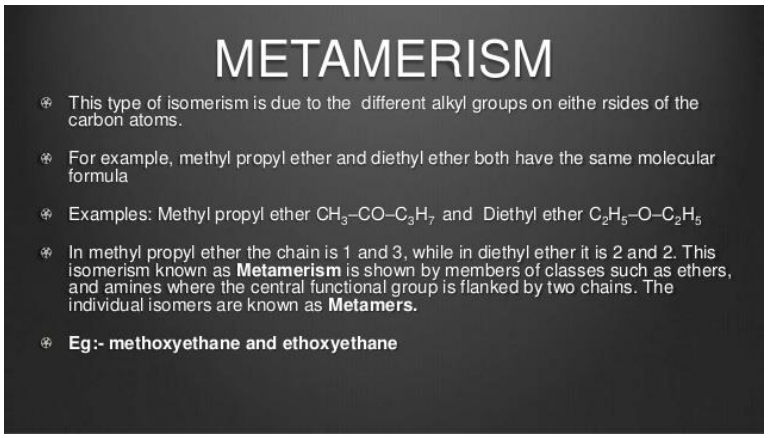
$CH_3 - CH_2OH$ — Ethanol (Ethyl alcohol)

$CH_3 - O - CH_3$ — Methoxymethane (Dimethylether)

(*ii*) C_3H_6O represents two functional isomers.

Propanal — Propanone

Example of metamerism



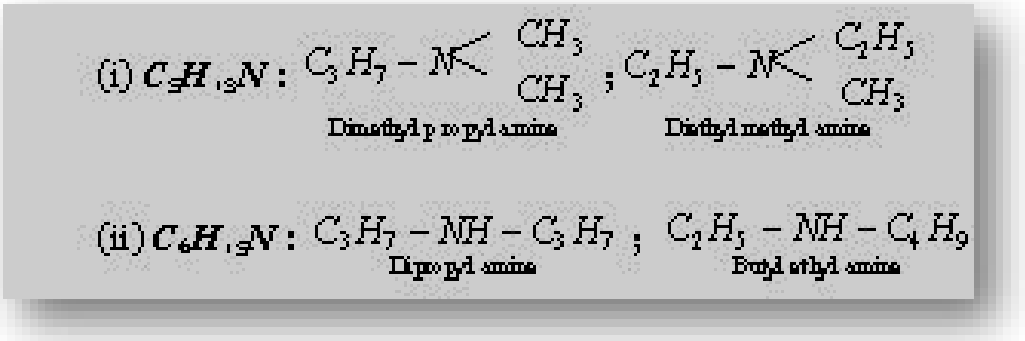
Example of metamerism

$CH_3 - CH_2 - O - CH_2 - CH_3$

Ethoxyethane

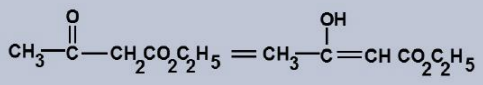
$CH_3 - O - CH_2 - CH_2 - CH_3$

1-Methoxypropane



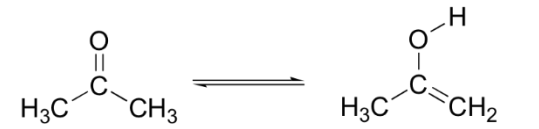
Tautomerism

- This is a special type of functional isomerism in which isomers are in dynamic equilibrium with each other
- For example: ethyl acetoacetate is an equilibrium mixture of 2 forms-93% keto form and 6% enol form



keto form enol form

Examples of tautomerism



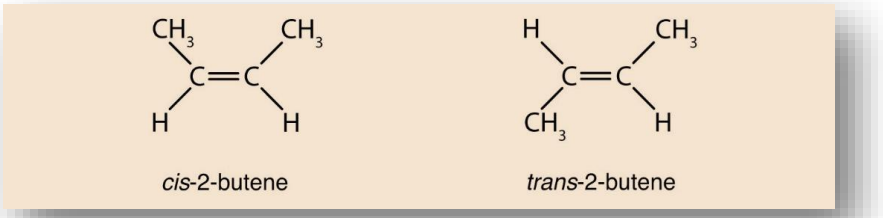
keto form of acetone **enol** form of acetone

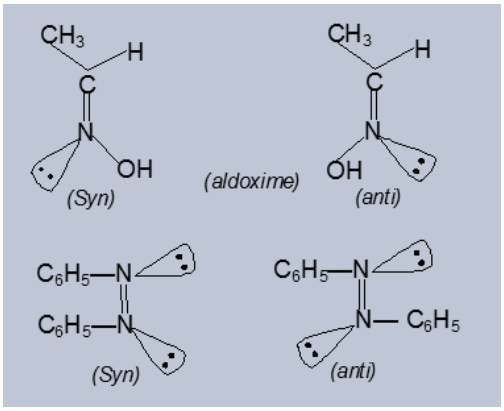
(2) Stereoisomerism: When isomerism is caused by the different arrangements of atoms or groups in space, the phenomenon is called stereoisomerism. The steroeoisomers have same structural formula but differ in arrangement of atoms in space. Stereoisomerism is of two types:

(i) Geometrical or Cis-Trans Isomerism
(ii) Optical Isomerism

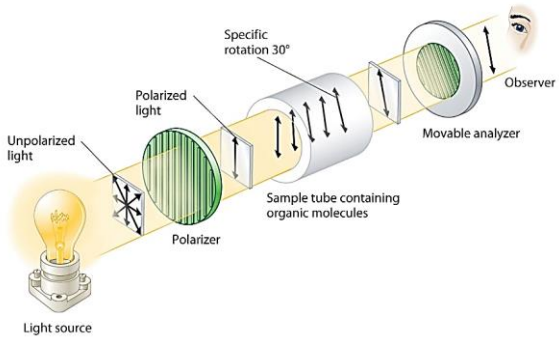
Geometrical isomerism:

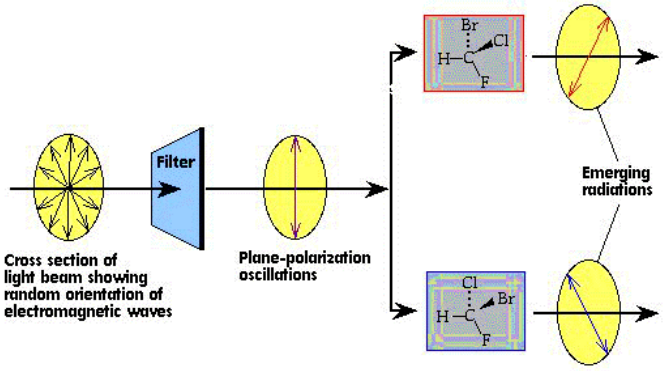
trans-1,2-dichloroethene *cis*-1,2-dichloroethene



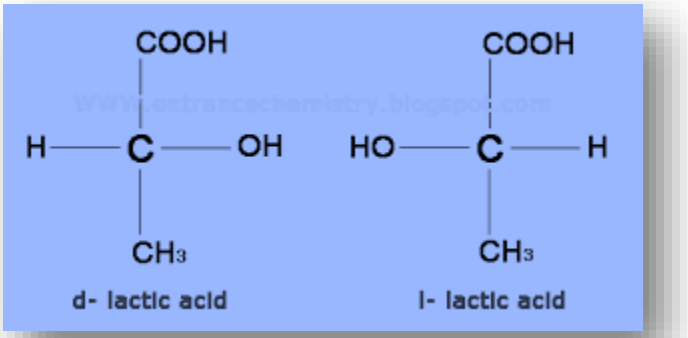


Optical isomerism

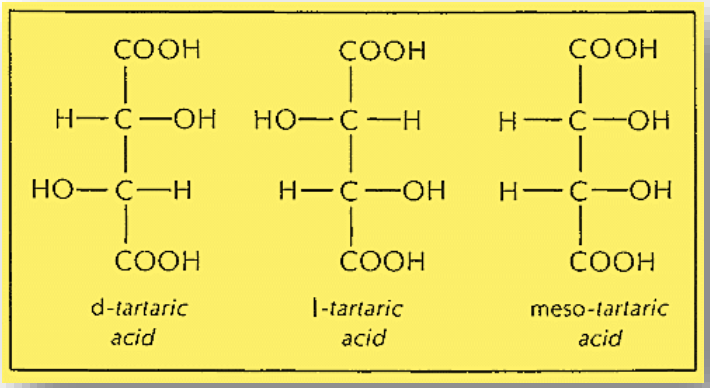


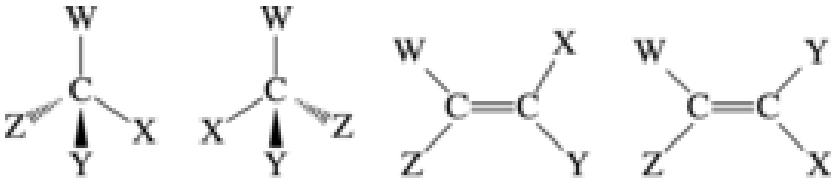


Examples of optical isomerism



Optical isomerism in Tartaric acid





Optical Isomers (Enantiomers)

Geometric Isomers