OPTICAL ISOMERISM

Name of the Faculty: Dr. Diwakar Chauhan

Isomerism

Those molecules which are having same molecular formula but they differ in chemical and physical properties are known as isomers and the phenomenon is known as Isomerism.

Types Of Isomerism

It is of two types-

(i) Structural Isomerism

(ii) Stereo or Space isomerism

(I) **STRUCTURAL ISOMERISM :** The isomers which are having same molecular formula but different structural formula are known as structural isomers and the phenomenon is known as structural isomerism.

(II) **STEREOISOMERISM**

The isomers having same molecular and structural formula but **differ in arrangement of atoms or group of atoms in space** are known as stereoisomers and the phenomenon is called stereoisomerism.

TYPES OF STEREOISOMERISM

It is of two types-

(a) Optical Isomerism (b) Geometrical Isomerism

OPTICAL ISOMERSIM

The isomers having similar chemical and physical properties but differ in their optical activity is known as optical isomers and the phenomenon is called optical isomerism.

VARIOUS TERMS INVOLVED IN OPTICAL ISOMERISM

I. PLANE POLARIZED LIGHT

When an ordinary light (which vibrates in all directions or planes) passed through a Nicole prism then it vibrates only in one plane, then this light is known as plane polarized light.

I. OPTICAL ACTIVITY

"When plane polarized light is passed through the solutions of certain organic compounds they rotate the plane polarized light either to the left or to the right. Substances which rotate the plane polarized light are known as optically active compounds and the phenomenon is known as optical activity."

OPTICAL ISOMERSIM

TYPES OF OPTICAL ACTIVITY

Depending upon the rotation of plane polarized light, optically active compounds are of two types

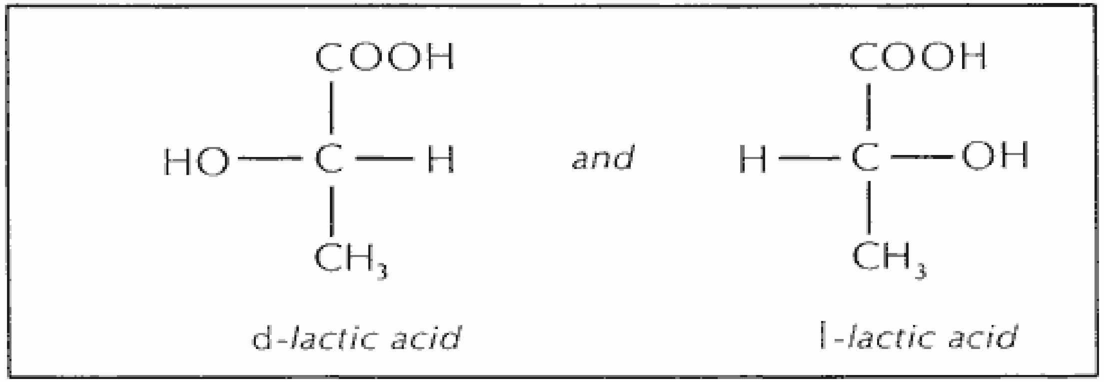
(a) Laevo rotatory (b) Dextro rotatory

(a) LAEVO ROTATORY

"Compounds which rotate the plane polarized light toward the left or in anti-clockwise direction is known as laevo rotatory compounds. It is also denoted by 'l' and (–) sign."

(b) DEXTRO ROTATORY

"Compounds which rotate the plane polarized light towards the right or in clockwise direction are known as dextro rotatory compounds. It is also denoted by 'd' and (+) Sign."

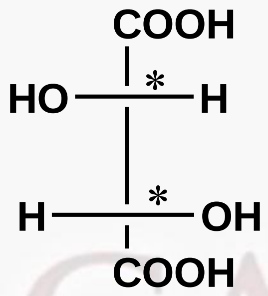


OPTICAL ISOMERSIM

❖ **CHIRALITY**

The compound in which central carbon atom has four different atoms or group of atoms and a non-superimposable mirror image is known as chiral carbon atom or asymmetric carbon atom and this phenomenon is known as chirality. The chiral or asymmetric carbon atom is represented by C*.

FOR EXAMPLE



Tartaric Acid

[‘*’MEANS CHIRAL CARBON ATOM]

OPTICAL ISOMERSIM

- **NUMBER OF OPTICAL ISOMERS**
  - **(A) WHEN COMPOUND HAVING ONE CHIRAL CARBON ATOM**
    Total number of optical isomers = 2^n
  - **(B) WHEN COMPOUND HAVING TWO DIFFERENT CHIRAL CARBON ATOM**
    Total number of optical isomers = 2^n
  - **(C) WHEN COMPOUND HAVING TWO SAME CHIRAL CARBON ATOM**
    Total number of optical isomers = $2^{n-1} + 2^{(n-2)/2}$ or $[2^n - 1]$
  - **(D) WHEN COMPOUND HAVING ODD NUMBER OF CHIRAL CARBON ATOM**
    Total number of optical isomers = $\{2^{n-1} - 2^{(n-1)/2}\} + 2^{(n-1)/2}$
    Where, n= number of chiral carbon atoms

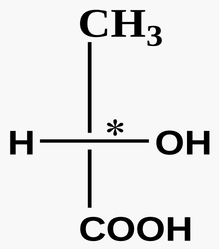
OPTICAL ISOMERSIM

- **Optical Activity Of Compounds Containing One Chiral Carbon Atom Or Centre**

  If an organic compound only have one chiral carbon atom, than number of optical isomers = **$2^n = 2^1 = 2$**.

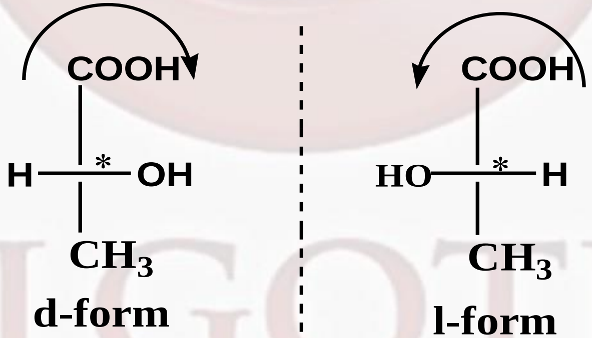
For Example

Lactic acid contains a chiral carbon atom or an asymmetric central carbon atom and it exists in two optical active forms (2^1=2), which are mirror images of each other and are non-superimposable.



Lactic Acid

The stereo forms of Lactic acid–



d-form **l-form**

Mirror

Non Superimposable
Mirror Image of Lactic Acid

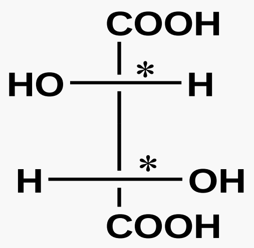
OPTICAL ISOMERSIM

OPTICAL ACTIVITY OF COMPOUNDS CONTAINING TWO CHIRAL CARBON ATOMS OR CENTRE'S

If an organic compound have two chiral carbon atoms and both chiral carbon atoms are same, than number of optical isomers = $\mathbf{2^n – 1 = 2^2 – 1 = 3}$.

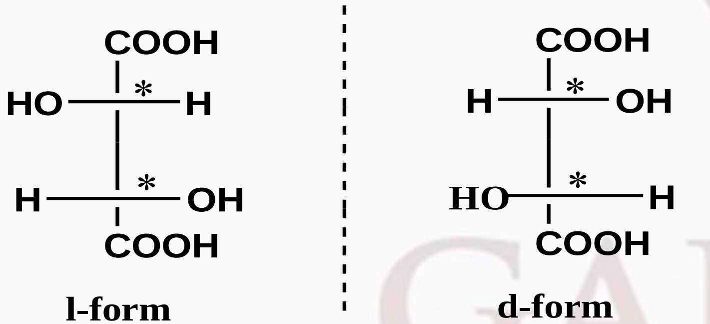
FOR EXAMPLE

Tartaric acid has two or even chiral or asymmetric carbon atoms. The two chiral carbon atoms are same then the number of optical isomers will be $\mathbf{(2^2 – 1) = 3}$.



Tartaric Acid

The stereo forms of Tartaric acid–

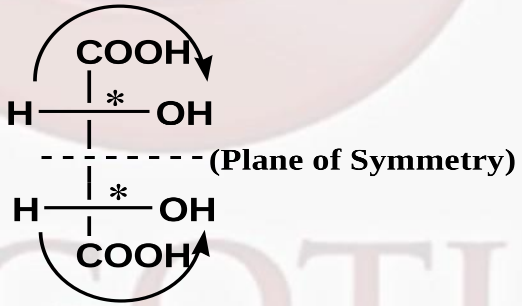


l-form

d-form

Mirror

Non Superimposable
Mirror Image of Tartaric Acid



Meso form

Meso Tartaric Acid

❖ ENANTIOMERS AND DIASTEREOMERS

ENANTIOMERS

Optical isomers that are non-superimposable mirror image to each other are known as Enantiomers.

FOR EXAMPLE

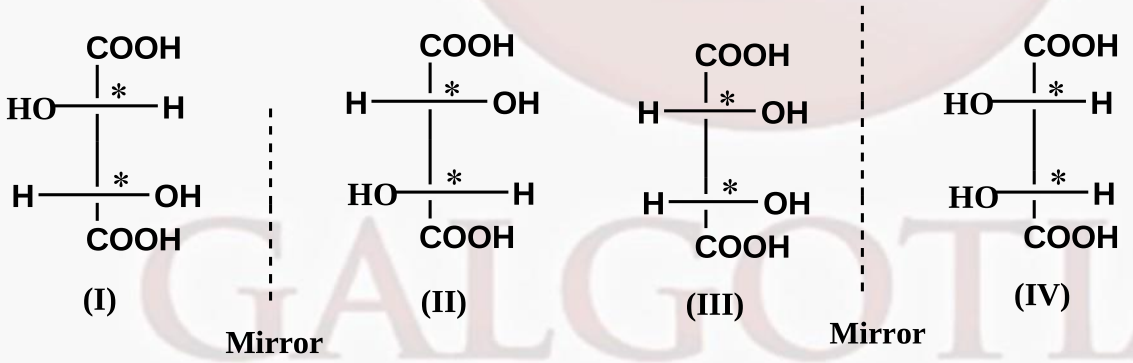
In Tartaric acid, (I) is mirror image of (II) and (III) is mirror image of (IV). Thus these four isomers are two pairs of enantiomers.

DIASTEREOMERS

Optical isomers which are neither mirror image nor superimposable to each other are diastereomers.

FOR EXAMPLE

In Tartaric acid, (I) and (III) they are neither mirror images nor superimposable to each other hence they are diastereomers. (I) & (IV), (II) & (III) and (II) & (IV) are also diastereomers.



Non Superimposable Mirror Images of Tartaric Acid

(I) & (II) and (III) & (IV) forms are Enantiomrs
(I) & (III), (II) & (IV), (I) & (IV) and (II) & (III) forms are Diastereomers

Differentiate Between Enantiomers And Diastereomers

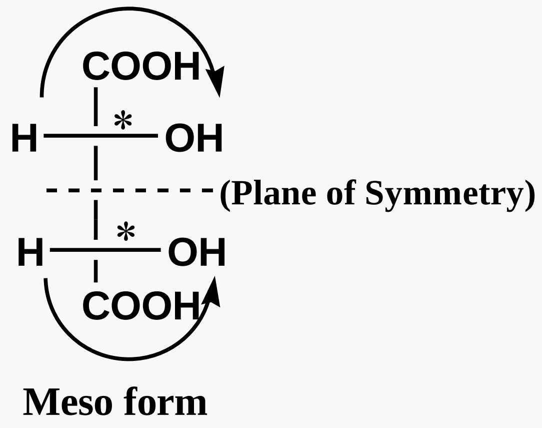
S.No.	Enantiomers	Diastereomers
1.	They have identical physical properties.	They have different physical properties like m.p., b.p. & density etc.
2.	They show identical chemical properties.	They show similar but not identical chemical properties.
3.	They are optically active.	Diastereomers other than geometrical isomers may or may not be optically active.
4.	The equimolar mixture of two enantiomers (racemic mixture) can be separated by resolution.	They can be separated from these techniques like fractional distillation etc. due to different physical properties.
5.	Optical isomers that are non-superimposable mirror image to each other are known as Enantiomers.	Optical isomers which are neither mirror image nor superimposable to each other are diastereomers.

MESO COMPOUNDS

"A compound, having two or more chiral or asymmetric carbon atom, which is superimposable on its mirror image are optically inactive are called meso compound."

These are optically inactive due to **internal compensation** of rotatory power through plane of symmetry. Therefore, molecule as whole is not dissymmetric because one half of the molecule is exactly the mirror image of other.

FOR EXAMPLE: Meso tartaric acid



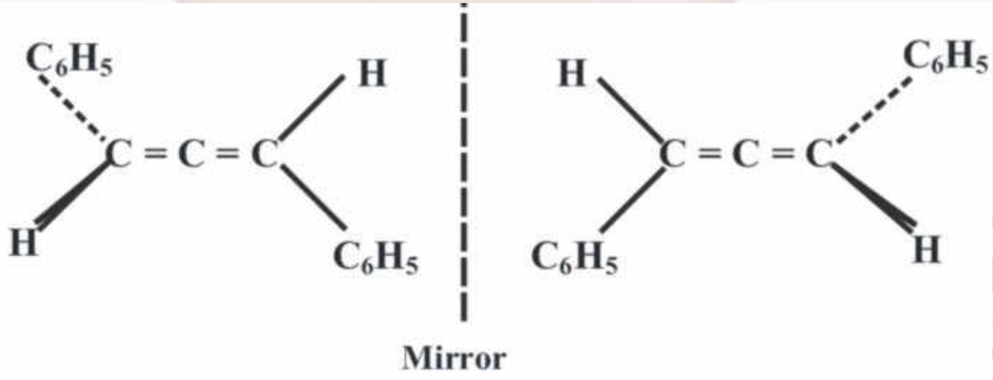
Meso Tartaric Acid

❖ RACEMIC MIXTURE

"When d- and l- forms of optical isomers are mixed in equimolar quantities is known as racemic mixture". racemic mixture becomes optically inactive due to **external compensation** because d- and l- forms are mix in equal quantities but rotate in opposite directions.

ATROPISOMERSINM (OPTICALLY ACTIVE COMPOUNDS WITHOUT CHIRAL OR ASYMMETRIC CARBON ATOM)

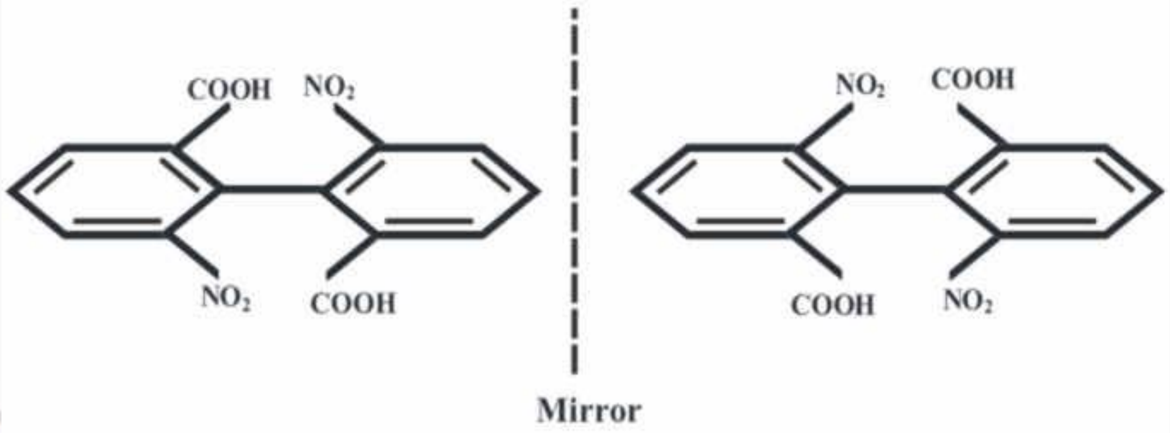
Allenes:- In allenes the central carbon atom is sp hybridized and terminal carbons are sp^2 hybridized. The central carbon also has two p-orbitals which are perpendicular to each other. These forms π bonds with the p orbitals on the other carbon atoms. As a result, the substituents at one end of the molecule are in a plane which is perpendicular to the substituents at other end of the molecule, so that the compound exists in two forms which are non-superimposable mirror images and are optically active.



Non-Superimposable mirror image
1,3 – Diphenyl propadiene

Biphenyl derivatives:-

Substituted biphenyls show optical isomerism when substituents at 2 positions are large enough to prevent rotation about the bond joining the two benzene rings.



Non – Super imposable mirror image
6,6 – Dinitrodiphenic acid.

Thank You