Stereochemistry

Rijoy Kodiyan Jacob

October 18, 2020

Enantiomerism

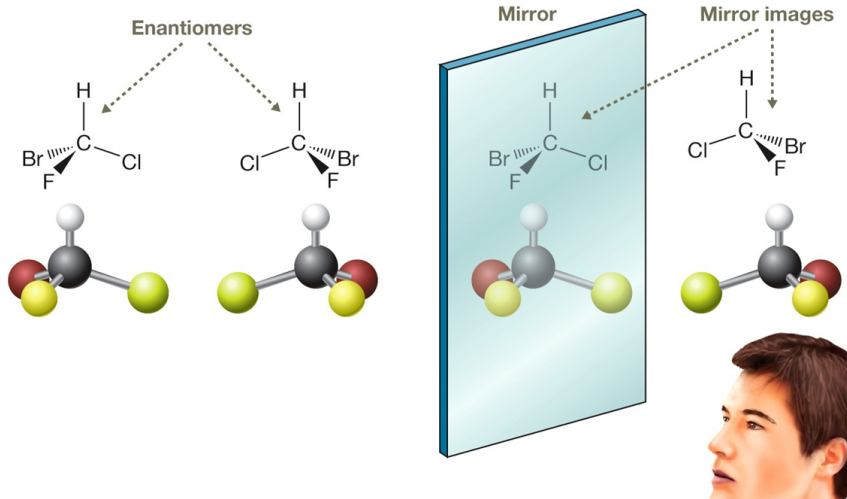
Stereoisomers which are related to each other as object to its non superimposable mirror image and rotate the plane of plane polarised light to equal extent but in opposite direction are called **enantiomers** or in **enantiomorphs** and the phenomenon is known as **Enanantiomerism**.

Enantiomerism

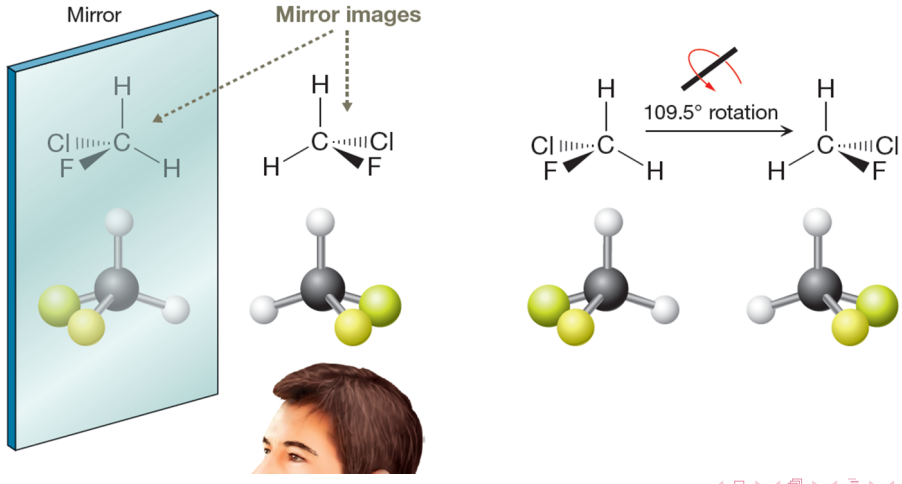
Stereoisomers which are related to each other as object to its non superimposable mirror image and rotate the plane of plane polarised light to equal extent but in opposite direction are called **enantiomers** or in **enantiomorphs** and the phenomenon is known as **Enanantiomerism**.

Enantiomers which rotate the plane of plane polarized light to the **right** is called the **dextrorotatory**[referred to as **dextro**(**'d'** or **'+'**)] and that which rotates the plane of plane polarised light to the **left** is called **laevorotatory**[referred to as **laevo**(**'l'** or **'-'**)].

Bromochloroflouromethane has nonsuperimposable mirror image, hence chiral and exhibit enantiomerism.

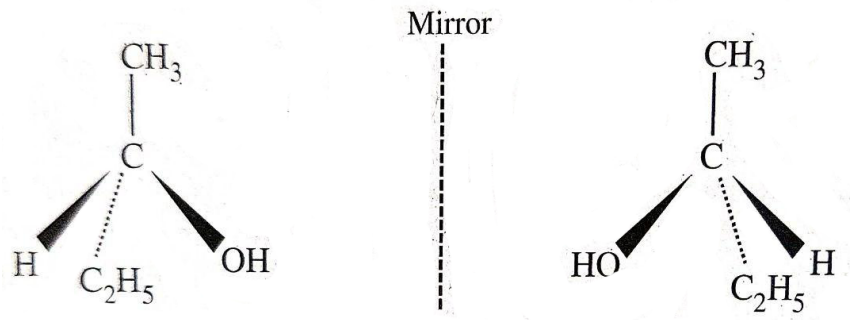


Chlorofluoromethane has superimposable mirror image, hence achiral and never shows enantiomerism.



Example

The enantiomers of **2-butanol**, which is a **chiral** molecule, are shown in figure.



(+) or *d*-2-butanol

(–) or *l*-2-butanol

Enantiomers have almost identical physical and chemical properties. In addition to their different behaviour towards plane polarised light, they may differ in their crystal shapes, rates of reaction with other of chiral compounds and biological activities.

Enantiomers have almost identical physical and chemical properties. In addition to their different behaviour towards plane polarised light, they may differ in their crystal shapes, rates of reaction with other of chiral compounds and biological activities.

An equimolecular mixture of the enantiomers of a substance is known as the **racemic mixture** or **racemic modification** or *'dl'* or $(\pm)$ form of the substance.

- Enantiomers have almost identical physical and chemical properties but along with opposite optical rotation, they may differ in their crystal shapes, rates of reaction with other chiral compounds and biological activities.

- Enantiomers have almost identical physical and chemical properties but along with opposite optical rotation, they may differ in their crystal shapes, rates of reaction with other chiral compounds and biological activities.
- An equimolecular mixture of the two enantiomers is known as racemic mixture or 'dl form' or '$\pm$ form'.

- Enantiomers have almost identical physical and chemical properties but along with opposite optical rotation, they may differ in their crystal shapes, rates of reaction with other chiral compounds and biological activities.
- An equimolecular mixture of the two enantiomers is known as racemic mixture or 'dl form' or '$\pm$ form'.
- A racemic mixture is optically inactive because the optical rotation due to one enantiomer is exactly cancelled by equal but opposite rotation caused by the other enantiomer(**mutual external compensation**).

- Enantiomers have almost identical physical and chemical properties but along with opposite optical rotation, they may differ in their crystal shapes, rates of reaction with other chiral compounds and biological activities.
- An equimolecular mixture of the two enantiomers is known as racemic mixture or 'dl form' or '$\pm$ form'.
- A racemic mixture is optically inactive because the optical rotation due to one enantiomer is exactly cancelled by equal but opposite rotation caused by the other enantiomer(**mutual external compensation**).
- Using suitable methods, it is possible to separate racemic mixture into corresponding enantiomers(into its 'd' and 'l' form) and the process is known as **'Resolution'**.

A chiral compound having ‘n’ chiral centres can have a maximum of 2^n stereo isomers.

A chiral compound having 'n' chiral centres can have a maximum of 2^n stereo isomers.

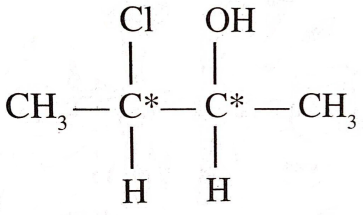
Example

3-chloro-2-butanol has 2 hiral centres and has $2^2 = 4$ stereo isomers.

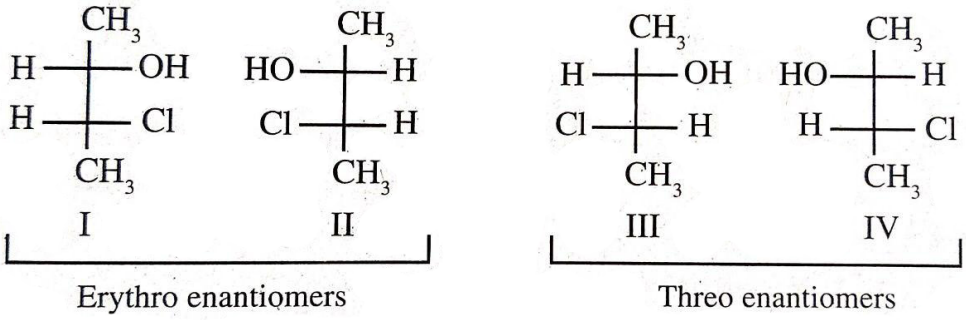
A chiral compound having 'n' chiral centres can have a maximum of 2^n stereo isomers.

Example

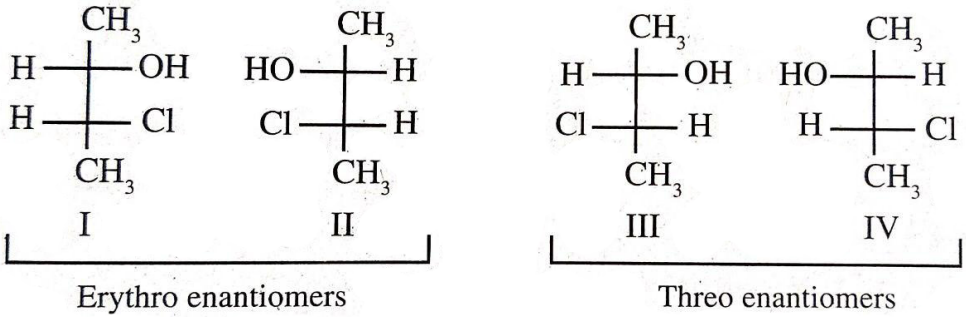
3-chloro-2-butanol has 2 hiral centres and has $2^2 = 4$ stereo isomers.



3-chloro-2-butanol



Stereo isomers I and II are non superimposable mirror images of each other and are enantiomers.



Stereo isomers I and II are non superimposable mirror images of each other and are enantiomers.

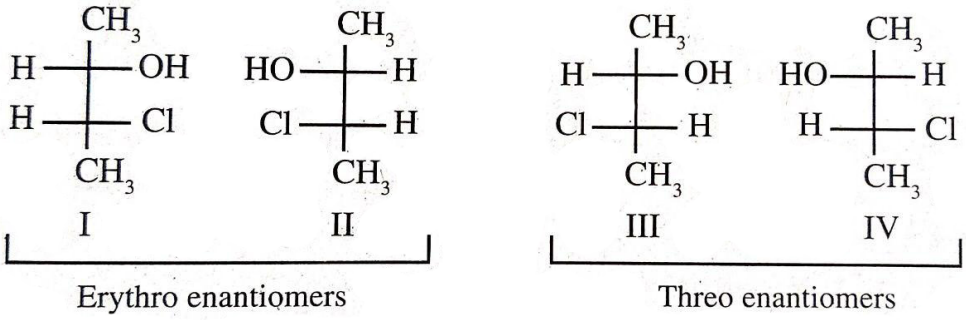
These structures are having similar groups on **same side(eclipsed)** are called **erythro isomers**.

- Stereo isomers III and IV are also mirror images of each other and constitute a pair of enantiomers. Here similar groups are on **opposite sides** and are called **threo** isomers.

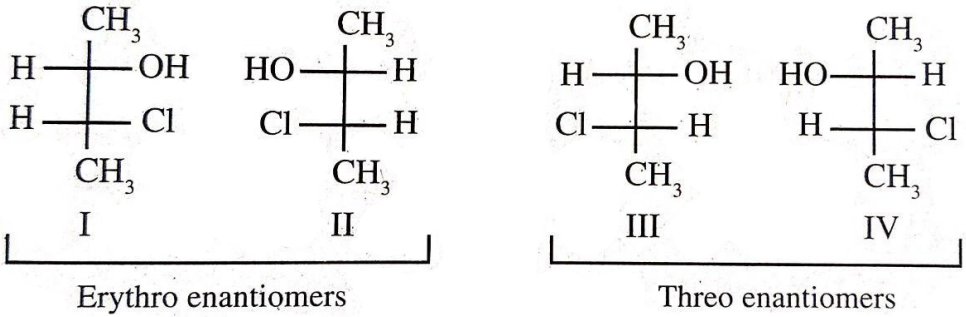
- Stereo isomers III and IV are also mirror images of each other and constitute a pair of enantiomers. Here similar groups are on **opposite sides** and are called **threo** isomers.
- Stereo isomers I and III are not mirror images and hence not enantiomers. They are called **diastereoisomers** or **diastereomers**.

- Stereo isomers III and IV are also mirror images of each other and constitute a pair of enantiomers. Here similar groups are on **opposite sides** and are called **threo** isomers.
- Stereo isomers I and III are not mirror images and hence not enantiomers. They are called **diastereoisomers** or **diastereomers**.
- Diastereomers are steroisomers which are not mirror images of each other.

- Stereo isomers III and IV are also mirror images of each other and constitute a pair of enantiomers. Here similar groups are on **opposite sides** and are called **threo** isomers.
- Stereo isomers I and III are not mirror images and hence not enantiomers. They are called **diastereoisomers** or **diastereomers**.
- Diastereomers are steroisomers which are not mirror images of each other.
- Diastereomers are configurational isomers that are not enantiomers.



- The stereo isomers I and IV, II and III, II and IV are diastereoisomers.



- The stereo isomers I and IV, II and III, II and IV are diastereoisomers.
- Diastereomers differ in physical properties such as MP, BP, densities, refractive indexes, optical rotations(if optically active), chemical properties and rates of reactions.

Distinction B/W Enantiomers and Diastereomers

Enantiomers	Diastereomers
1. Enantiomers are stereo isomers that are non-superimposable mirror images of each other.	1. Diasteroisomers are stereoisomers which are not mirror images of each other.

Distinction B/W Enantiomers and Diastereomers

Enantiomers	Diastereomers
1. Enantiomers are stereo isomers that are non-superimposable mirror images of each other.	1. Diasteroisomers are stereoisomers which are not mirror images of each other.
2.They are optically active	2.They may or may not be optically active

Distinction B/W Enantiomers and Diastereomers

Enantiomers	Diastereomers
1. Enantiomers are stereo isomers that are non-superimposable mirror images of each other.	1. Diasteroisomers are stereoisomers which are not mirror images of each other.
2.They are optically active	2.They may or may not be optically active
3. They have almost the same physical properties except their optical rotation	3. They show different physical properties.

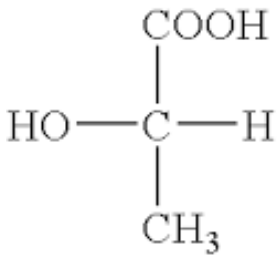
Enantiomers	Diastereomers
4. They show equal but opposite optical rotations.	4. Optically active diastereomers show different specific rotations.

Enantiomers	Diastereomers
4. They show equal but opposite optical rotations.	4. Optically active diastereomers show different specific rotations.
5. They have the same chemical properties and react at same rate with other optically active reagents.	5. They have the different chemical properties and react at different rates with a given achiral reagent.

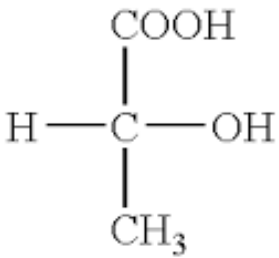
Enantiomers	Diastereomers
4. They show equal but opposite optical rotations.	4. Optically active diastereomers show different specific rotations.
5. They have the same chemical properties and react at same rate with other optically active reagents.	5. They have the different chemical properties and react at different rates with a given achiral reagent.
6. An equimolecular mixture (+), (-) enantiomer is optically inactive due to external compensation and is known as racemic mixture.	6. An equimolecular mixture of a pair of optically active diastereomers will not yield an inactive mixture.

Optical Isomerism in Lactic Acid

Lactic acid (CH_3—CHOH—COOH), contains one chiral carbon and exhibits optical isomerism. Two stereoisomers are possible which are shown below.



L(+) lactic acid



D(-) lactic acid

Dextro Rotatory Lactic Acid

The enantiomer which rotates the plane of plane polarised light to the **right** is said to be dextrorotatory and is called **dextro-lactic acid**or **'d-lactic acid'** or '**(+)lactic acid'**. It has a specific rotation $+3.82^0$

Dextro Rotatory Lactic Acid

The enantiomer which rotates the plane of plane polarised light to the **right** is said to be dextrorotatory and is called **dextro-lactic acid**or **'d-lactic acid'** or '**(+)lactic acid'**. It has a specific rotation $+3.82^0$

Laevo Rotatory Lactic Acid

The enantiomer which rotates the plane of plane polarised light to the **left** is said to be dextrorotatory and is called **laevo-lactic acid** or **'l-lactic acid'** or '**(-)lactic acid'**. It has a specific rotation -3.82^0

Racemic Lactic Acid

An **equimolecular** mixture of d- lactic acid and l- lactic acid will be **optically inactive** due to mutual external compensation. Such a mixture known as **racemic lactic acid**