



*Welcome to Our  
Feature Presentation*

# Presentation on stereochemistry

**DEPT. OF PHARMACY**


**JESSORE UNIVERSITY OF SCIENCE & TECHNOLOGY**

# Outline..

1. Stereochemistry
2. Isomerism
3. Classification of isomerism
4. Chiral and achiral carbon
5. Enantiomer
6. Diastereomer
7. Geometric isomerism
8. Geometric isomerism in cyclic compounds
9. Asymmetric synthesis
10. Optical resolution method
11. Racemic mixture
12. Meso compound
13. (*R*) and (*S*) configuration
14. Fischer projections
15. Specific rotation
16. Optical activity
17. Application


# Stereochemistry

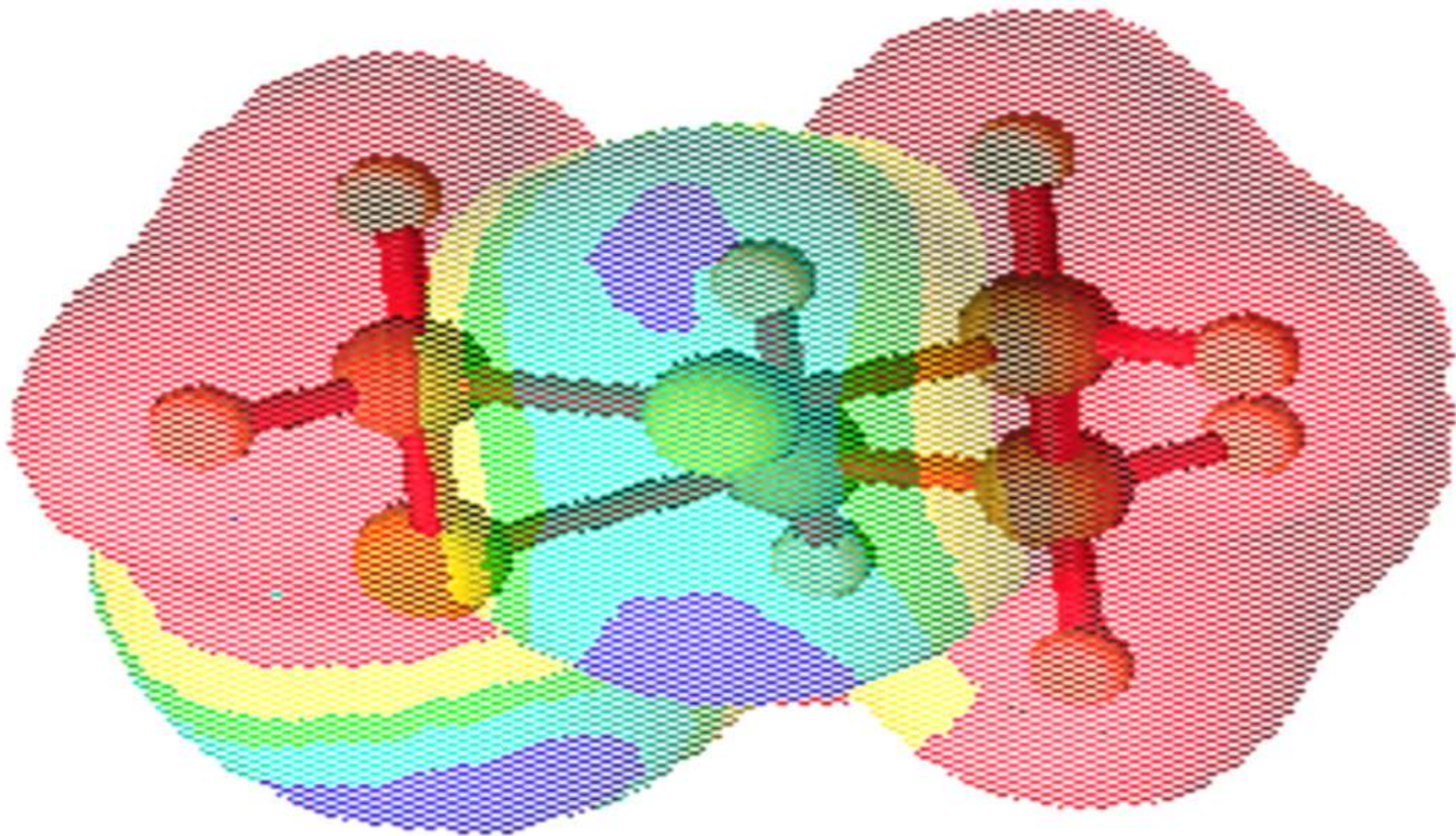




Stereochemistry is the study of the three-dimensional structure of molecules.

It also define as the branch of chemistry that concerned with the three-dimensional arrangement of atoms and molecules and the effect of this on chemical reactions.

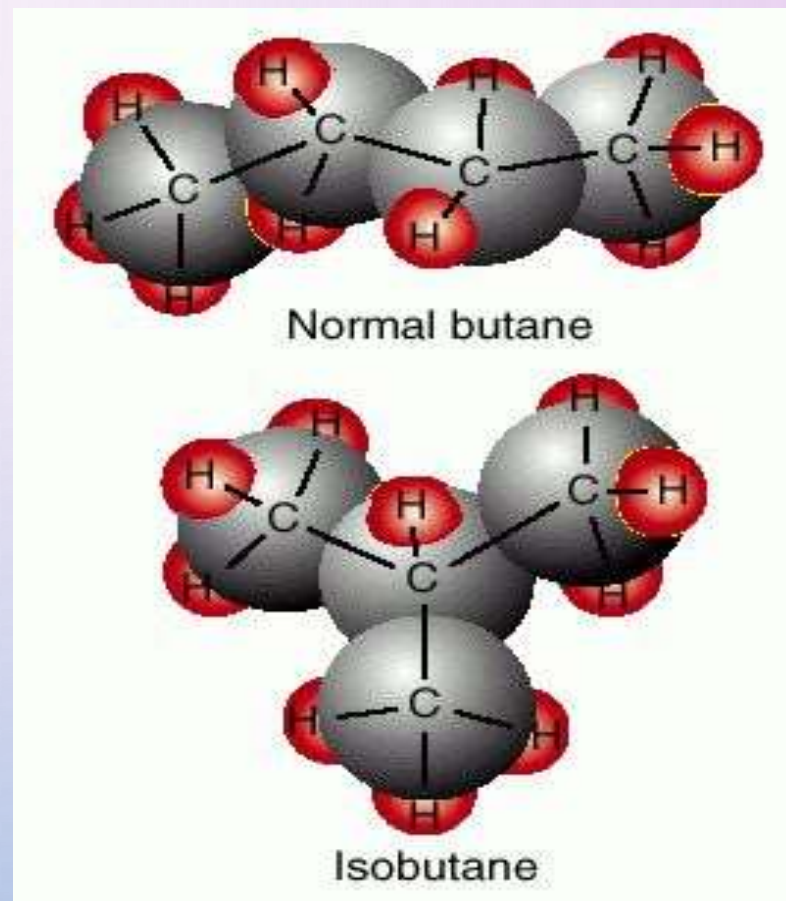






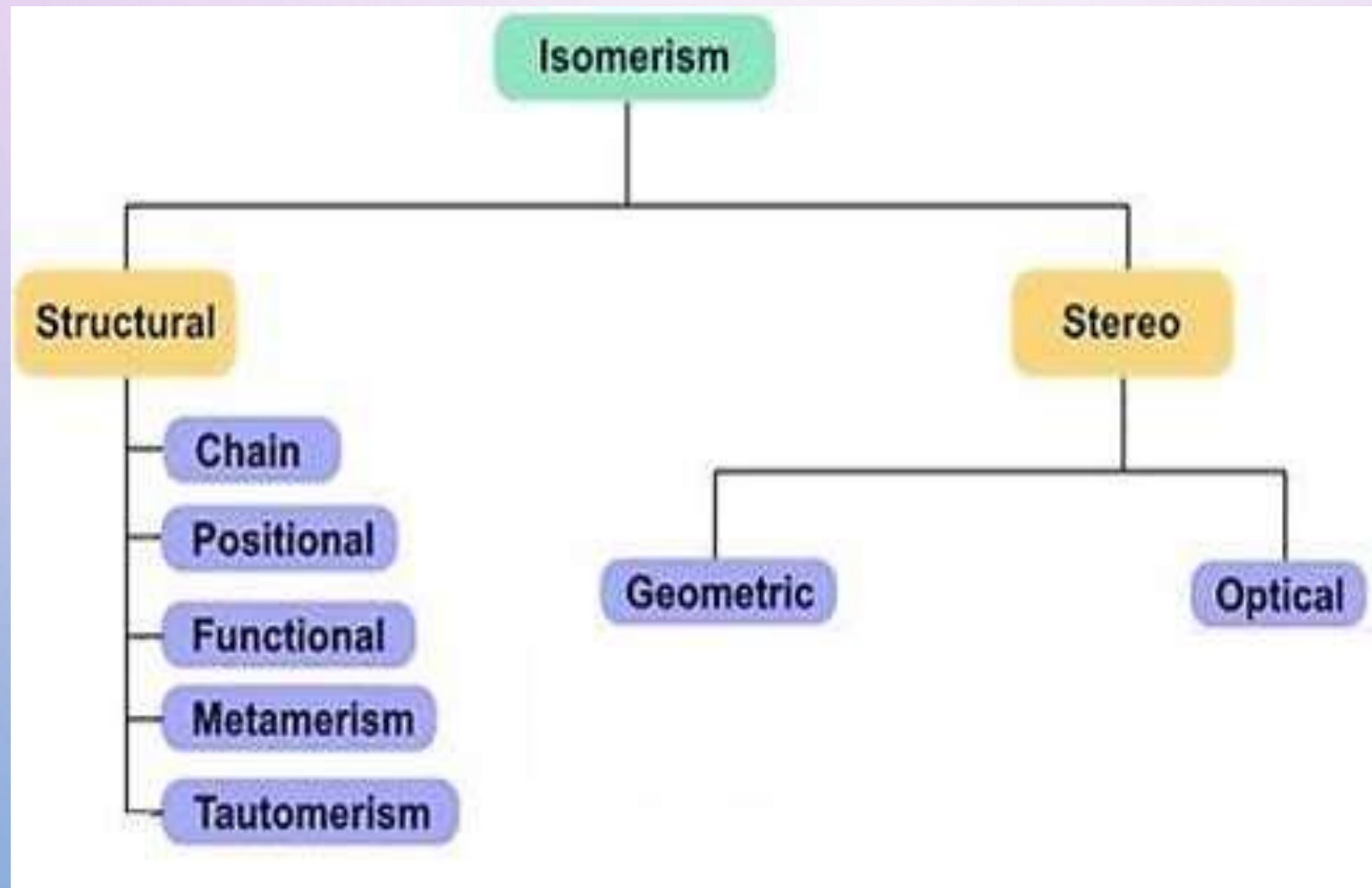
# Isomerism

**The different compounds which have same molecular structure are called isomers & the phenomenon is called isomerism.**

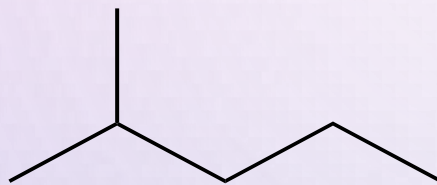




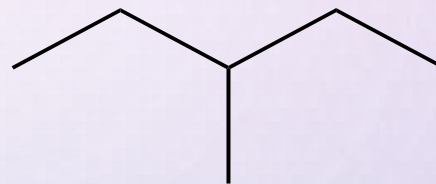
# Classification of isomerism



- **Structural isomerism** - Compounds of the same molecular formula with different connectivity.

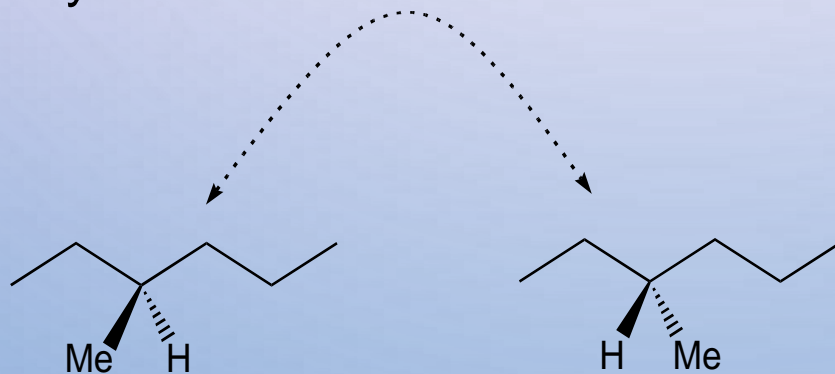


2-methylpentane



3-methylpentane

- **Stereoisomerism** - Compounds of the same structure that differ in one or more aspects of stereochemistry.

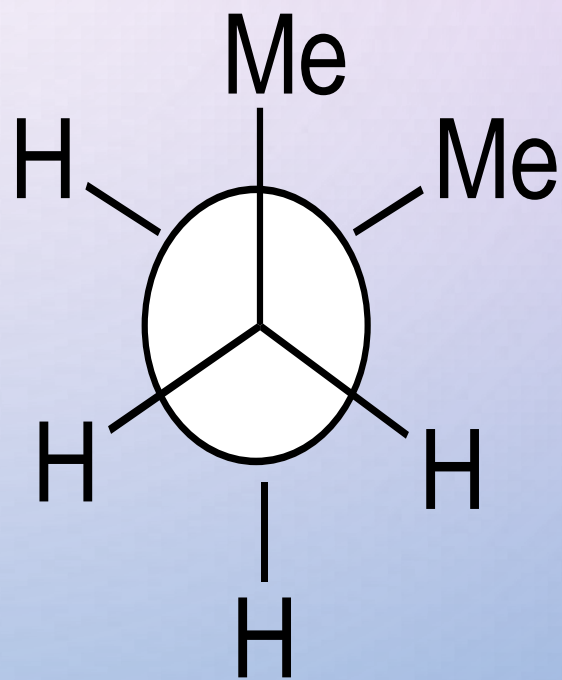
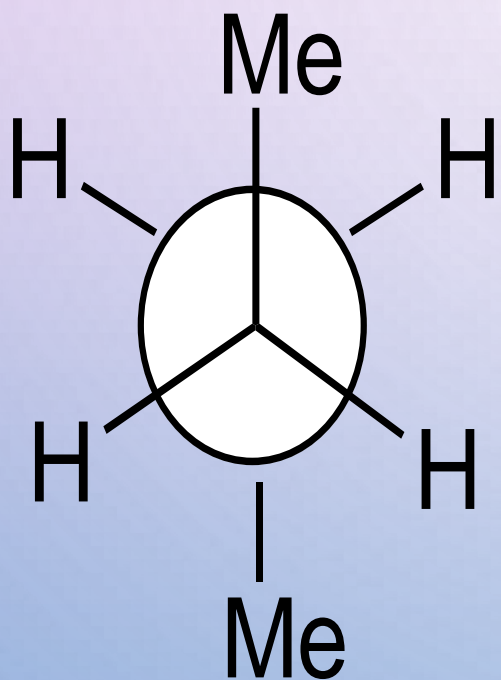


3-methylhexane

3-methylhexane

*We need a way to describe the stereochemistry!*

**Conformational isomers** - compounds of the same structure that differ in rotation around one or more single bonds



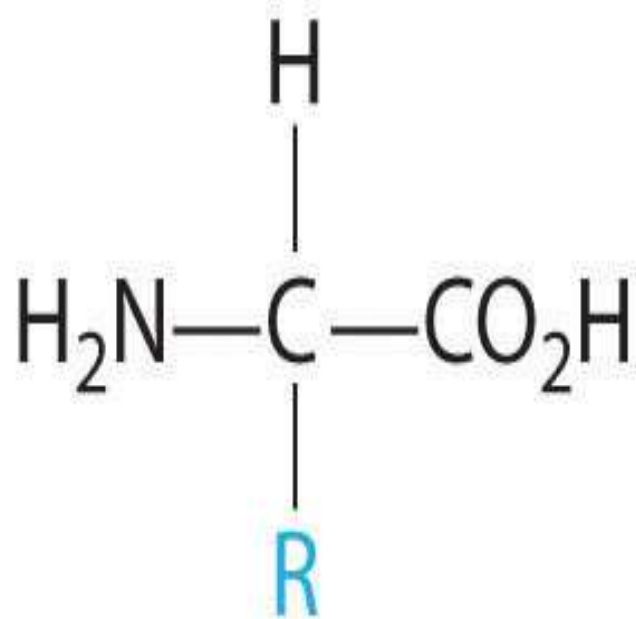


# **Chiral and achiral carbon**

# Chiral carbon

A molecule containing a carbon with four different groups results in a chiral molecule, and the carbon is referred to as a *chiral*, or *asymmetric*, or *stereogenic* center.

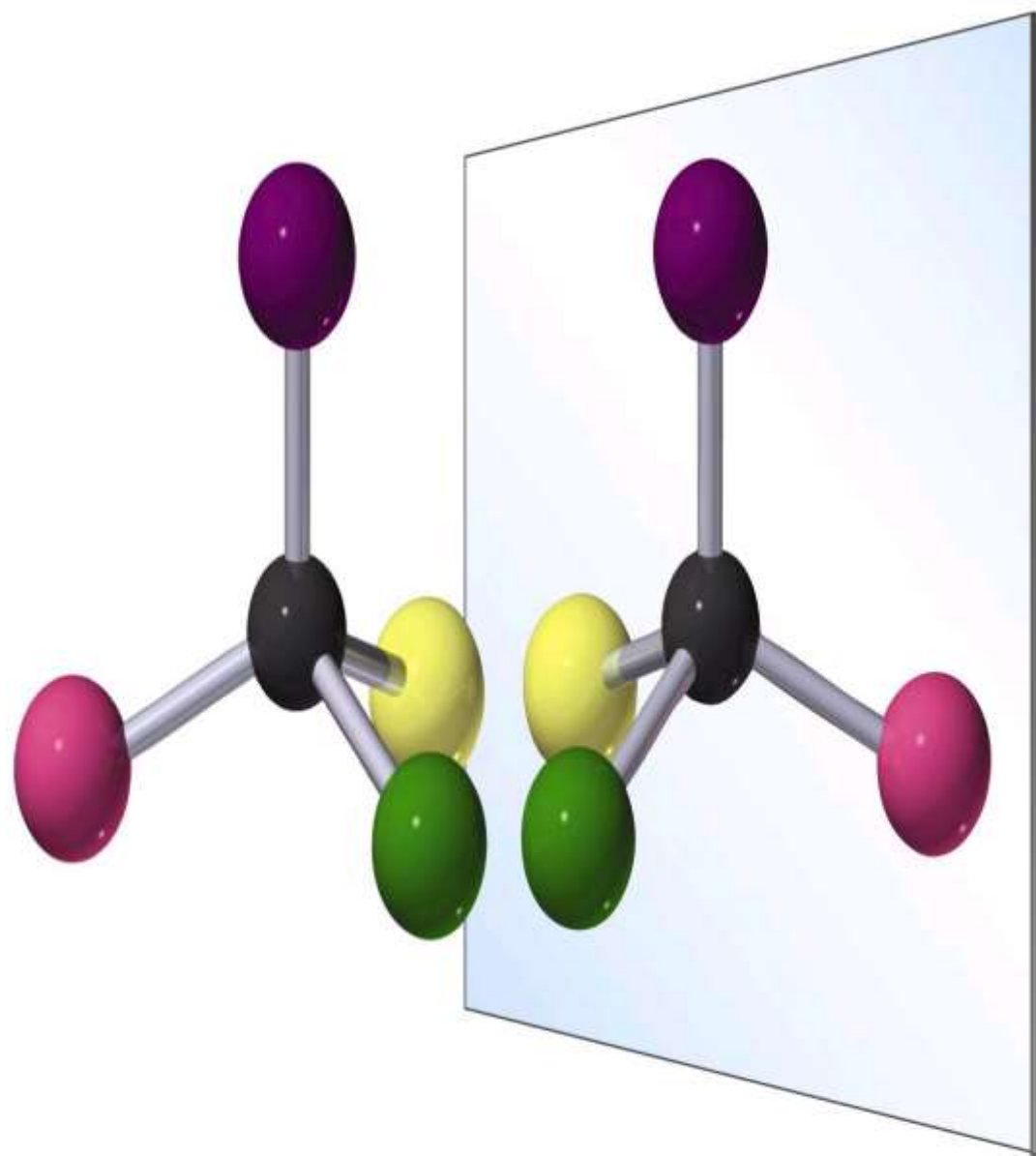
# Example of chiral carbon



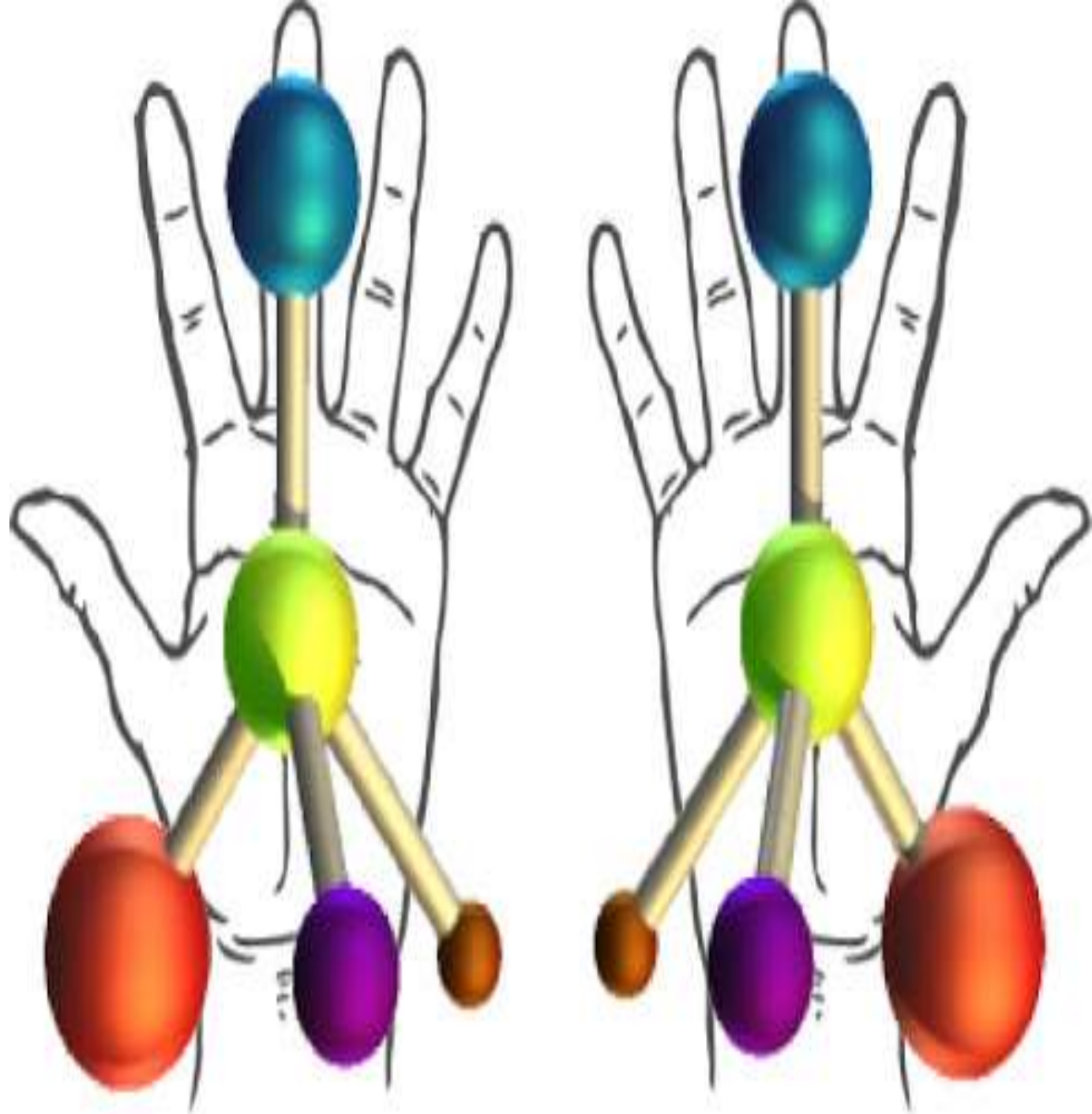
Amino acid

# Properties of a Chiral carbon

- ❖ Chiral compound is a compound that is optically active & can rotate light.
- ❖ Although everything has a mirror image, mirror images may or may not be superimposable.
- ❖ Actually chiral molecule contains four different atoms by  $sp^3$  hybridization.
- ❖ Chiral compounds are non-superimposable mirror image like our two hands-



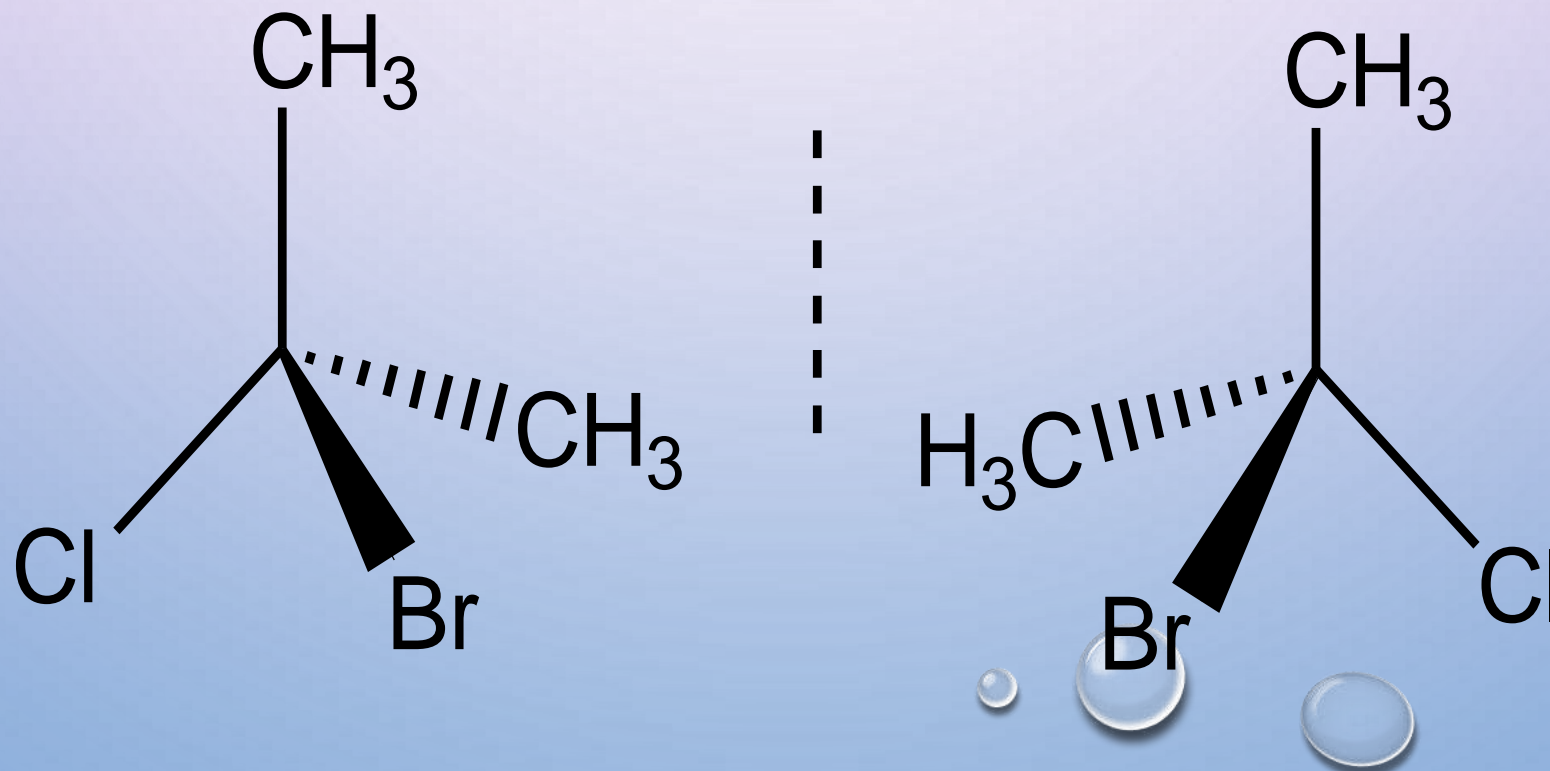
nonsuperimposable  
mirror images





# Achiral carbon

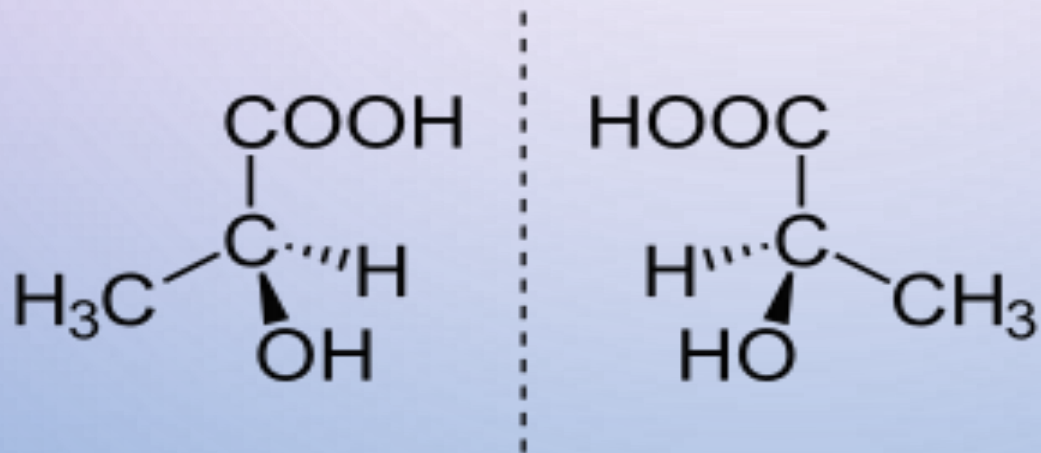
A molecule or object that is superimposable on its mirror image is said to be achiral. In a achiral molecule – carbon atom contain at least two same molecule on their hand.



# Enantiomer

Enantiomer are the chiral molecules that are mirror image of one another. They have same physical properties.

**Example: d-lactic acid & l-lactic acid.**



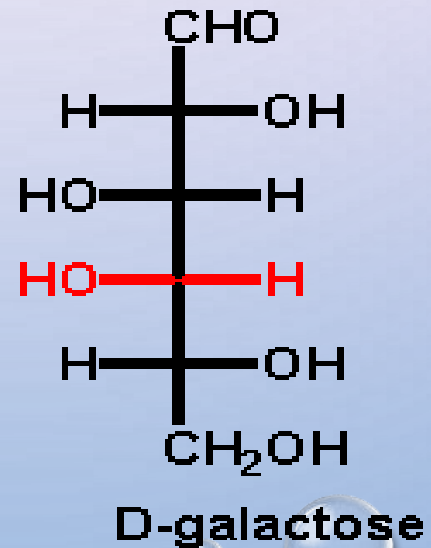
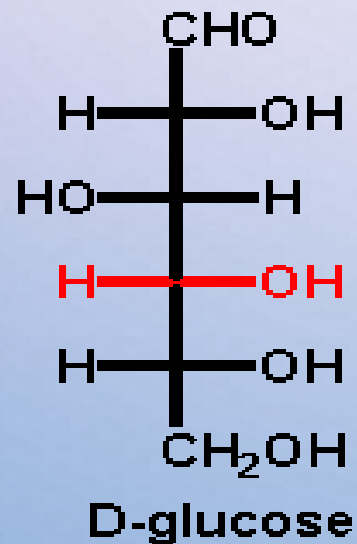
D-lactic acid

L-lactic acid

# Diastereomer

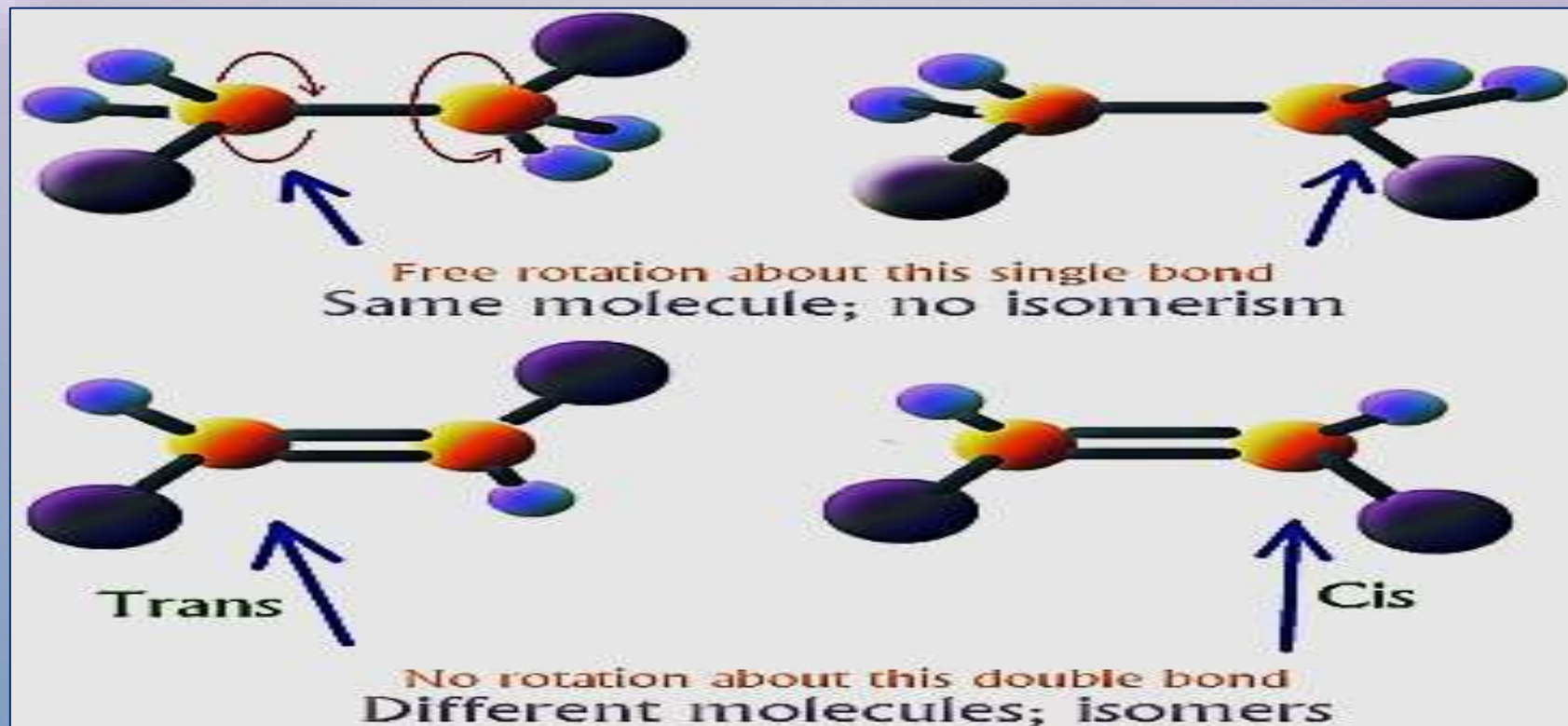
Diastereomers are the stereoisomers that are not the mirror images of each other.

**Example:** d-glucose & d-galactose are diastereomer



# Geometric isomerism

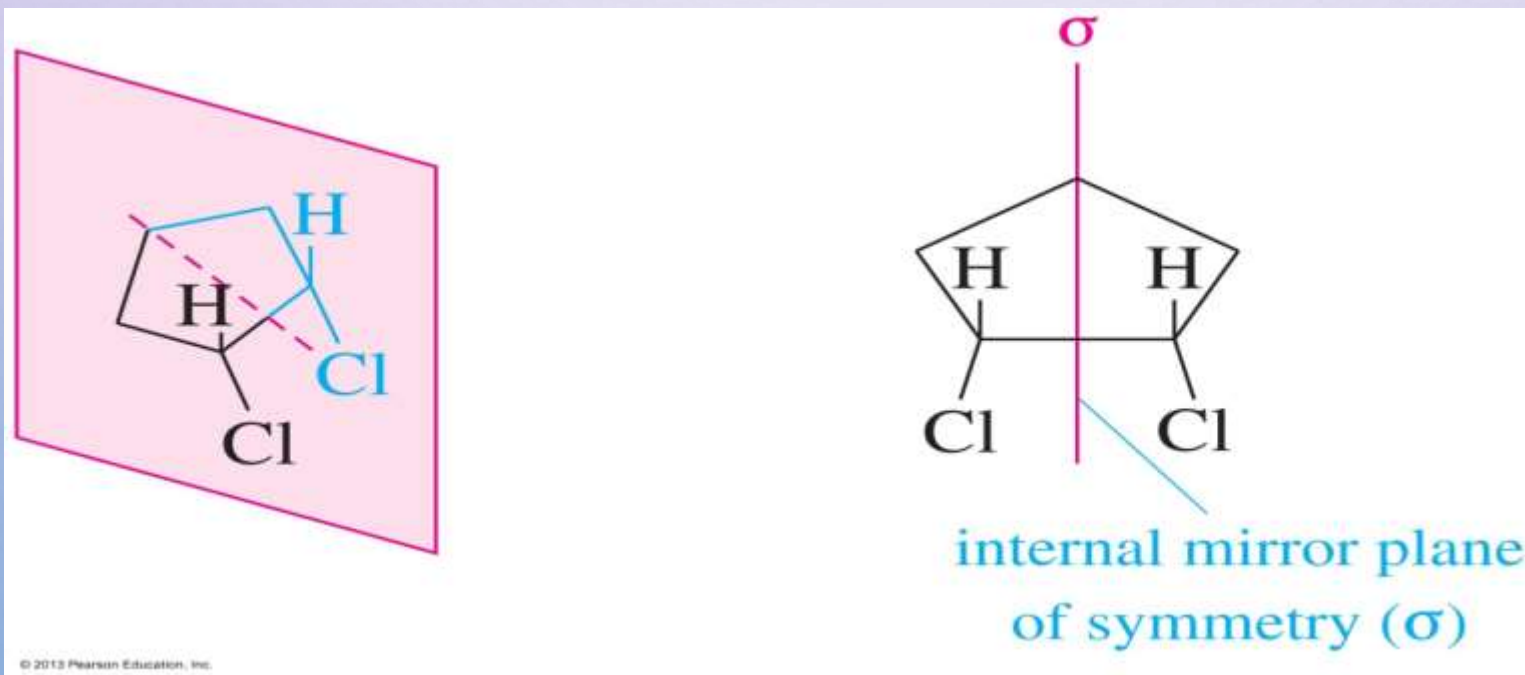
Alkene shows geometric isomerism because it contains C=C bond which is unable to rotate.



# Geometric isomerism in cyclic compounds

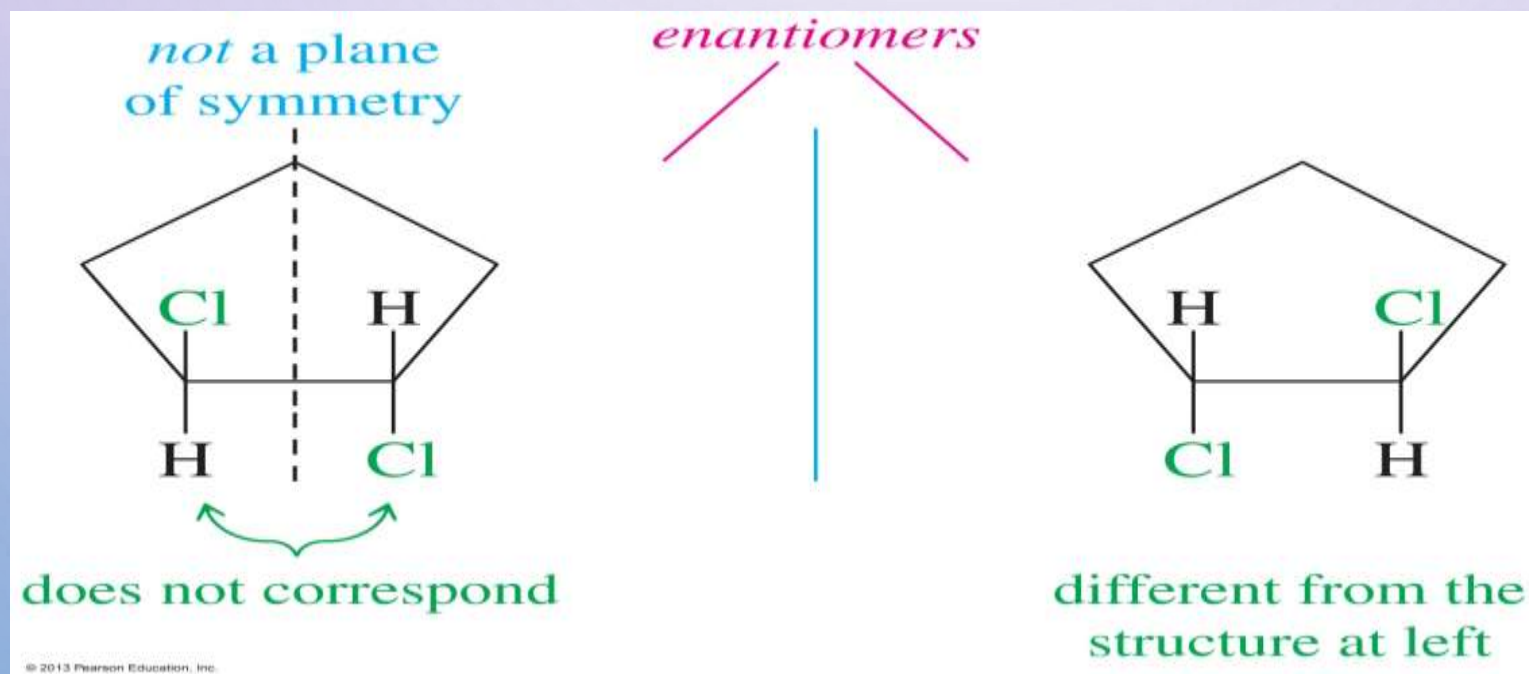
## 1. *Cis* cyclic compounds

*Cis*-1,2-dichlorocyclohexane is achiral because the molecule has an internal plane of symmetry.



## 2. Trans cyclic compounds

*Trans*-1,2-dichlorocyclohexane does not have a plane of symmetry so the images are nonsuperimposable and the molecule will have two enantiomers



# Asymmetric Synthesis

Asymmetric synthesis may be defined as the chemical reaction in which stereoisomeric product is formed in unequal amount under the influence of suitable optically active reagent.

# Optical resolution method

Optical resolution method is the method of enantiomer separation.

Generally there are five types of optical resolution methods-

- 1) mechanical separation
- 2) biochemical separation
- 3) chemical separation
- 4) kinetic separation
- 5) selective adsorption.

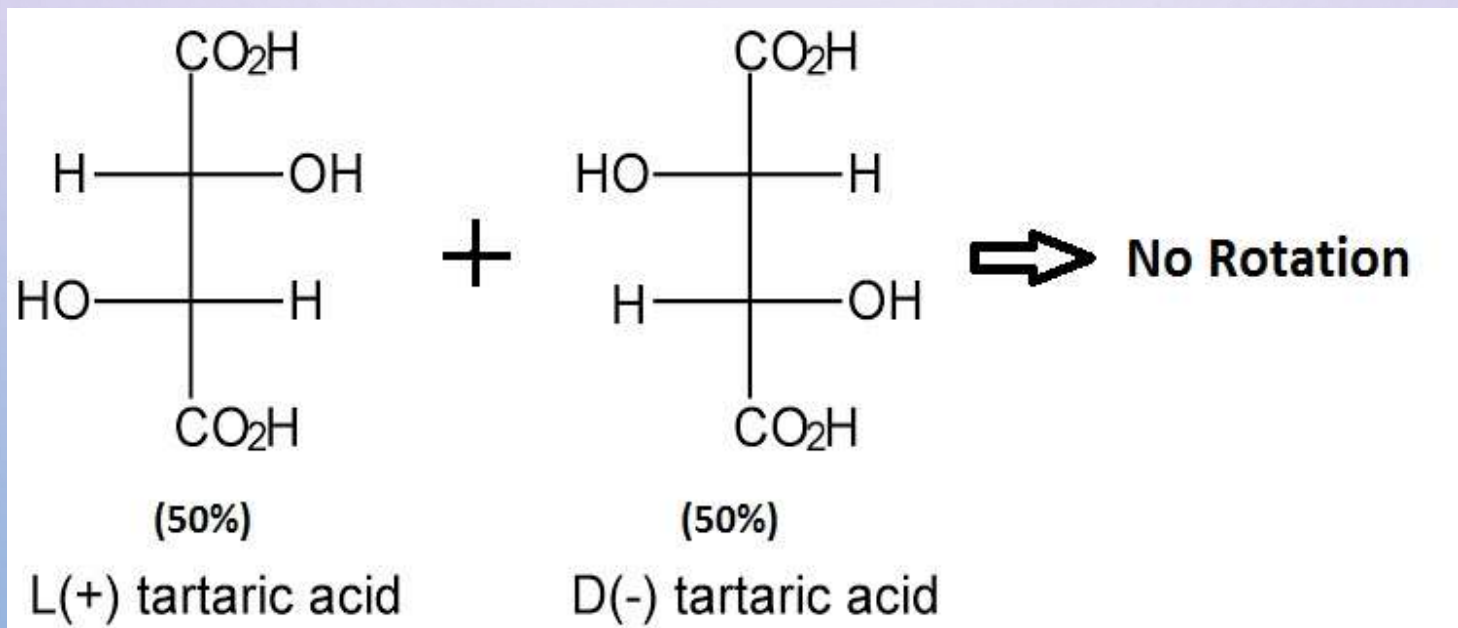


# Racemic mixture

An equal amount of two enantiomers is called a racemic mixture.

❖ A racemic mixture is optically inactive.

❖ **Example:** 50% d-tartaric acid & 50% l-tartaric acid mixture.



# Meso compound

Meso compounds are the achiral compounds that have a plane of symmetry.

If one image was rotated  $180^\circ$ , then it could be superimposed on the other image.

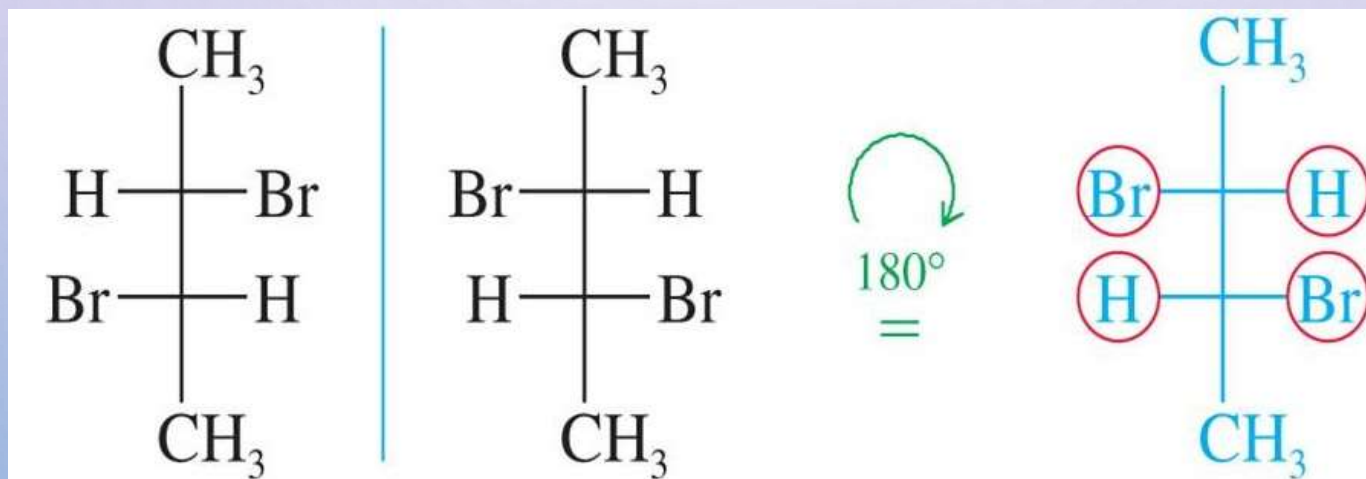
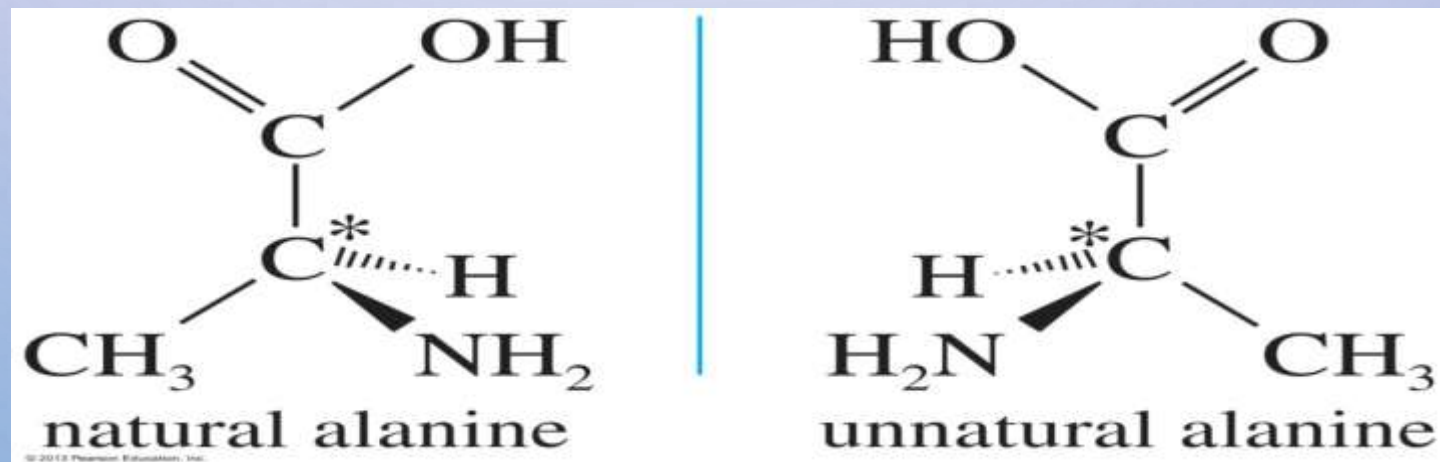


Fig- 2,3-dibromo butane is a meso compound.

# (R) AND (S) CONFIGURATION

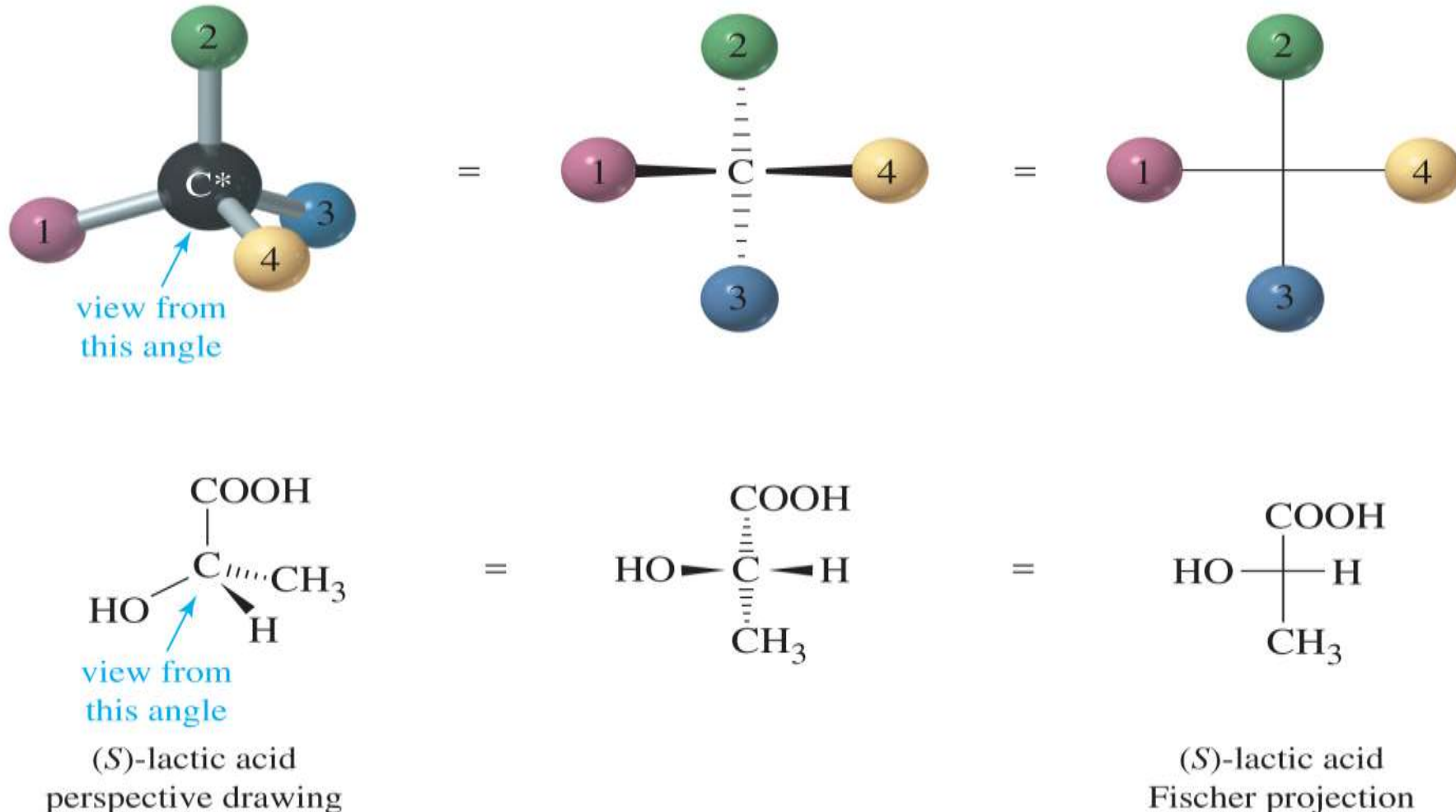
1. Both enantiomers of alanine receive the same name in the IUPAC system: 2-aminopropanoic acid.
2. Only one enantiomer is biologically active. In alanine only the enantiomer on the left can be metabolized by the enzyme.
3. A way to distinguish between them is to use stereochemical modifiers (r) and (s).



# Fischer projections

- Flat representation of a 3-D molecule.
- A chiral carbon is at the intersection of horizontal and vertical lines.
- Horizontal lines are forward, out of plane.
- Vertical lines are behind the plane

# Fischer Projections (Continued)



# Specific rotation

- Specific rotation is a standardized physical constant for the amount that a chiral compound rotates plane-polarized light.

$$\text{specific rotation} = [\alpha] = \frac{\alpha}{l \times c}$$

$\alpha$  = observed rotation ( $^{\circ}$ )

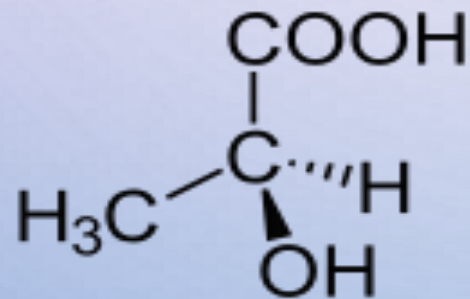
$l$  = length of sample tube (dm)

$c$  = concentration (g/mL)

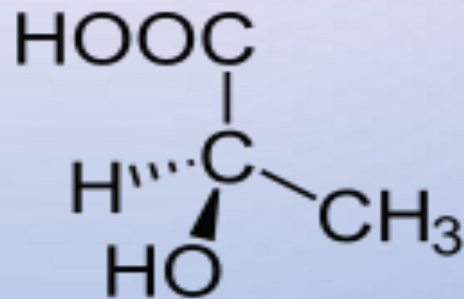
[ dm = decimeter  
1 dm = 10 cm ]

# Optical activity

Enantiomers rotate the plane of polarized light in opposite directions, but same number of degrees.



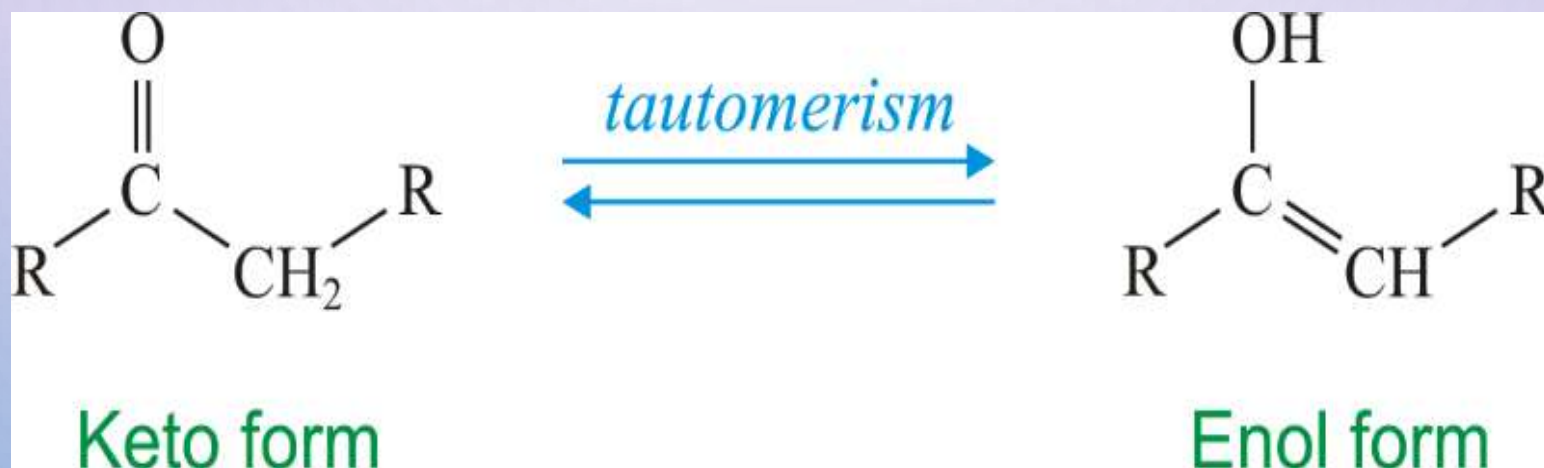
D-LACTIC ACID



L-LACTIC ACID

# Tautomerism

Tautomerisms are constitutional isomers of interconvert. This reaction commonly result in the relocation of proton.





# Application of stereochemistry

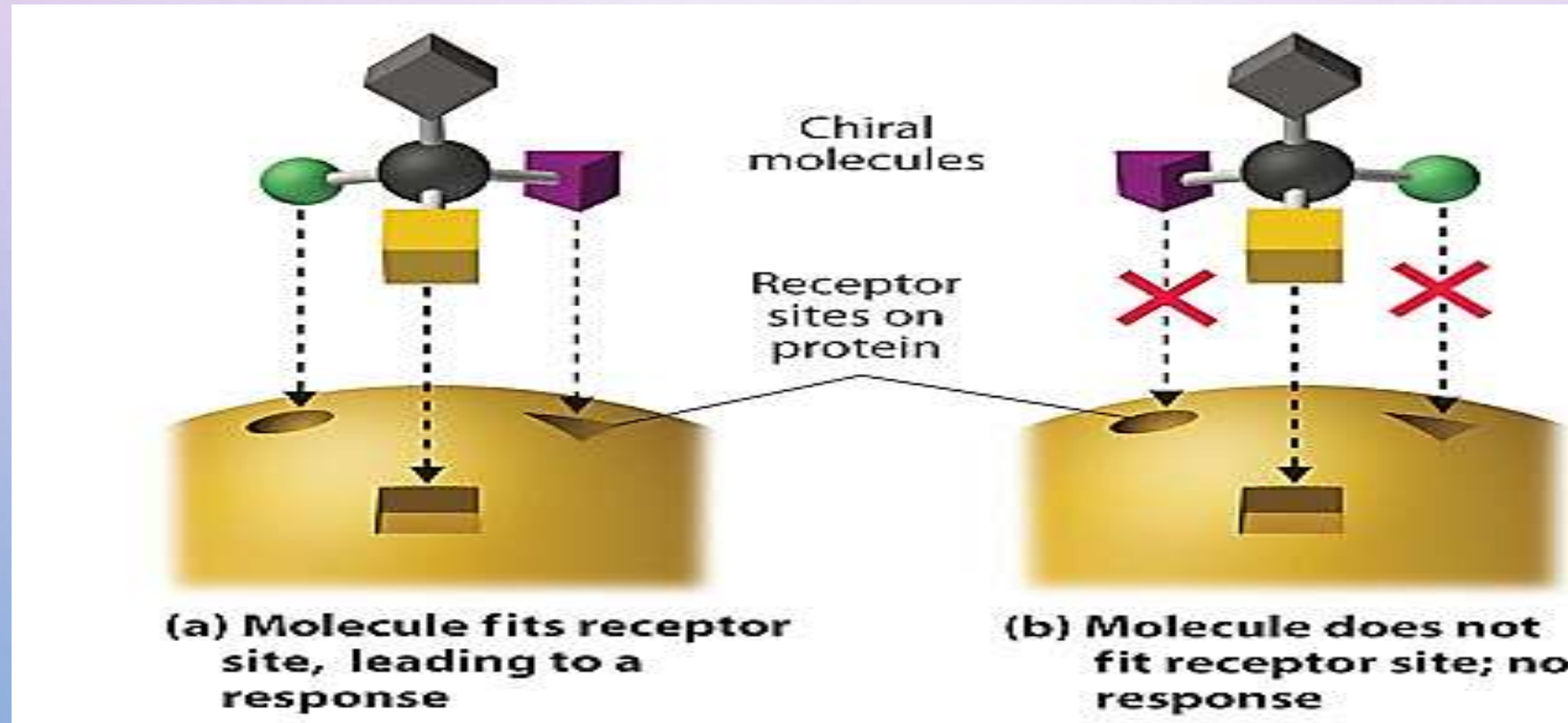
Stereochemistry has a significance role in pharmacy. It has importance in two sectors, such as-

## 1. Medicinal importance-

1) d-methorphan is a cough suppressant but l-methorphan is a narcotic.

2) darvon is a painkiller but its enantiomer is an anticoagulant.

# Biological importance-



# Reference

## 1. Books

- Basic organic chemistry
- Advanced organic chemistry

## 2. Internet

- [www.wikipidea.com](http://www.wikipidea.com)
- [www.slideshare.com](http://www.slideshare.com)
- [www.google.com/steriochemistry](http://www.google.com/steriochemistry)

Thank you!