



# **STEREOCHEMISTRY – I**



# Objectives

- **Structural isomerism:** chain, positional, functional, ring-chain, isomerism, metamerism , tautomerism Homologous series
- **Stereoisomerism:** conformational, optical and geometrical isomerism

# Stereoisomerism

**Isomers**  
same molecular formula

**Constitutional Isomers**  
Different nature/sequence  
of bonds

**Stereoisomers**  
Different arrangement of  
groups in space

**Conformational Isomers**  
Differ by rotation about a  
single bond

**Configurational Isomers**  
Interconversion requires  
breaking bonds

**Enantiomers**  
Non-superposable mirror  
images

**Diastereoisomers**  
Not mirror images

# Structural isomerism

**Chain Isomerism:** When two or more compounds have similar molecular formula but different carbon skeleton.

**Functional Isomerism:**

Having the same molecular formula but different functional groups. For example,  $\text{CH}_3\text{CH}_2\text{OH}$  &  $\text{CH}_3\text{OCH}_3$

**Positional Isomerism:** When two or more compounds differ in the position of substituent atom and group on the carbon skeleton.

**Metamerism:** Arises due to unequal distribution of alkyl groups on either side of the functional group in the molecule.



Ethoxyethane

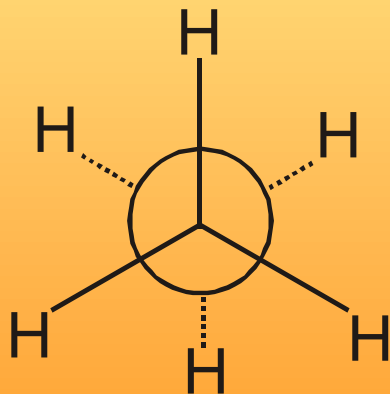


1 - Methoxypropane

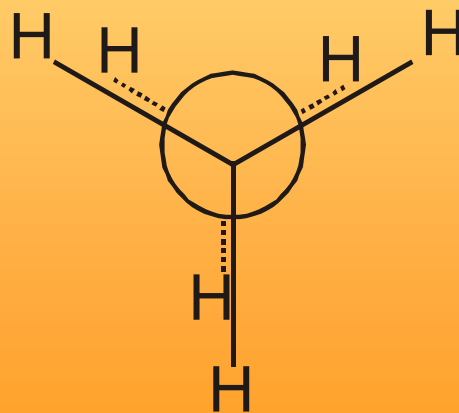
# Conformational

Carbon atoms connected through  $\sigma$  bonds in alkanes can undergo rotation leading to conformational isomers.

## Conformations of ethane

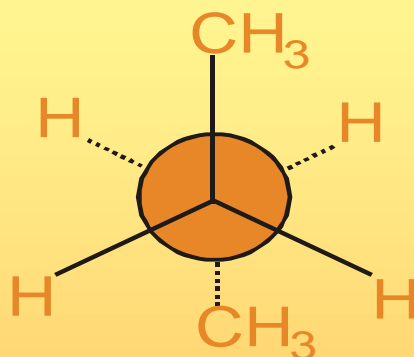
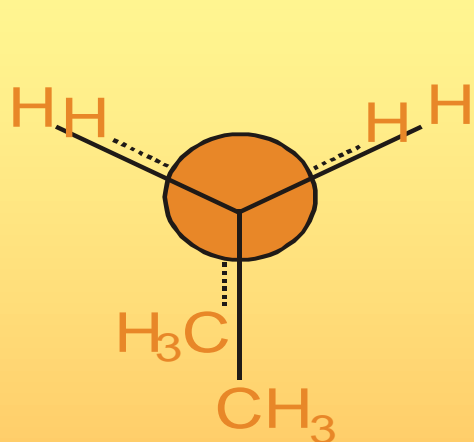


Staggered

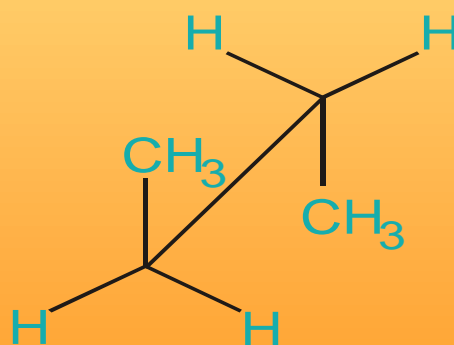
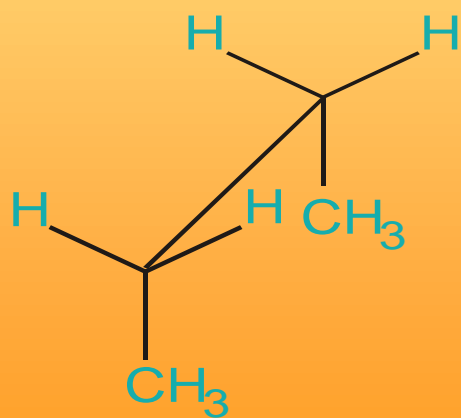


Eclipsed

# Newmann and Sawhorse projection



Newman projection



Sawhorse projection

Eclipsed

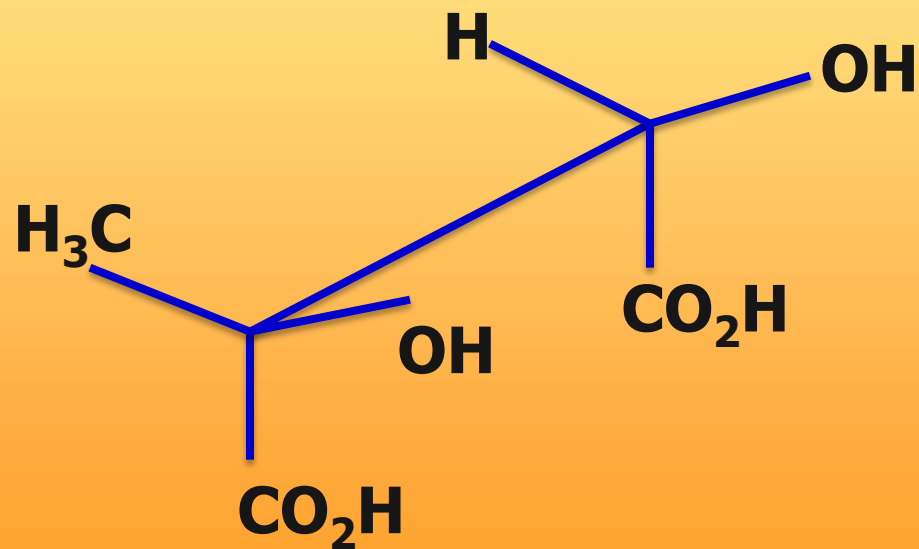
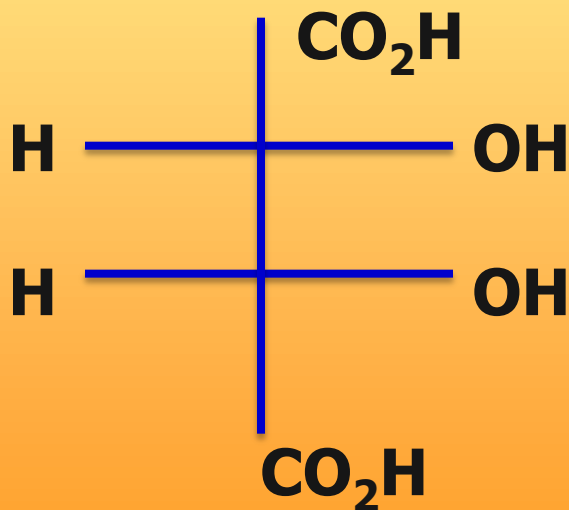
Staggered

# Interconversions

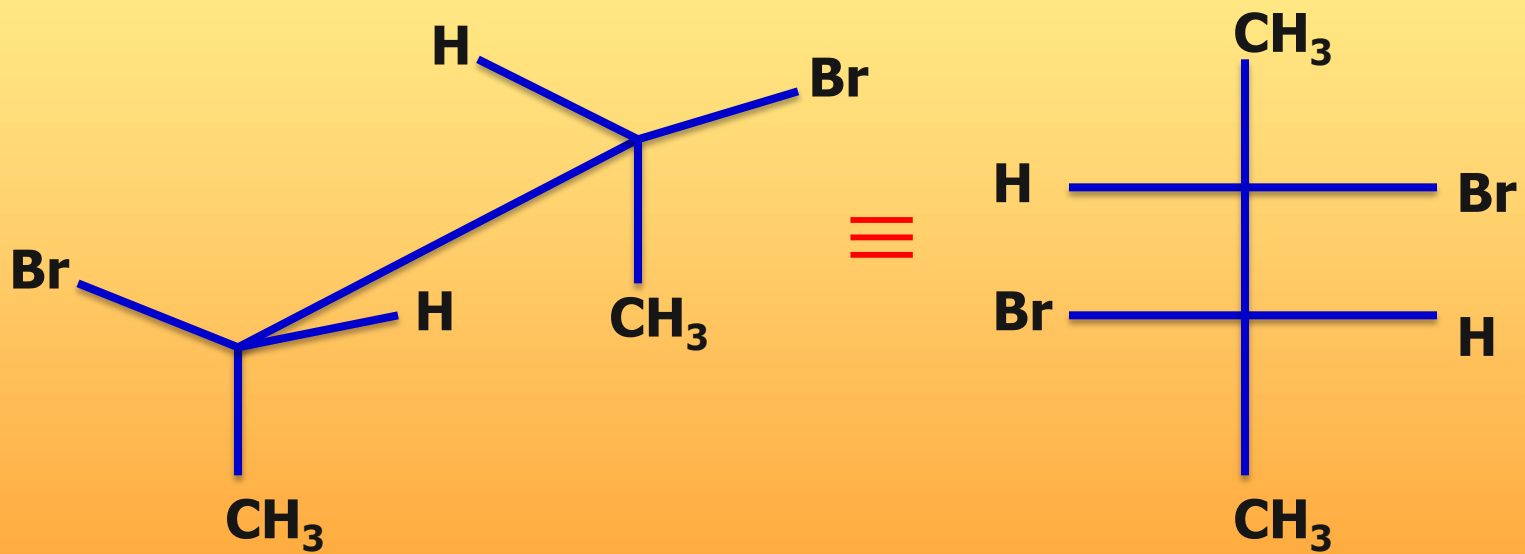
Fischer



Sawhorse

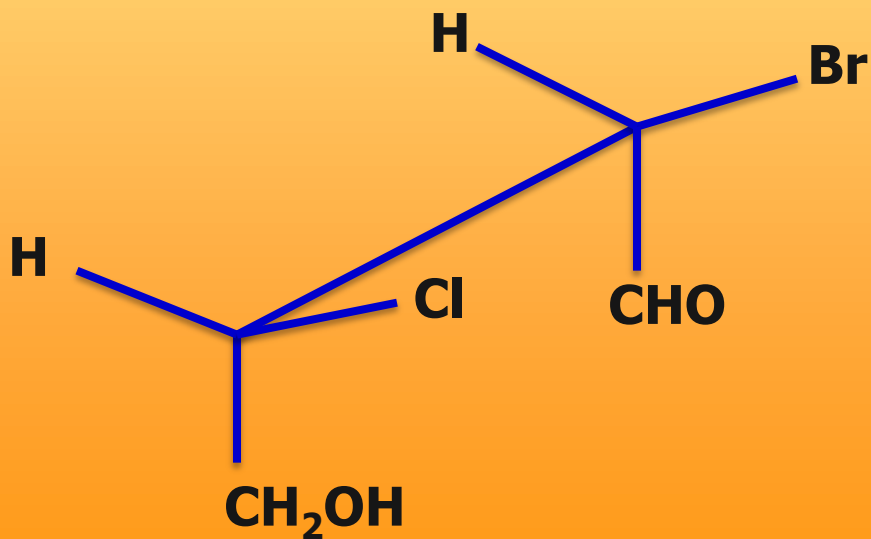
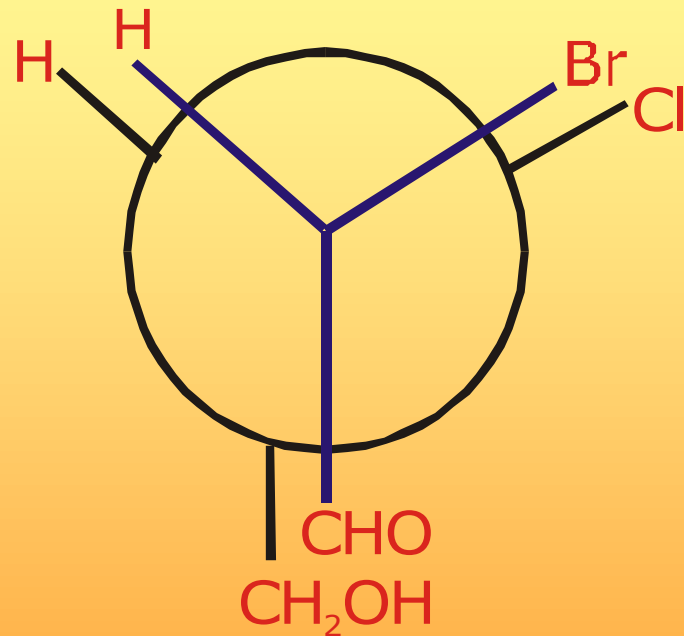
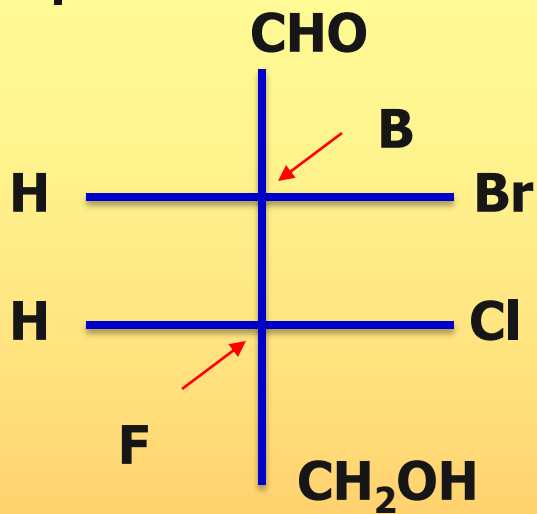


# Interconversions

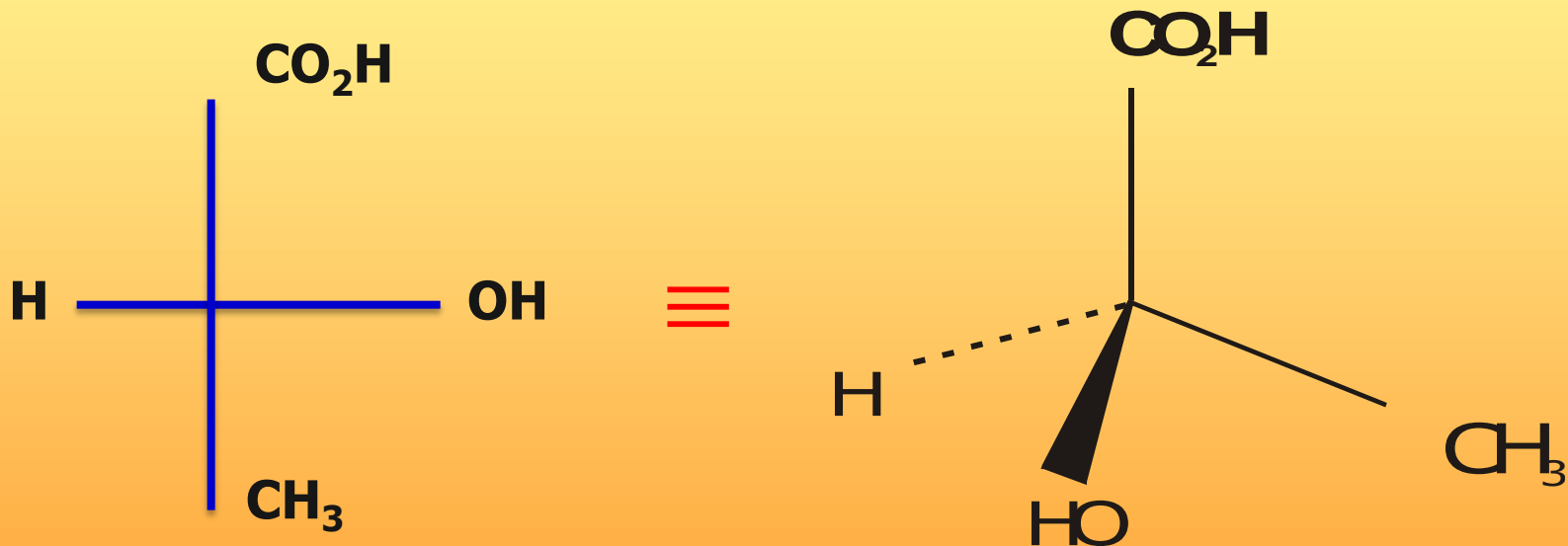




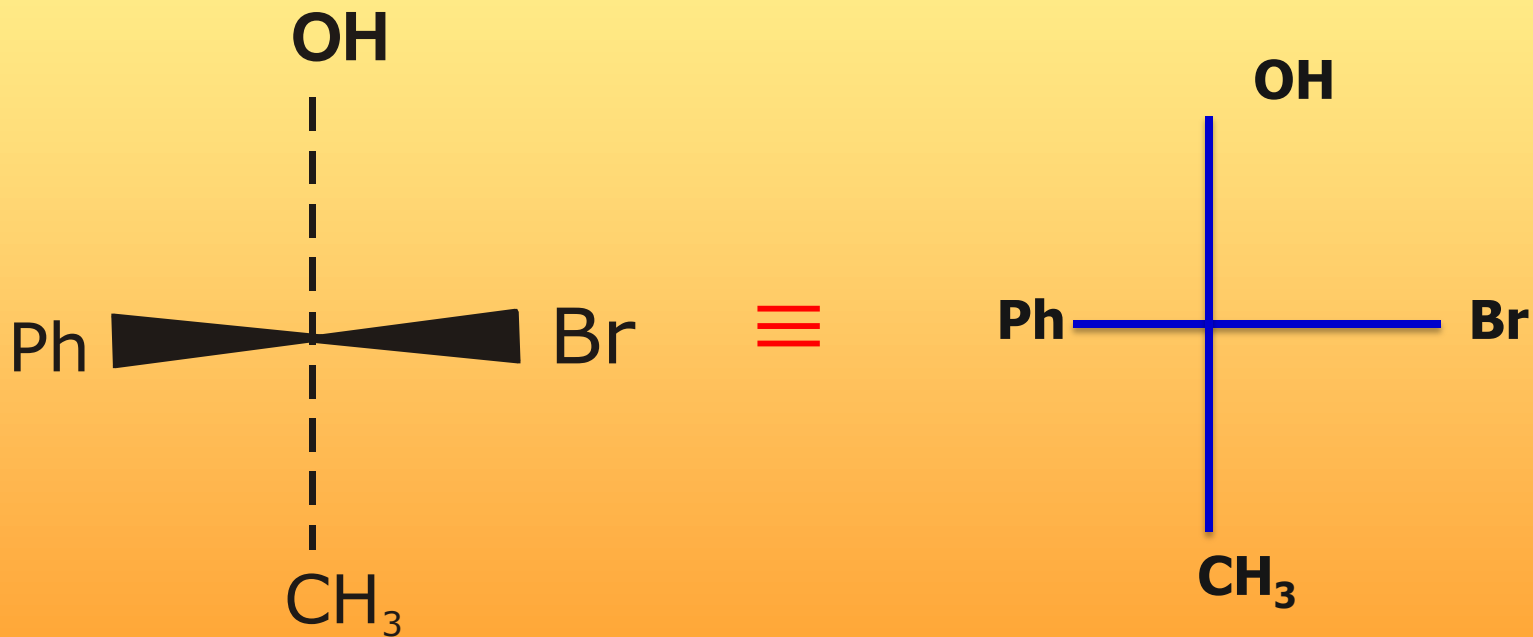
# Interconversions



# Interconversions



# Interconversions



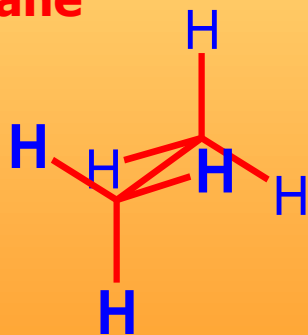
# Conformational Isomers

Results from free rotation about C-C single bond.

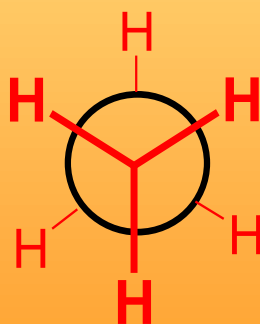
Conformers differ in energy through

- Torsional strain: through repulsive interaction between bonding electrons in adjacent  $\sigma$ -bonds.
- 'Steric strain' or 'van der Waals' strain – through space interaction between filled orbitals on groups attached to adjacent atoms.

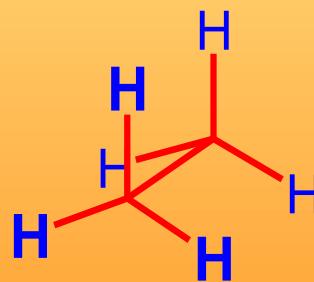
Ethane



'sawhorse'



'Newman'



'sawhorse'

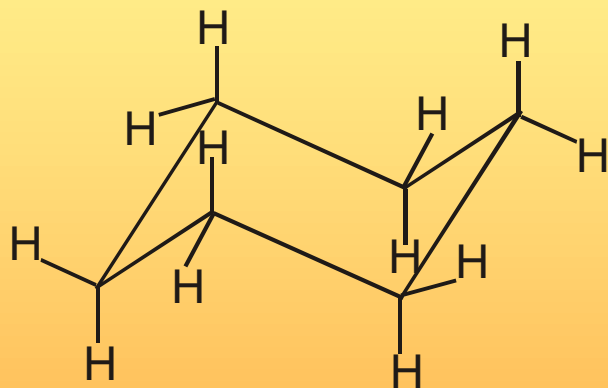


'Newman'

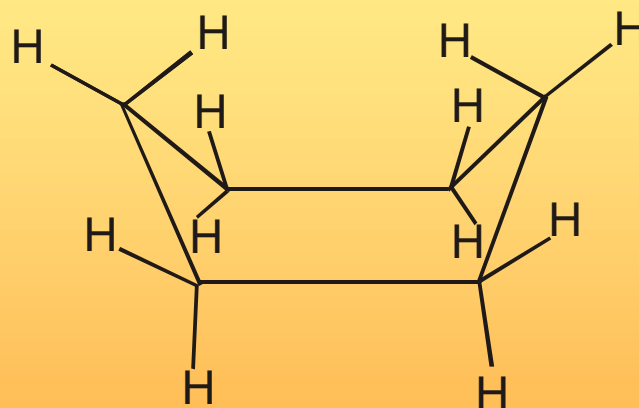
'staggered'

'eclipsed'

# Conformations of Cycloalkanes

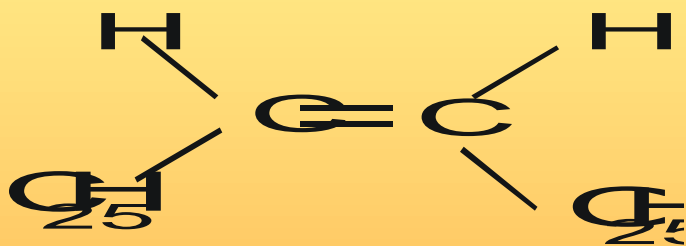


**Chair form**

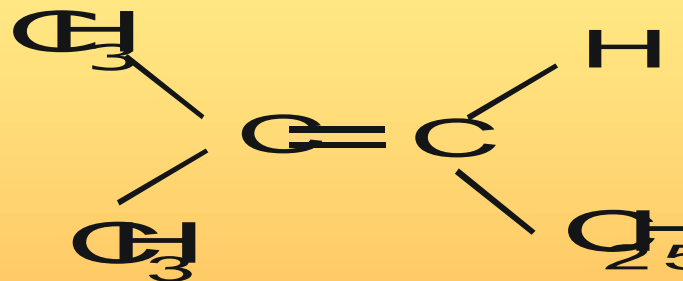


**Boat form**

# Geometrical isomerism



**Cis-isomer**



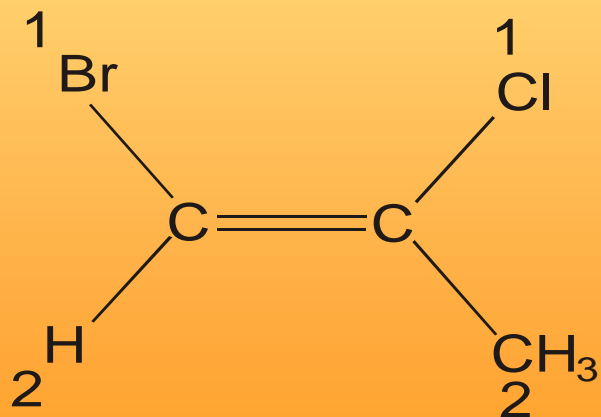
**Trans-isomer**

# E-Z configuration

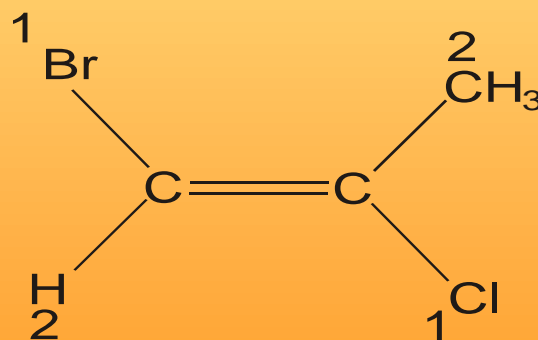
When all the groups attached to the carbon carbon double bond are different, cis trans nomenclature is not possible.

We give the priority to the groups on each carbon atom on the bases of atomic number.

Now, we see whether the high priority groups are at same side or not. For example:



Higher priority substituents on same side. Z-isomer.



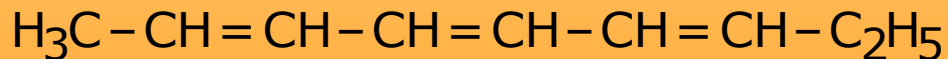
Higher priority substituents on opposite side. E-isomer.

# Geometrical isomerism

**Number of geometrical isomers =  $2^x$**   
 **$x$  = No. of double bonds**

**For compounds with two different terminal groups**

## Example



**No. of geometrical isomers =  $2^3 = 8$**



# Geometrical isomerism

Number of geometrical isomers =  $2^{x-1} + 2^{y-1}$

**For two identical terminal groups in alkene**

$y = \frac{x}{2}$  **For even no. of double bonds**

$y = \frac{x+1}{2}$  **For odd no. of double bonds**

2,4-hexadiene  $\longrightarrow$  **3 geometrical isomers**



# **Optical isomerism**

**Required asymmetric carbon atom called 'achiral'.**



# Optical isomerism

Same molecular formula but different behaviour with the plane polarised light.

1. Presence of chiral C-atom  
(for single asymmetric centre)

For more than one asymmetric centres –

1. Non-superimposable mirror images



**Enantiomers (d,l-pair)**

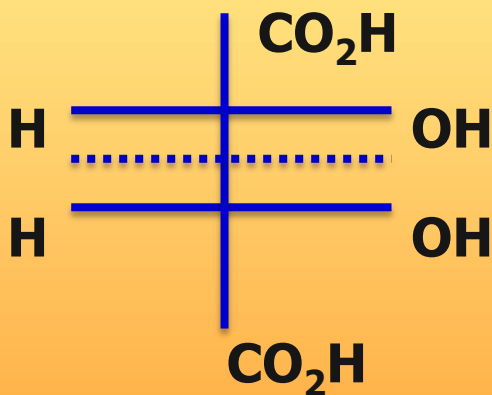
Note: Superimposable mirror images



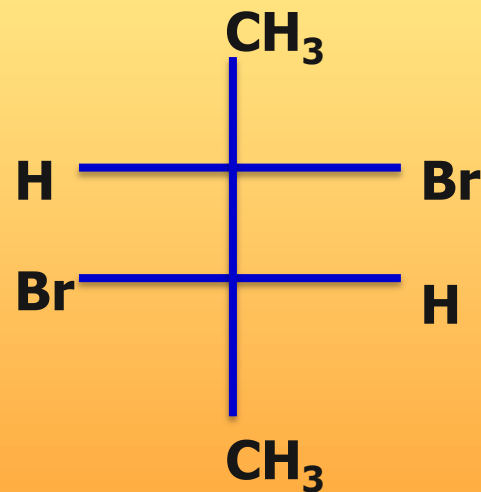
**Meso compounds**

# Optical isomerism

## 2. No plane or centre of symmetry

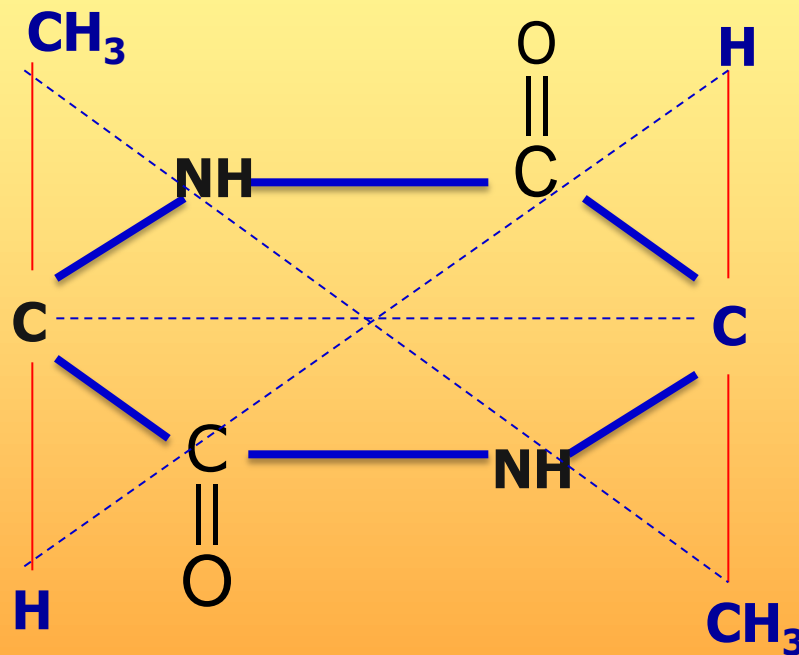


Plane of symmetry (Meso)



No plane of symmetry  
(Enantiomer)

# Optical isomerism



**Centre of symmetry results optical inactivity**



# Optical isomerism

**1. When the molecule is asymmetrical:**

**Number of enantiomers =  $2^m$**

**Number of meso isomers = 0**

**2. For symmetrical molecule with even number of asymmetric centres :**

**Number of enantiomers =  $2^{m-1}$**

**Number of meso isomers =  $2^{\left(\frac{m}{2}-1\right)}$**

# Optical isomerism

## 3. For symmetrical molecule and odd number of asymmetric centres

$$\text{Number of enantiomers} = 2^{(m-1)} - 2^{\binom{m-1}{2}}$$

$$\text{Number of meso isomers} = 2^{\frac{(m-1)}{2}}$$



**Thanks...**