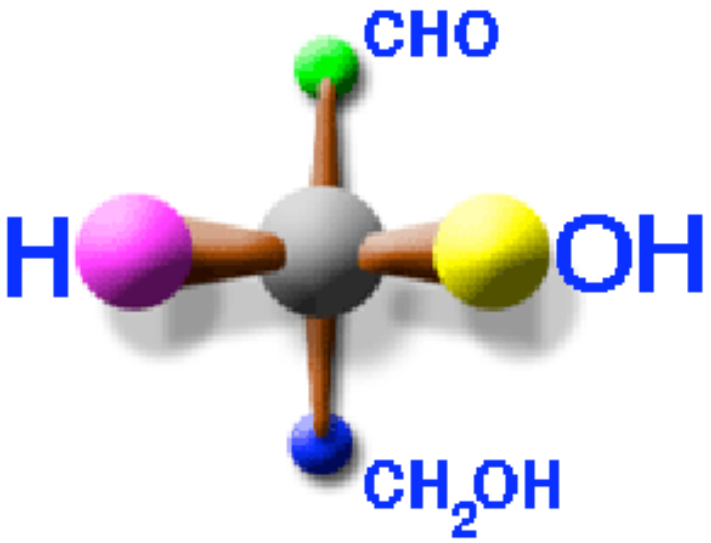
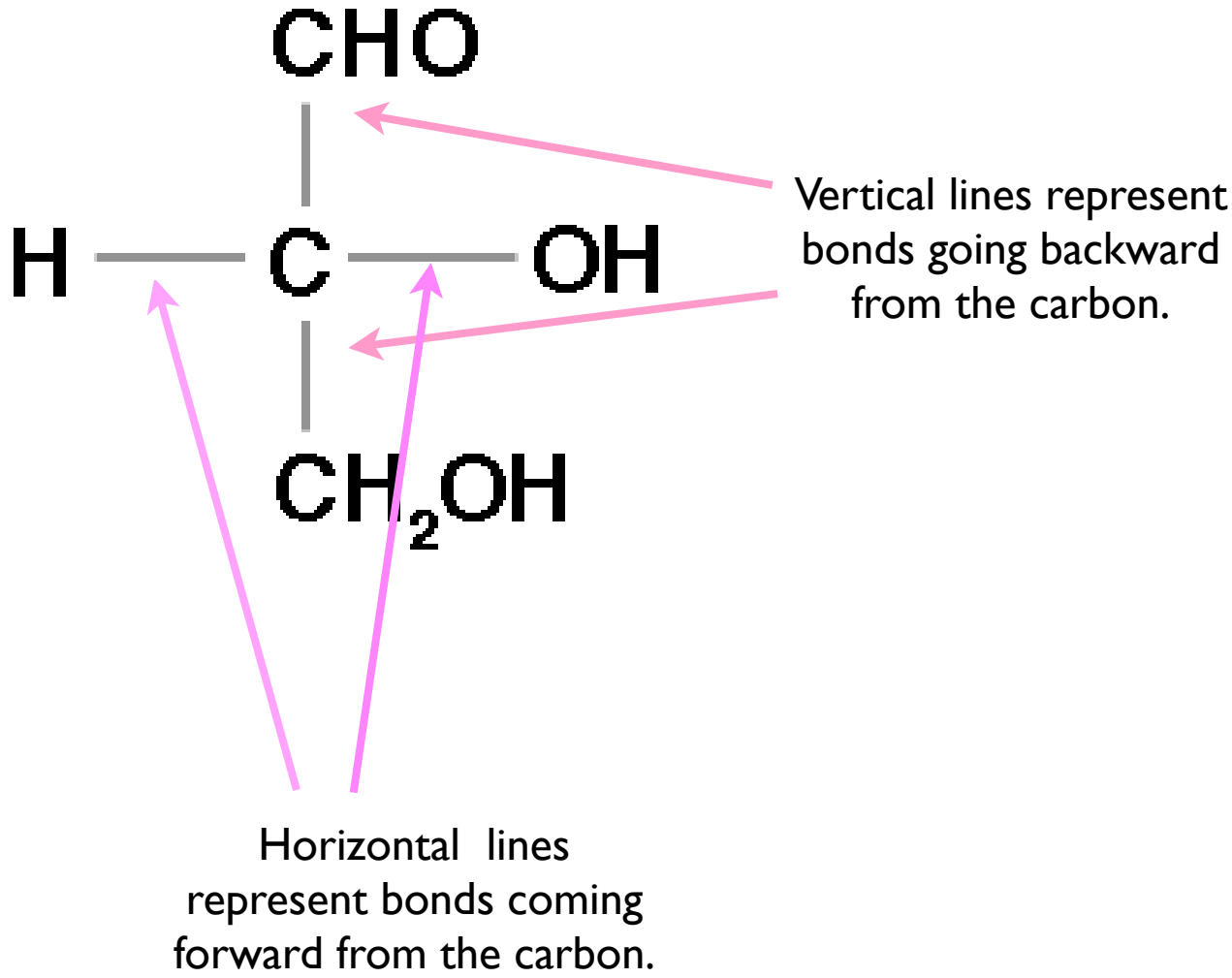
Stereochemistry - The Fischer Projection

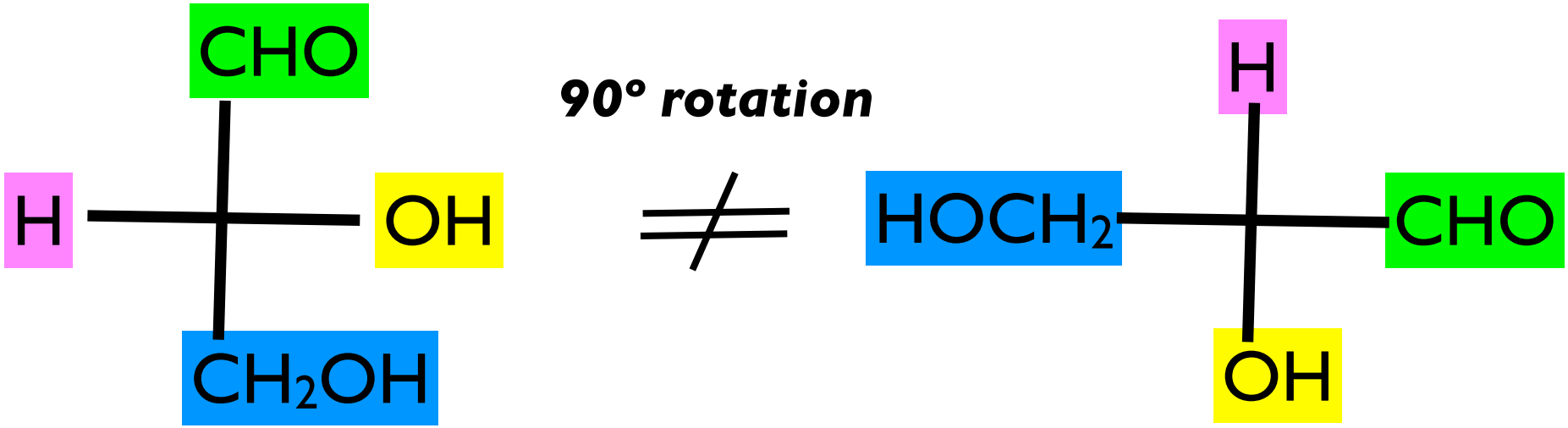
A Method for Representing Tetrahedral Asymmetric Carbons

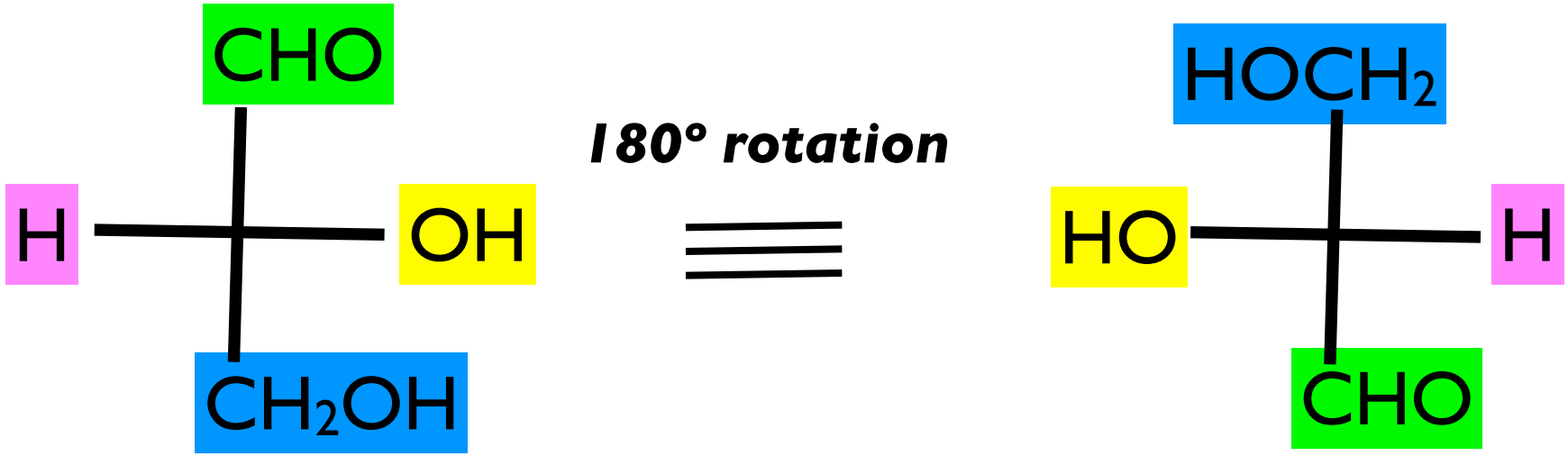




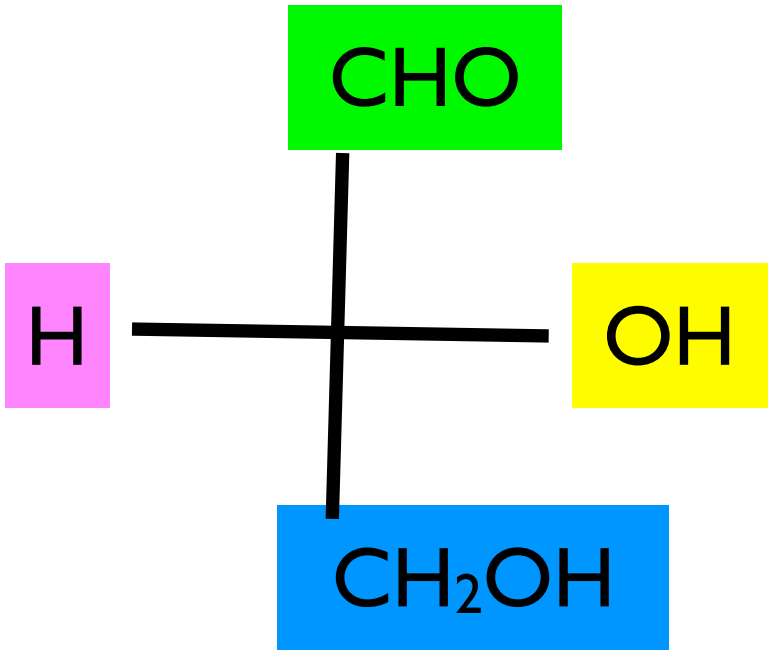
D-glyceraldehyde

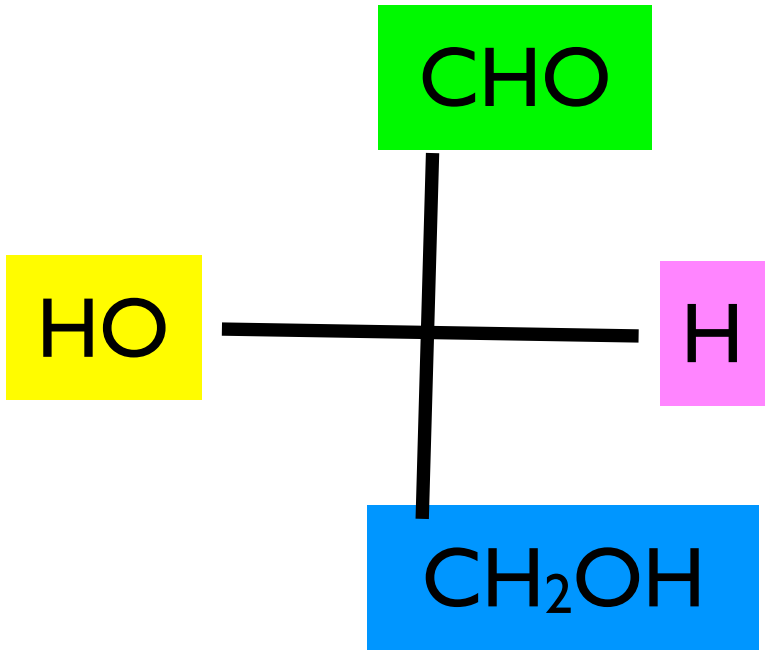
Stereochemistry - The Fischer Projection





Stereochemistry - The Fischer Projection





D-glyceraldehyde

L-glyceraldehyde

enantiomers

Stereochemistry - Diastereomers

Diastereomers - stereoisomers which **are not** mirror images .

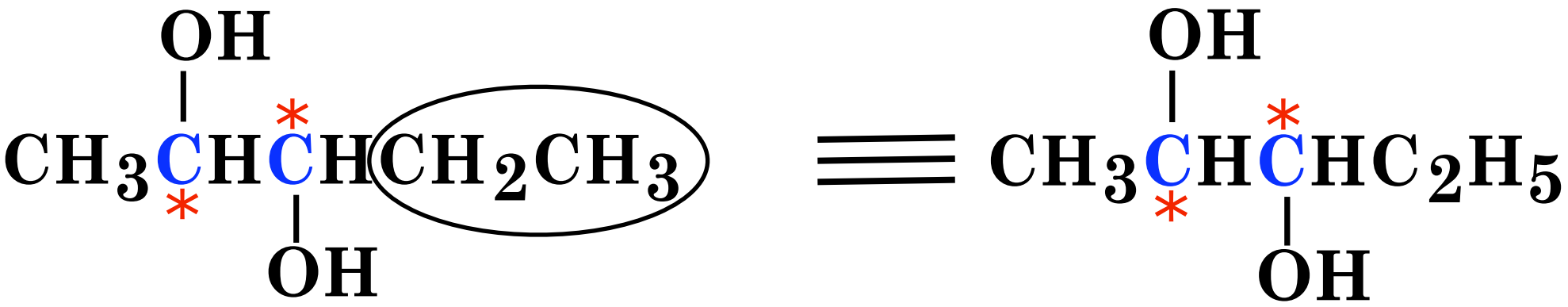
The maximum number of stereoisomers possible for a compound with ***n*** tetrahedral stereocenters is $\mathbf{2^n}$.

Note: ***Glyceraldehyde*** *has 1 stereocenter (chiral carbon) and, therefore,* $\mathbf{2^1 = 2}$ ***stereoisomers***

As ***n*** increases, the maximum number of stereoisomers increases as: 2, 4, 8, 16, 32, 64, 128 ...

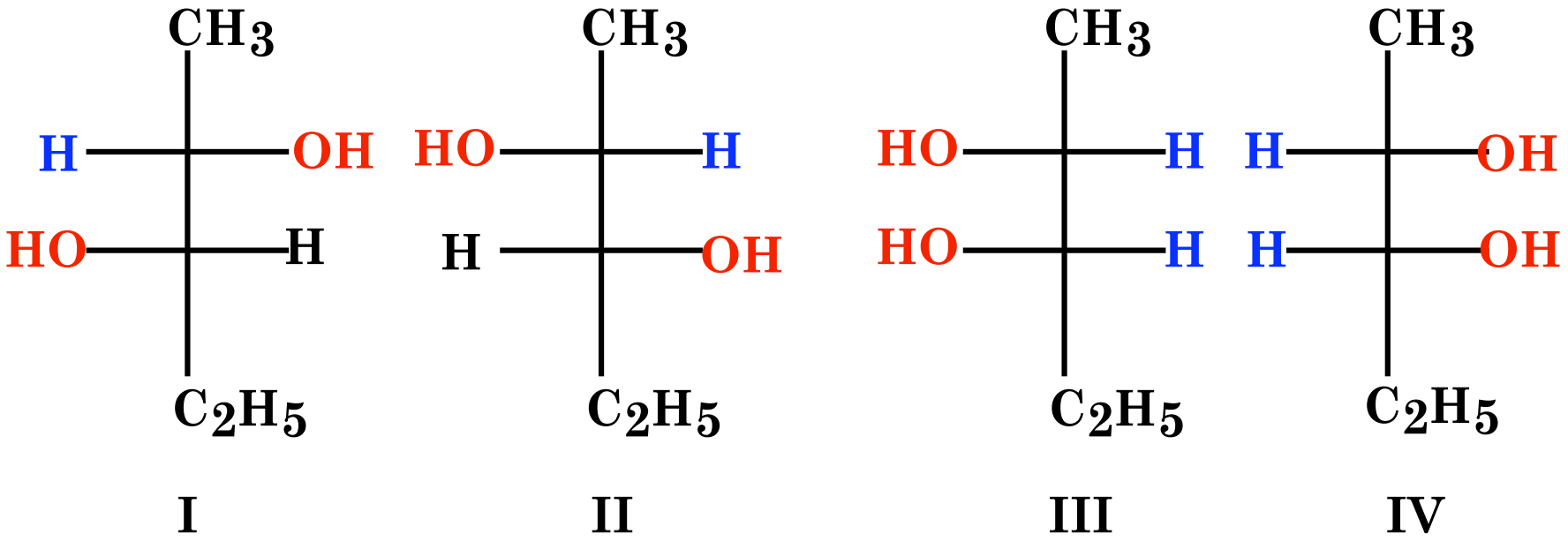
Stereochemistry - Diastereomers

Two Tetrahedral Stereocenters with Different Sets of Substituents

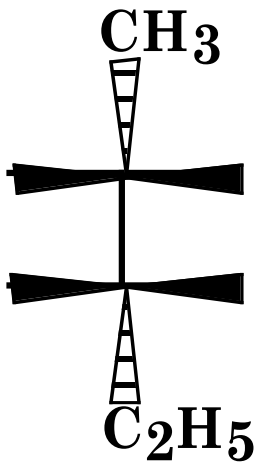


In **2,3-pentanediol**, there are **2 x 2 = 4 stereoisomers** differing from one another in the configurations at C2 and C3.

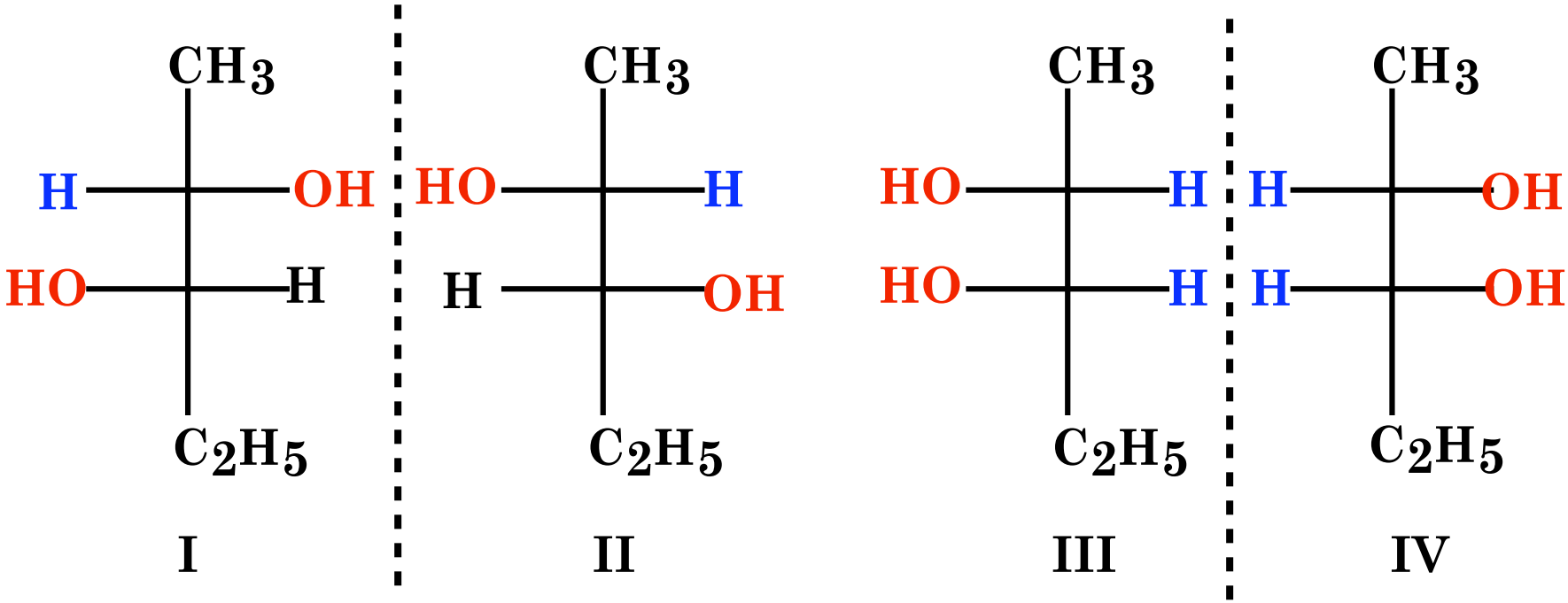
Stereochemistry - Diastereomers



(The vertical bond between C2 and C3 in these four structures can be considered to be in the plane of the paper, with the bonds to C1 and C4 extending below the plane of the screen.)



Stereochemistry - Diastereomers

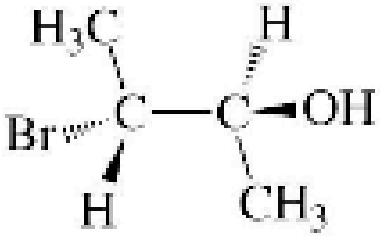


Compounds I and II are **enantiomers** of each other.

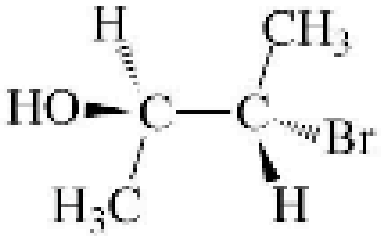
Compounds III and IV are **enantiomers** of each other.

Compounds I and III are **diastereomers.**
Compounds I and IV are **diastereomers**.
Compounds II and III are **diastereomers.**
Compounds II and IV are **diastereomers.**

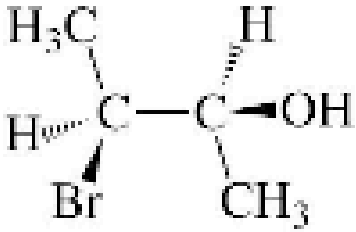
Stereochemistry - Diastereomers



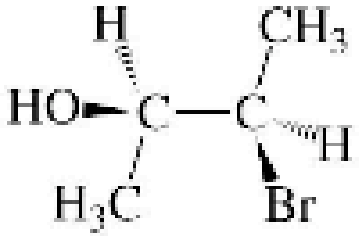
(2*S*,3*R*)-3-bromo-2-butanol



(2*R*,3*S*)-3-bromo-2-butanol

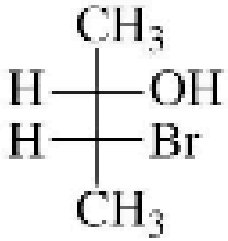


(2*S*,3*S*)-3-bromo-2-butanol

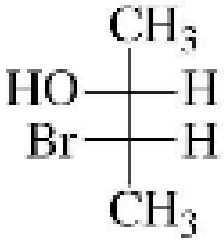


(2*R*,3*R*)-3-bromo-2-butanol

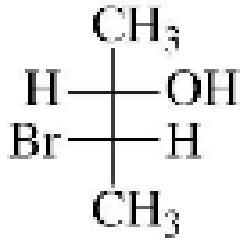
perspective formulas of the stereoisomers of 3-bromo-2-butanol



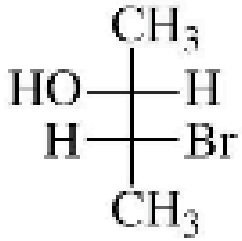
(2*S*,3*R*)-3-bromo-2-butanol



(2*R*,3*S*)-3-bromo-2-butanol



(2*S*,3*S*)-3-bromo-2-butanol



(2*R*,3*R*)-3-bromo-2-butanol

Fischer projections of the stereoisomers of 3-bromo-2-butanol

Diastereomers - Physical Properties

1) **Diastereomers may be optically active** but, unlike enatiomers, a pair of diastereomers may have specific rotations that differ in magnitude and direction of rotation.

2) **Diastereomers differ in other physical properties** such as MP, BP, and solubility. They also usually differ in their chemical properties.

3) ***DIASTEREOMERS ARE PHYSICALLY UNRELATED EXCEPT FOR POSSESSING THE SAME CHEMICAL FORMULAS.***

Diastereomers - Biological Properties

1) Many biological molecules contain more than one tetrahedral stereocenter.

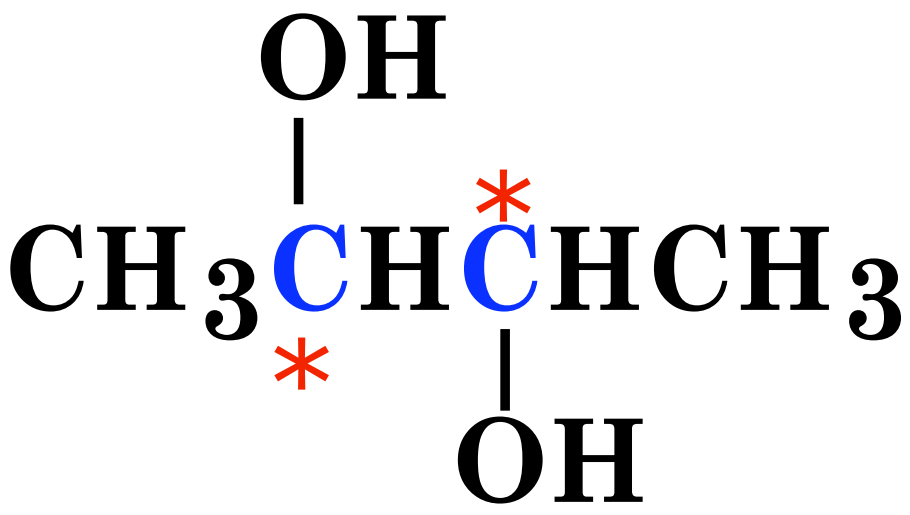
2) Each biological molecule represents exactly one out of the possible stereoisomers

3) Starch and cellulose are polymers of glucose and may contain hundreds or thousands of stereocenters. D-glucose has four stereocenters.

4) Proteins consist of polymers of from 100 to several 1000 amino acids. Most amino acids have one stereocenter,and every amino acid in a protein is an L-amino acid.

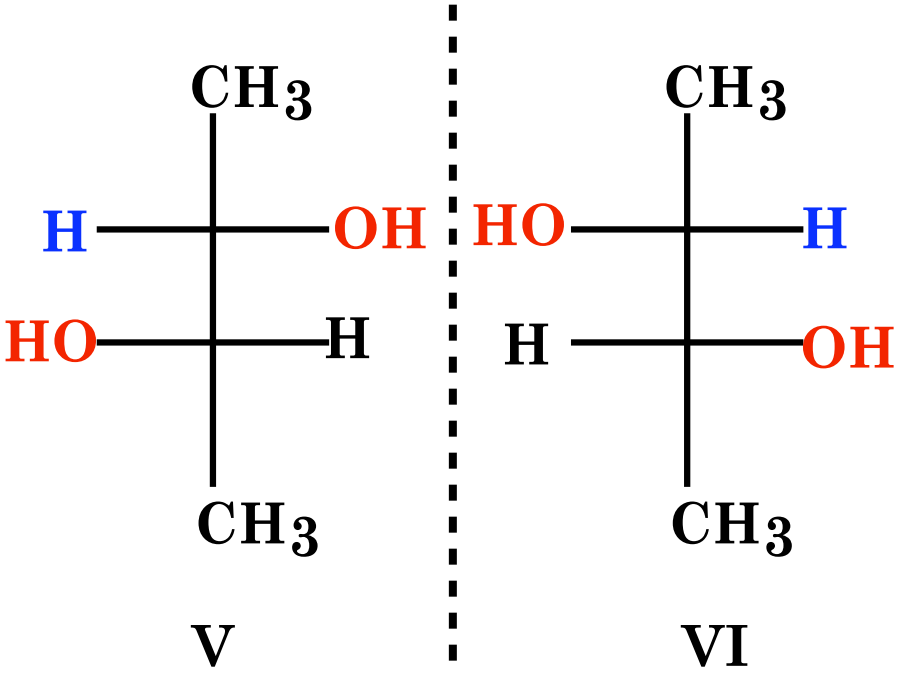
Stereochemistry - Diastereomers

Two Tetrahedral Stereocenters with the Same Sets of Substituents

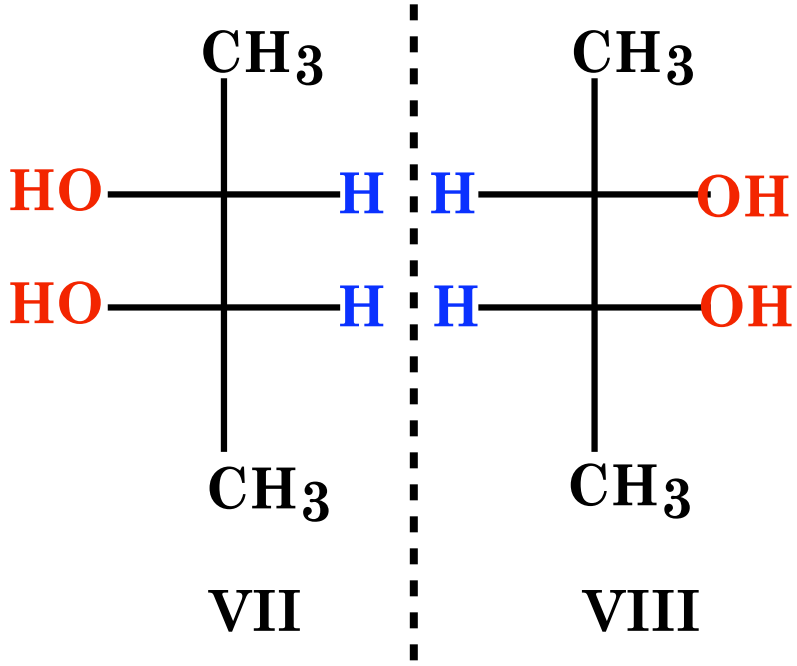


In 2,3-butanediol, there are 2 tetrahedral stereocenters, however, 2 of the 4 combinations of stereocenters represent the same molecule.

Stereochemistry - Diastereomers

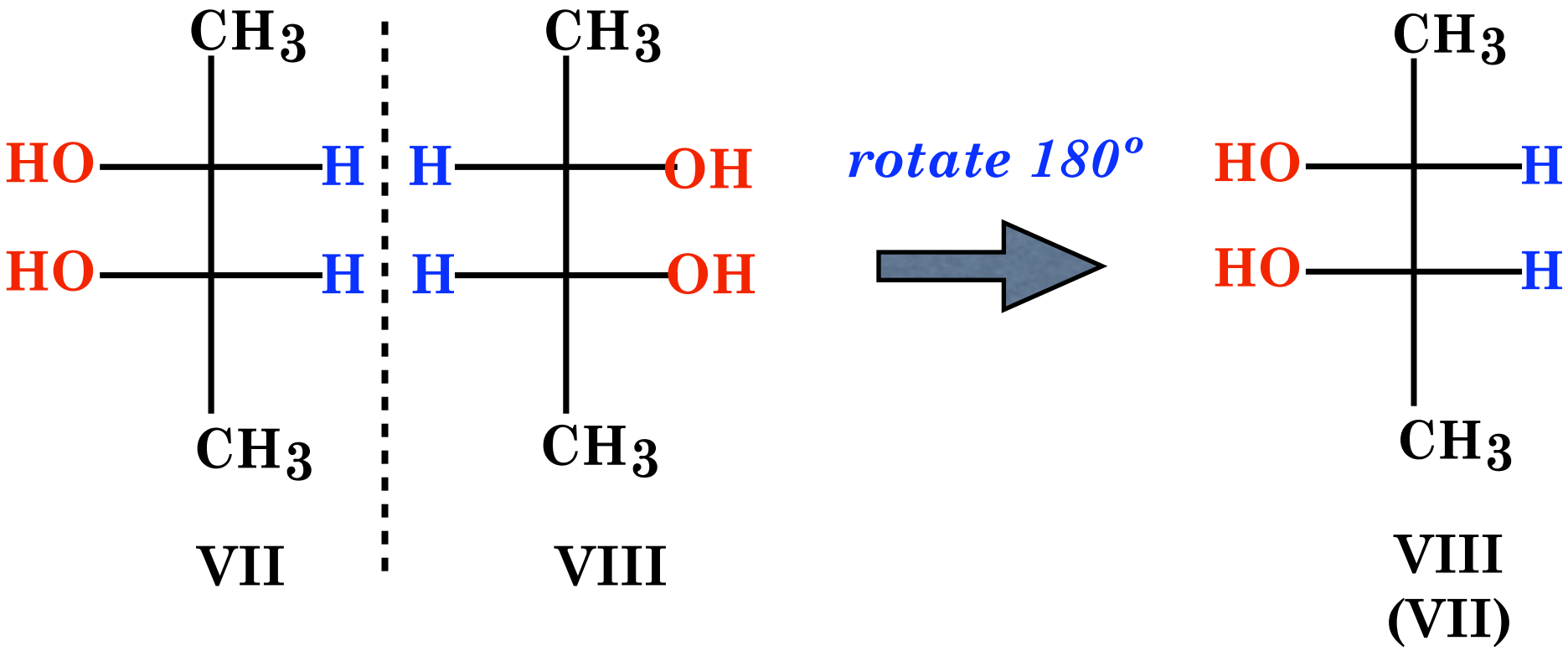


Compounds V and VI are **enantiomers** of each other.



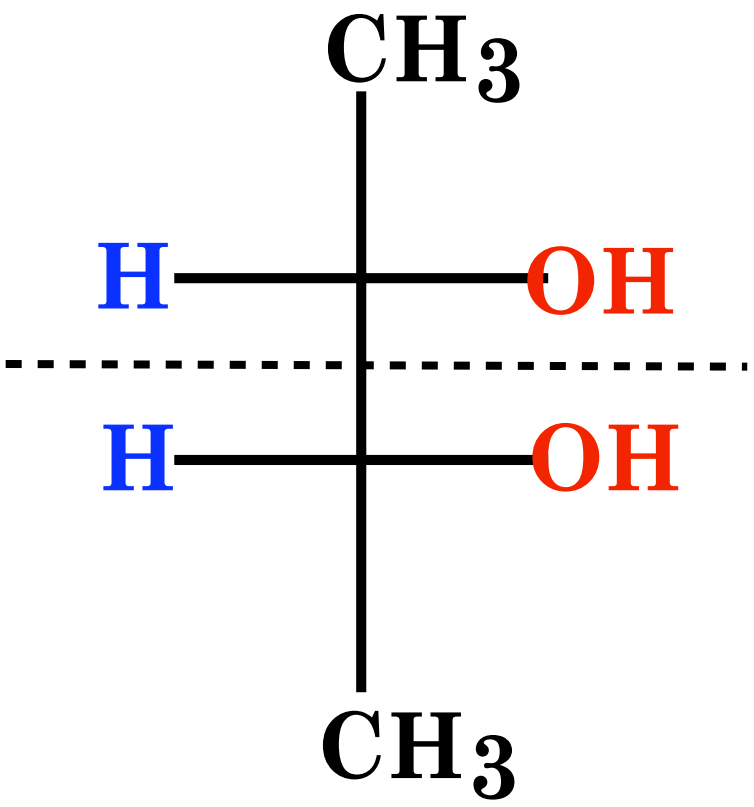
Compounds VII and VIII **appear to be enantiomers** of each other.

Stereochemistry - Meso Compounds



Structures VII and VIII are superimposable and represent the SAME COMPOUND !!!!

Stereochemistry - Meso Compounds

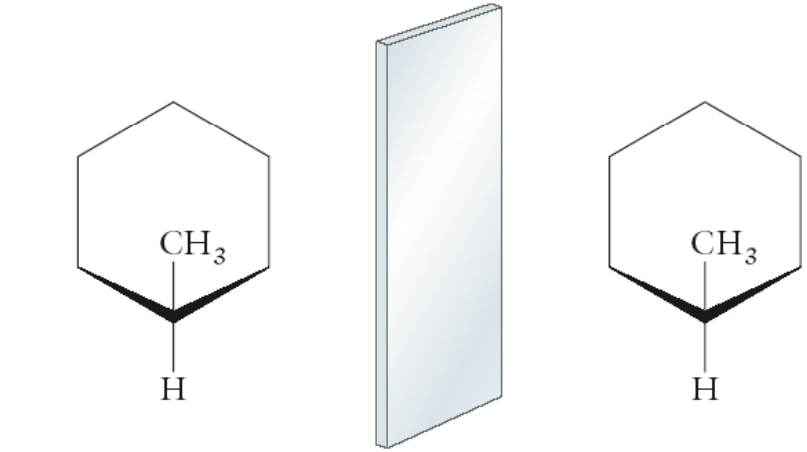


Notice that the molecule possesses an **internal plane of symmetry**, i.e., one half of the molecule is a reflection of the other. Such molecules are called **meso compounds** and are **optically inactive** even though they possess tetrahedral stereocenters.

Stereochemistry - Cyclic Compounds

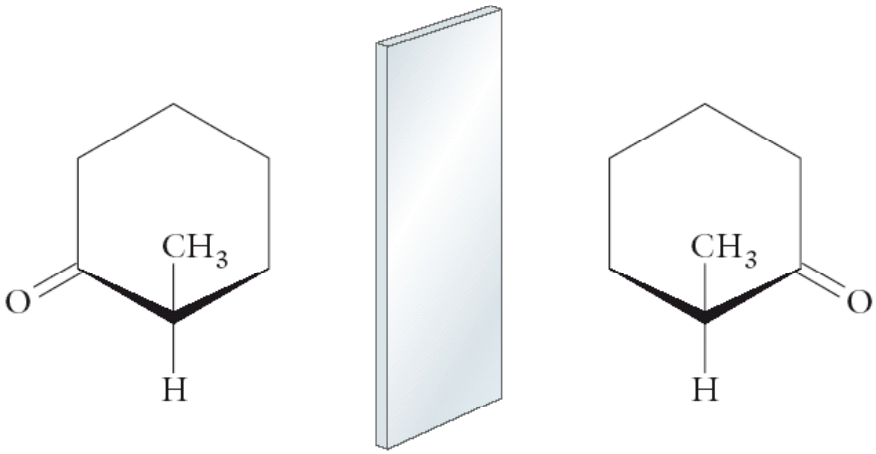
A ring carbon is a tetrahedral stereocenter if

1) The two nonring substituents are different, and
2) The ring is not symmetrical with respect to the specific carbon



(a) Methylcyclohexane

The two nonring substituents are different.
The two halves of the ring on each side of C1 are the same.
There is no tetrahedral stereocenter.



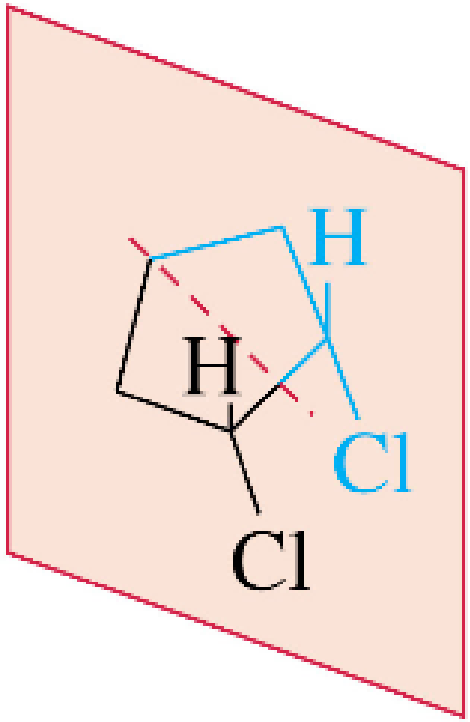
(b) 2-Methylcyclohexanone

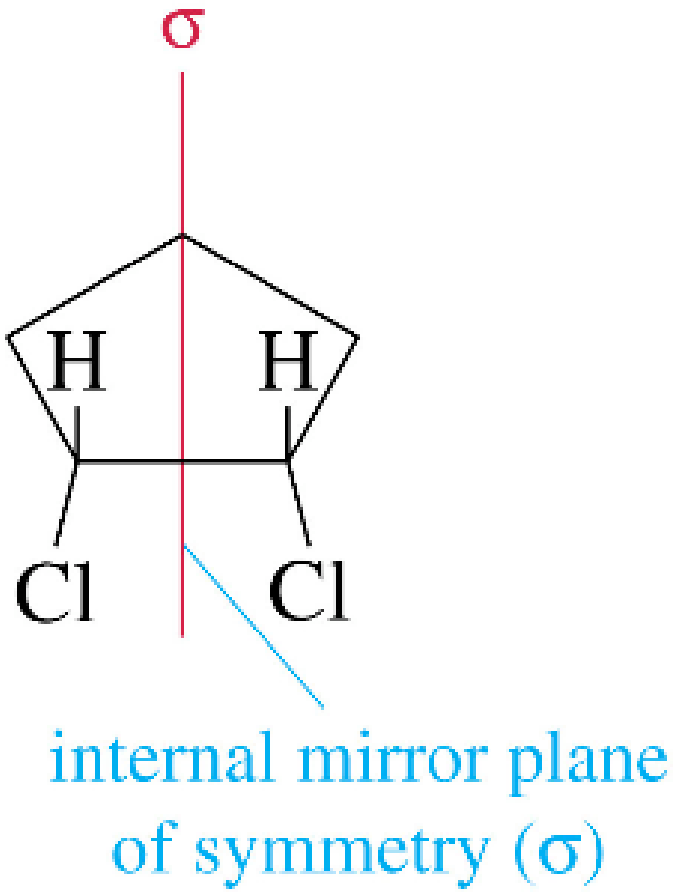
The two nonring substituents are different.
The two halves of the ring on each side of C2 are different.
C2 is a stereocenter.
2-Methylcyclohexanone exists as a pair of enantiomers.

Stereochemistry - Cyclic Compounds

Two Tetrahedral Stereocenters in a Cyclic Structure

cis-1,2-dichloro cyclopentane



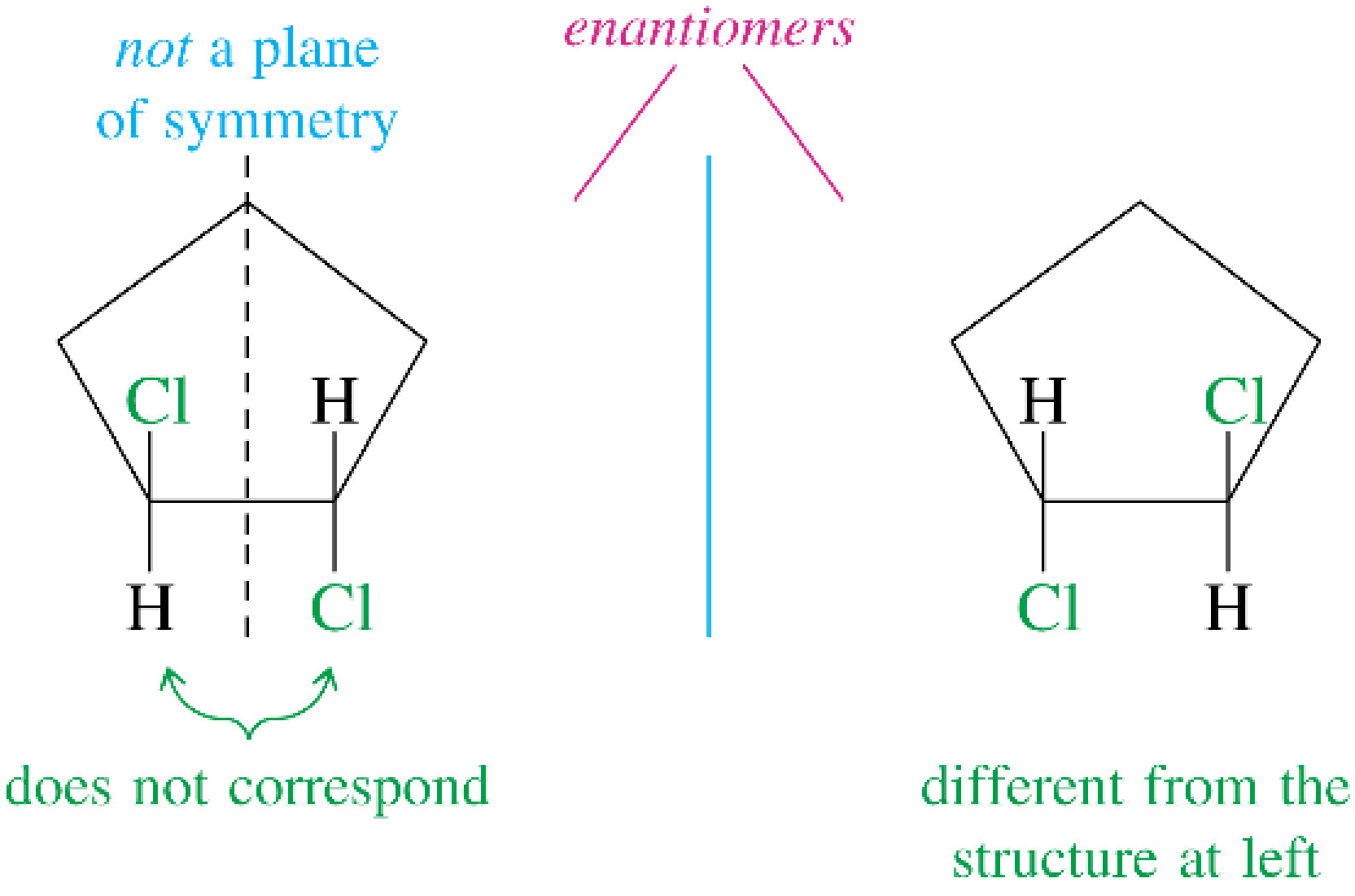


a meso compound

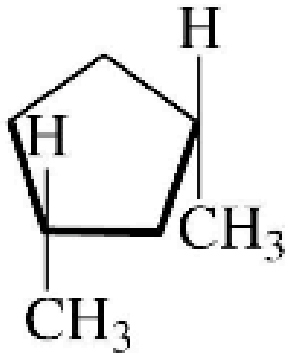
Stereochemistry - Cyclic Compounds

Two Tetrahedral Stereocenters in a Cyclic Structure

***trans*-1,2-dichloro cyclopentane**

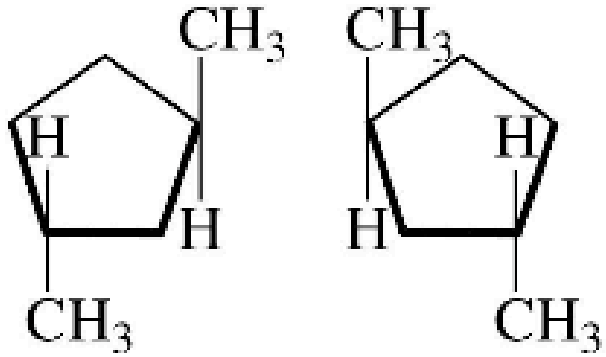


Stereochemistry - Cyclic Compounds



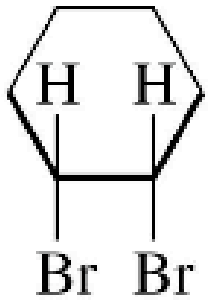
cis-1,3-dimethylcyclopentane

a meso compound



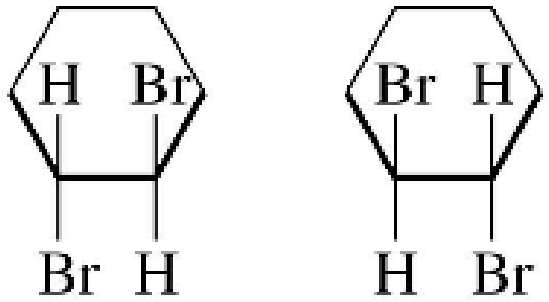
trans-1,3-dimethylcyclopentane

a pair of enantiomers



cis-1,2-dibromocyclohexane

a meso compound



trans-1,2-dibromocyclohexane

a pair of enantiomers