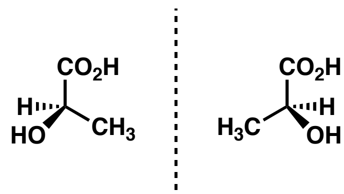
CHEM 6352 Organic Reactions & Synthesis
Principles of Asymmetry

<u>Criteria For Chirality</u>

If a structure lacks all symmetry elements, it is

ASSYMMETRIC,

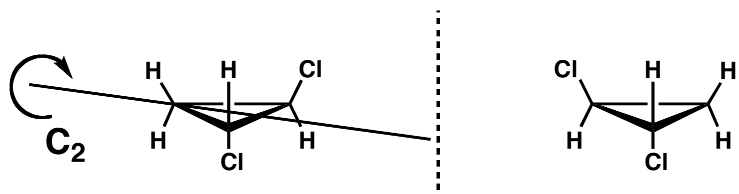
(point group C_1), nonsuperimposable on its mirror image and chiral.



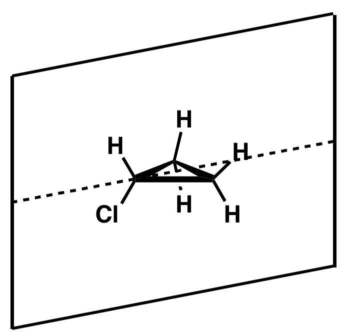
If a structure lacks a plane of symmetry but has other symmetry elements, it is

DISSYMMETRIC,

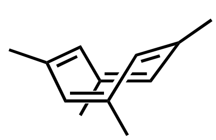
nonsuperimposable on its mirror image, and chiral. Note that an asymmetric structure is dissymmetric, but a dissymmetric structure is not necessarily asymmetric.



If a structure possesses a plane of symmetry, it will be achiral (i.e., superimposable on its mirror image).

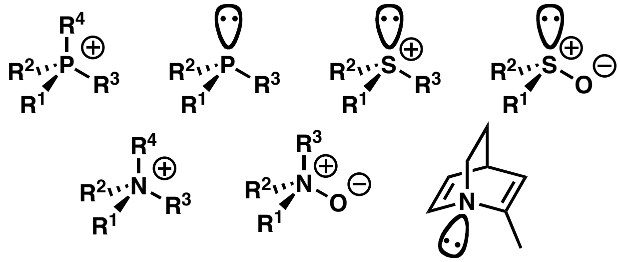


A plane of symmetry is a sufficient but not a necessary condition for achirality. Another sufficient condition is that the molecule possess a rotation-reflection axis, S_n, where n is even.

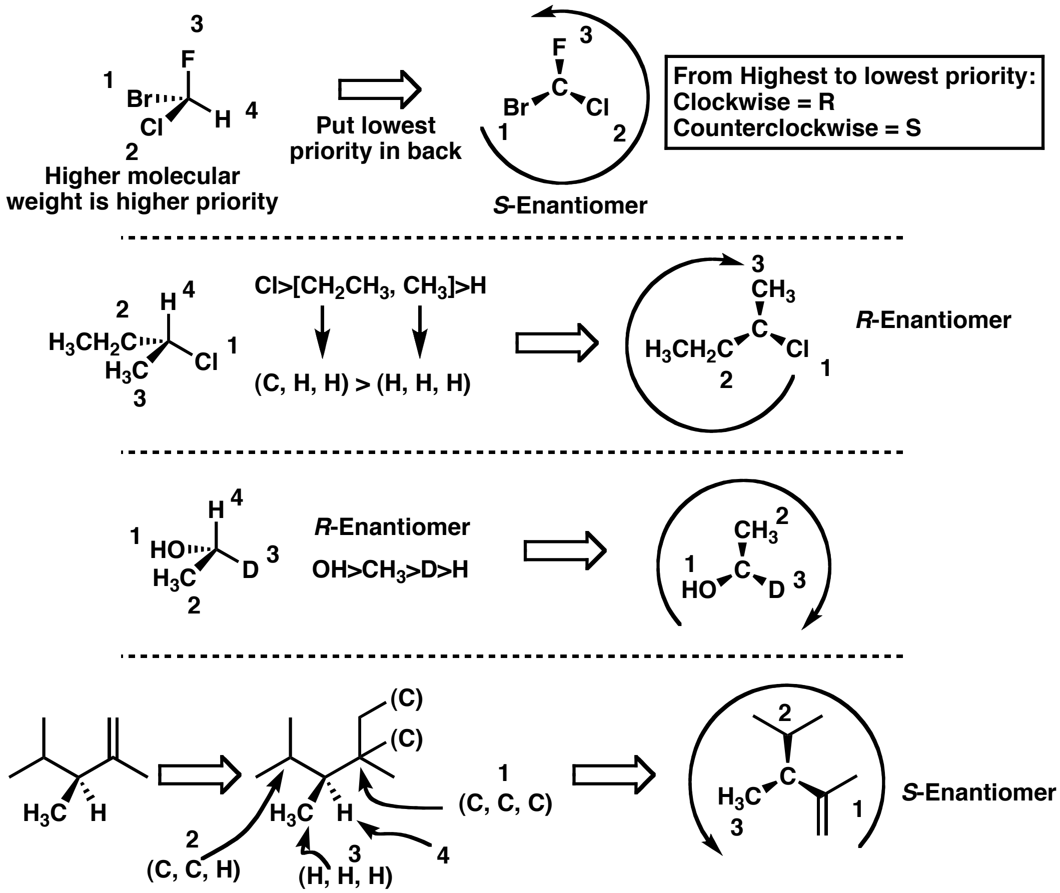


Restricted Heteronuclear Geometries

The following have restricted geometries and are hence stereogenic:

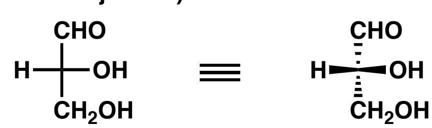


The Sequence Rule (Cahn-Ingold-Prelog Convention)



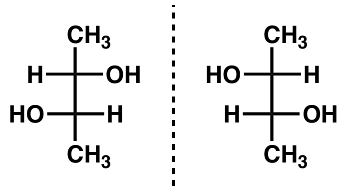
Multiple Chiral Centers

(Fischer Projection)

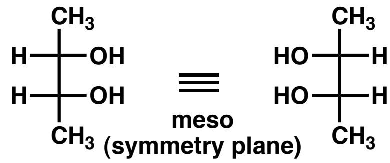


R-(+)-glyderaldehyde
D-glyceraldehyde

The D and L convention (carbohydrates): Note the D≠d. D or L refers to the right- or left-hand, respectively, position of the OH substituent on the highest numbered asymmetric carbon in a Fischer Projection.



2*S*,3*S*-butane-2,3-diol **2*R*,3*R*-butane-2,3-diol**

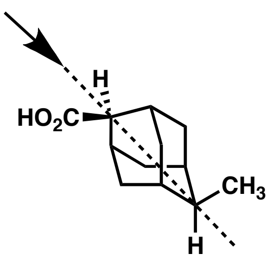


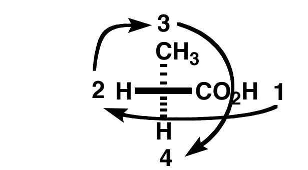
2*S*,3*R*-butane-2,3-diol **2*R*,3*S*-butane-2,3-diol**

2*S*,3*S* and 2*R*,3*R* are **enantiomeric** (C_2 axis of rotation). 2*S*,3*R* is a **meso** compound, so its mirror image gives the same compound. The [2*S*,3*S* and 2*S*,3*R*] or [2*R*,3*R* and 2*S*,3*R*] are **epimers** (inversion of stereochemistry at one stereocenter).

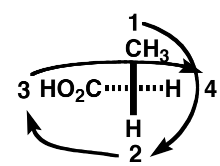
The erythro and threo convention: When drawn in a Fischer projection, erythro isomers have the two non-hydrogen substituents on the same side. Hence 2*S*,3*R* is erythro while 2*S*,3*S* and 2*R*,3*R* are threo.

Chiral Axes

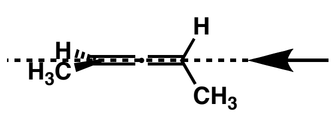


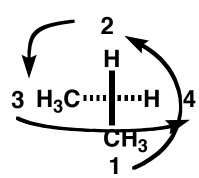


(Near groups > Far groups)
***R*-Enantiomer**

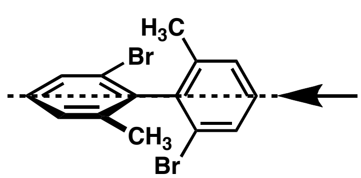


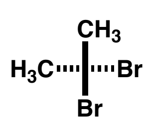
From other direction
***R*-Enantiomer**





***S*-Enantiomer**





***R*-Enantiomer**