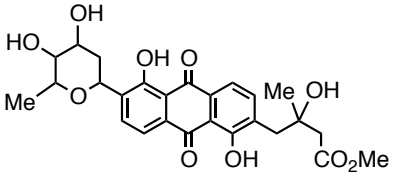


Chirality and Stereochemistry
Learning Objectives

As we study this chapter, you should...

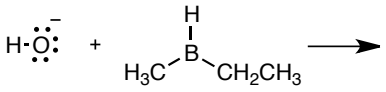
1) Be able to recognize asymmetric centers in molecules and when they are formed in reactions.

Ex. 1: Identify the chiral centers in the following compound, which was reported in 2006 in the *Journal of the American Chemical Society* by S.F. Martin, et.al., to have anti-tumor activity.



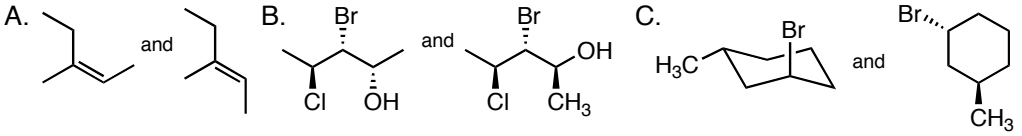
Vineomycinone B_2 methyl ester

Ex. 2: How many possible products are formed when hydroxide undergoes a Lewis acid-base reaction with the boron compound shown below? Provide a mechanism for the reaction.



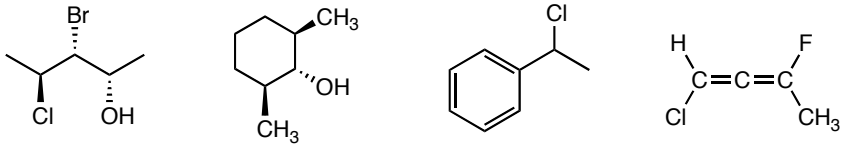
2) Be able to recognize when two or more molecules are identical, nonisomers, constitutional isomers, conformers, enantiomers, or diastereomers.

Ex. 3: Define the relationship between the following sets of compounds.



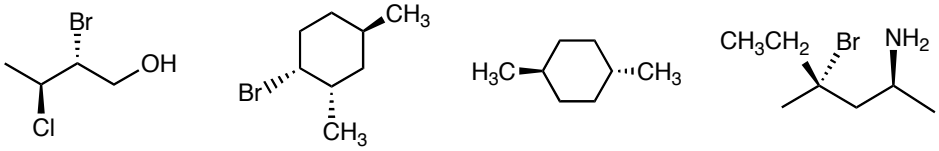
3) Be able to recognize when a compound is chiral or achiral (or meso).

Ex. 4: Determine whether the following compounds are chiral or achiral. If achiral, indicate whether the compound is meso.



4) Be able to incorporate stereochemistry into organic nomenclature.

Ex. 5: Provide unambiguous names for the following compounds.



5) Understand that chiral compounds interact with plane polarized light and with other chiral compounds in ways that achiral compounds might not.
   a) Understand how these interactions can affect biological systems and how they can be used to separate stereoisomers.
   b) Understand optical activity & enantiomeric excess

6) Know all the definitions on the back of this handout and be able to apply them where appropriate. For example, did you know that all chiral compounds are optically active and each has an enantiomer that rotates plane polarized light? Some chiral compounds have optically inactive stereoisomers, and some have optically active stereoisomers that are not enantiomers (they are diastereomers). Were these two previous statements confusing to you? If so, this is a signal to you that you still need to know stereochemistry well enough such that these two sentences (and others like it) make perfect sense.

Note: the above examples *do not* represent *all* the possible types of questions you will encounter. You'll encounter other types when you practice problems from OCHeM.com or from your text.

Stereochemistry Terms

This is a definition intensive topic. You should know and be able to identify & apply the following terms:

A. Stereoisomers: **isomers that differ in the spatial arrangement of their atoms.**

B. Constitutional Isomers: **isomers that differ in the connectivity of their atoms.**

C. Chiral: **a molecule that is not superposable on its mirror image.**

D. Achiral: **a molecule that is superposable on its mirror image.**

E. Enantiomers: **stereoisomers that are nonsuperposable mirror images.**

F. Diastereomers: **stereoisomers that are nonsuperposable, but not mirror images.**

G. Optical Activity: **refers to the ability of molecules to rotate plane polarized light.**

1. Optically active: **a sample which rotates plane polarized light.**
2. Optically inactive: **a sample which does not rotate plane polarized light.**

H. Racemic mixture: **a 50:50 mixture of enantiomers. A racemic mixture is optically inactive.**

I. Meso: **describes a molecule which contains stereocenters but is achiral.**

J. Chiral or Asymmetric Center: **an atom connected to 4 different groups.**

K. Stereocenter or Stereogenic center: **an atom which,when two of its attached groups are switched, produces a stereoiosmer of the original molecule.**

L. Plane polarized light: **light which occupies a single plane.**

M. Cahn-Ingold-Prelog nomenclature system

1) prioritize the groups attached to the chiral center (higher M.W.=higher priority [#1]). In case of a tie, the first point of difference determines the priority.

2) view the chiral center such that the lowest priority group points away from you.

3) draw a curved arrow from the highest to lowest priority groups (1-2-3).

a) an arrow going clockwise indicates an absolute configuration of (R).

b) an arrow going counterclockwise indicates an absolute configuration of (S).

N. (*R*) vs (*S*) : **based on the Cahn-Ingold-Prelog nomenclature system. Indicates absolute configuration of a chiral center.**

O. (*d*) vs (*l*) : **indicates whether a sample rotates plane polarized light clockwise (*d*) or counterclockwise (*l*).**

P. (+) vs (-) : **indicates whether a sample rotates plane polarized light clockwise (+) or counterclockwise (-).**

Q. Absolute configuration : **the (*R*) or (*S*) designation of a chiral center.**

R. Relative configuration : **any designation that depends on a reference point (e.g. another substituent) in a molecule. For example: cis & trans, anti & syn, gauche**

S. The terms specific rotation, observed rotation, observed specific rotation, enantiomerically pure, and enantiomeric excess refer to quantitative aspects of optical activity & concentrations