Chapter 5: Stereoisomers

• NOT Constitutional Isomers (Connectivity is the Same)

• Include cis/trans Isomers Seen in Substituted Alkenes

• Enantiomers: Nonsuperposable Mirror Images

• Diastereomers: Stereoisomers; Not Mirror Images

• All Enantiomers are Diastereomers; NOT all Diastereomers are Enantiomers

• This Chapter: Classifying and Naming Stereoisomers; Recognizing Chiral Atoms and Molecules
Isomers: The Flavors

• We Want to Give an Isomer the Most Specific Classification The We Can (More Information)

• Constitutional Isomers: Different Connectivity

• Stereoisomers: How to Identify/Distinguish These??
Enantiomers and Chirality

• Enantiomers Only Occur With Chiral Molecules

• A Chiral Molecule and its Mirror Image: Pair of Enantiomers

• Molecules with Superposable Mirror Images: Achiral

• Universal Chirality Test: Nonsuperposability of Mirror Image
  
  ➢ Left and Right Hands are Chiral
  
  ➢ Your Instructors Crutches are Achiral
Enantiomers (2): Molecules—CHFBrCl

$R$ and $S$ Designations Indicate “Handedness” of Enantiomer

Superposable Mirror Images? Build the Models and See.
Checking for Chirality

• Identify Asymmetric Carbon Atoms (4 Different Substituents)

• These are Chiral Centers (Atoms)

• Also Called Stereogenic Centers (Carbons, Atoms)

• Stereogenic Center: Exchange 2 Groups, Get New Stereoisomer

• If all Tetrahedral Atoms have Two or More Like Groups: Achiral

• Any Stereogenic Centers Can be Assigned an (R) or (S) Label

These Labels were Used on the Previous Slide; How do we Determine These Designations?
Enantiomer Nomenclature: $R$ and $S$

- Identify Asymmetric Carbons
- Assign Priorities to the Substituents
  - Attached Atoms of Higher Atomic # Get Higher Priority
  - If Two or More Directly Attached Atoms are Alike, Go to Next Attached Atoms
  - Count Double Bonded C, O etc. as Two Attached Atoms
  - Continue Expanding Out One Atom Set Until All Four Substituents on Stereogenic Carbons are Differentiated
Enantiomer Nomenclature: $R$ and $S$

Stereogenic Carbon

- H atom: Lowest Priority
- OH Group (O Directly Bonded) Highest Priority
- Two Carbon Groups: CHO (aldehyde) Higher than CH$_3$ (methyl)
Enantiomer Nomenclature: \( R \) and \( S \)

- Stereogenic Carbon
  - Want Low Priority Group Pointed “Back”
  - Look at Spatial Arrangement of Groups 1-3
  - Clockwise “Rotation” Means \((R)\); Counterclockwise \((S)\)
Enantiomer Nomenclature: $R$ and $S$

- If Low Priority Group Is Not “Back”; Must Rotate Molecule
- Alternatives
  - If Low Group “Out”; Take Opposite Designation
  - Advisable to Draw Rotated Structures on Paper
  - Best Way to be Sure: BUILD THE MODEL

- Let’s Apply This to Some Wedge and Dash Structures
Racemic Mixtures (Racemates)

- Racemates (Racemic Mixtures): 50/50 Mixes of Enantiomers
- Mixture Causes no Net Rotation of Plane Polarized Light
- Racemic Form Designation: Often (±)
- Remember Racemic Forms Later With $S_{N1}$ Reactions
- Enantiomeric Excess of Racemate = 0 (By Definition)
- If one Enantiomer in Excess; can Calculate %ee
- %ee = percent enantiomeric excess
Molecules with Multiple Stereocenters

- Generally, Will Have $2^n$ Stereoisomers
- Consider 2,3-Dibromopropane; Here are 2 Enantiomers

Wedge/Dash

Fischer Projection
Molecules with Multiple Stereocenters (2)

- Consider 2,3-Dibromobutane; No Longer $2^n$ Stereoisomers

Enantiomers  Meso Compounds