Week 5

Stereochemistry / Reactions of Alkenes

5.1 Stereochemistry Nomenclature and Intro to Alkenes

10/28:

- Last time:
  - Chapter 4 (di-substituted cyclohexanes, bicyclic/polycyclic rings).
  - Chapter 5 (stereochemistry, stereoisomers/chirality center, chirality tests [plane/center symmetry], R/S system [nomenclature; a very important survival skill for this class], physical properties of enantiomers, achiral environment: same; chiral environment: different, rotate plane polarized light [left (−) levorotatory, right (+) dextrorotatory, racemic (±) mixture], $[\alpha]_D^{25}$ specific rotation[1], enantiometric excess, Fischer projections [less important]).
- Intro to Guangbin Dong.
- The textbook is only a guide — follow the lecture. Also, if you see discrepancies either with the book or with Piccirilli, bring them up.
- Capital E is energy and lowercase e is electrons in this class.
- Reading assignment: Chapter 5.12, 5.14, 4.5 (review), 4.17, 7.1-7.4.
- Nongraded homework: 6.39, 5.40, 5.46, 5.48, 7.1, 7.17, 7.18, 30a-d.
- Multiple stereocenters.
- Worked example: Naming (2S,3R)-2-chloro-3-iodobutane.
  - $n = 2$ stereocenters yields at most $2^n = 2^2 = 4$ stereoisomers.
  - Draws all enantiomers.
- **Diastereomers**: Have at least 2 stereocenters, same formula, same connectivity, but different orientation in space and are not mirror images of each other.
  - Special case: *cis*/*trans* isomerism.
- Compounds with 2 stereocenters don't always have 4 stereoisomers.
- Example: Tartaric acid, for which the (2S,3R) compound is superimposable on the (2R,3S) compound. This stereoisomer is a **meso** isomer and not a chiral molecule (there exists a plane of symmetry).

[1] We don't need to know this, but "25" indicates that the sample is at 25 °C, and "D" indicates that we're using light of wavelength $\lambda = 589\,\text{nm}$ (the sodium D line — think electronic transitions and term symbols).

  - Thus, a molecule can be achiral even if it has a chiral center!

- **Meso** (compound): A compound with chiral stereocenters and an internal plane of symmetry.
  - The following compound (two conformers shown) is also meso because the Conformer 2 has the desired plane of symmetry.

(a) Conformer 1. (b) Conformer 2.

Figure 5.1: Meso compounds.

- Alkenes:
  - One of the most important functional groups.
  - Basic industry materials: polyethylene and polypropylene.
  - Biological systems: Fatty acids, vitamins (Vitamin A), drugs/natural products, important building block in other FGs.
- Alkenes have a π bond — $2s$, $2p_x$, and $2p_y$ get hybridized into sp^2 orbitals, and $2p_z$ forms the π bond.
  - The π bond leads to the enforced coplanar geometry of the alkanes.
  - The bond energy of a C=C bond is significantly greater than that of a C–C bond.
- Alkene *cis*/*trans* isomerism.
  - *trans* is more stable b/c of steric hindrance.
  - E/Z system.