

M: Course Objectives/Learning Outcomes: The student will be able to:

1. given the formula of an organic compound, give the IUPAC name, or the common name, if one exists.
2. given the formula of an organic compound, draw diagrams of all possible isomers, and describe each type of isomer.
3. be able to name and identify the common functional groups.
4. given the formulas of two compounds, list the types of intermolecular forces that apply to each molecule, and predict which will have the higher boiling point, or heat of vaporization.
5. given the structure of an organic compound and the type of functional groups present, be able to predict the relative acidity (pKa) or basicity (pKb).
6. be able to draw the lowest and highest energy conformations of alkanes via Newman projections and cyclohexanes in 3D indicating axial and equatorial bonds and 1,3-diaxial interactions
7. given an compound with a stereogenic centre, be able to identify it using the R/S system of nomenclature and for isomers with more than one stereocentre be able to draw the Fischer projection and identify if the isomer will exist as a meso compound or an enantiomeric pair.
8. define terms and give examples of reactions that are stereoselective, stereospecific, regioselective, or under thermodynamic or kinetic control.
9. be able to define and give examples of the types of ring strain found in cyclopropane through to cycloheptane.
10. be able to provide the mechanism of either an S_N1 or S_N2 reaction.

N: Course Content

Chemical Bonding - Review: Importance of carbon in organic chemistry. Types of chemical bonds - ionic, covalent, polar covalent, metallic. Covalent Bonding Theories - Lewis, VSEPR, Valence Bond, Molecular Orbital Theory.

Isomerism and Functional Group Overview - Review: Representation of structural formulas. Isomerism - definition, types, nomenclature. General formulas, physical properties, nomenclature and representative reactions for the following types of compounds - Hydrocarbons, Alkenes, Alkynes, Alkyl Halides, Alcohols, Ethers, Amines, Aldehydes, Ketones, Carboxylic Acids, Amides and Esters.

Acids and Bases in Organic Chemistry: Bronsted/Lowry and Lewis Acid/Base theories - background, definitions, examples, and identification of common acids and bases. Use of curved arrows in Organic Chemistry and reaction mechanisms.

Alkanes and Cycloalkanes - Conformational Analysis: Newman projections - conformations of ethane, butane, and potential energy diagrams. Relative stabilities of cycloalkanes and ring strain. Banana bonds in cyclopropane, conformations of cyclobutane and cyclohexane. Chair and boat forms of cyclohexane. Conformational analysis of substituted cyclohexanes. Reduction of alkyl halides and lithium dialkylcuprates.

Optical Isomerism: Concept of chirality - examples and test for. Enantiomers and diastereomers - definition, differences in physical and chemical properties. Cahn - Ingold - Prelog R-S system of naming chiral centers. Optical activity - methods of determination, theory, specific rotation, optical purity. Fischer projection formulas.

Nucleophilic Substitution Reactions and Reaction Kinetics : Differences between radical and ionic reactions. Definition of nucleophilicity and electrophilicity. Reaction Kinetics – thermodynamic vs. kinetic control, transition states, collision theory, rate determining steps, endergonic and exergonic reactions. S_N2 reactions – mechanism, transition state, stereochemical outcomes, reaction kinetics. S_N1 reactions – mechanism, carbocation stability, stereochemical outcomes, kinetics. Factors affecting rates of S_N1 and S_N2 reactions – substrates, nucleophiles, concentrations, temperature, solvent type.

Radical Reactions: Formation, stability and reactions characteristic of radicals. Hammond – Leffler postulate.

Alkenes and Alkynes – Nomenclature and Synthesis: (E) – (Z) system for designating alkene diastereomers. Hydrogenation of alkenes and alkynes. Alkene stability. Elimination reactions and alkene synthesis. E1, E2 reactions – mechanisms, transition states, reaction kinetics, Zaitsev's rule, stereochemical implications. Dehydrohalogenation, dehydration of alcohols, molecular rearrangements.

Alkenes and Alkynes – Addition reactions: Energetics and mechanism of ionic addition reactions. Regioselective and regiospecific reactions and Markovnikov's rule. Radical addition of hydrogen bromide. Radical polymerization of alkenes. Oxidation of alkenes.

Alcohols and Ethers: Nomenclature, physical properties, synthesis (via hydration of alkenes, oxymercuration-demercuration, hydroboration). Conversion of alcohols into mesylates, tosylates and alkyl halides. Synthesis of ethers via the Williamson ether synthesis. Reactions of ethers and epoxides including ring opening reactions of epoxides.

Introduction to Carbonyl Compounds and Spectroscopy: Oxidation and Reduction reactions in organic chemistry. Oxidation reactions of alcohols, alkenes, aldehydes. Reduction of carbonyl compounds. Grignard reaction. U.V. and I.R. spectroscopy – theory and spectra interpretation.

Laboratory Content

The following laboratory experiments will be selected from the following list and performed during the lab period:

1. Lab Introduction: Simple and Fractional Distillation of an Acetone/Water Mixture
2. Melting Point Determination
3. Extraction: Separation of a Three Component System (Two Weeks)
4. Purification of Solid Compounds: Recrystallization and Sublimation
5. Isolation of Eugenol and Eugenol Acetate from Oil of Cloves (Three Weeks)
6. UV/Vis Spectroscopy: Spectrum of Suntan Lotion
7. Thin Layer Chromatography: Separation of Alkaloids From Tobacco
8. Practical Lab Exam

