

Virginia Western Community College

CHM 242

Organic Chemistry II

Prerequisites

CHM 241 with a grade of C or better.

Course Description

Introduces fundamental chemistry of carbon compounds, including structures, physical properties, syntheses, and typical reactions. Emphasizes reaction mechanisms. Intended for chemistry majors as well as science, chemical engineering, and pre-professional health students.

Semester Credits: 3

Lecture Hours: 3

Required Materials

Textbook:

Organic Chemistry. Bruice. 7th edition. Pearson Publishing. ISBN: 9780321819031

Goal of Course

The general purpose of this course is to prepare the student for advanced study in organic chemistry through development of: skills in synthetic organic problem solving and in critical thinking, an understanding of the methods of organic chemistry, understanding of the general concepts and principles of organic chemistry.

Course Outcomes

At the completion of this course, the student should be able to:

- Name all other functional group organic molecules.
- Understand the relationship between the structure of organic compounds and their physical and chemical properties.
- Synthesize all classes of organic compounds from simpler molecules.
- Predict the products obtained in different organic reactions.
- Understand the mechanistic pathways through which different classes of organic reactions proceed.

Topical Description

Part 4: Identification of Organic Compounds

Chapter 14: Mass Spectrometry, Infrared Spectroscopy, and Ultraviolet/Visible Spectroscopy

- 14.1 Mass Spectrometry
- 14.2 The Mass Spectrum / Fragmentation
- 14.3 Using the m/z of the Molecular Ion to Calculate the Molecular Formula
- 14.4 Isotopes in Mass Spectrometry

- 14.5 High-Resolution Mass Spectrometry Can Reveal Molecular Formulas
- 14.6 The Fragmentation Patterns of Functional Groups
- 14.7 Other Ionization Methods
- 14.8 Gas Chromatography-Mass Spectrometry
- 14.9 Spectroscopy and the Electromagnetic Spectrum
- 14.10 Infrared Spectroscopy
- 14.11 Characteristic Infrared Absorption Bands
- 14.12 The Intensity of Absorption Bands
- 14.13 The Position of Absorption Bands
- 14.14 The Position and Shape of an Absorption Band is Affect by Electron Delocalization, Electron Donation and Withdrawal, and Hydrogen Bonding
- 14.15 Absence of Absorption Bands
- 14.16 Some Vibrations are Infrared Inactive
- 14.17 How to Interpret an Infrared Spectrum
- 14.18 Ultraviolet and Visible Spectroscopy
- 14.19 The Beer-Lambert Law
- 14.20 The Effect of Conjugation on λ_{max}
- 14.21 The Visible Spectrum and Color
- 14.22 Some Uses of UV/Vis Spectroscopy

Chapter 15: NMR Spectroscopy

- 15.1 An Introduction to NMR Spectroscopy
- 15.2 Fourier Transform NMR
- 15.3 Shielding Causes Different Hydrogens to Show Signals at Different Frequencies
- 15.4 The Number of Signals in an ^1H NMR Spectrum
- 15.5 The Chemical Shift Tells How Far the Signal is from the ReferenceSignal
- 15.6 The Relative Positions of ^1H NMR Signals
- 15.7 The Characteristic Values of Chemical Shifts
- 15.8 Diamagnetic Anisotropy
- 15.9 The Integration of NMR Signals Reveals the Relative Number of Protons Causing Each Signal
- 15.10 The Splitting of the Signals is Described by the $N + 1$ Rule
- 15.11 What Causes Splitting?
- 15.12 More Examples of ^1H NMR Spectra
- 15.13 Coupling Constants Identify Coupled Protons
- 15.14 Splitting Diagrams Explain the Multiplicity of a Signal
- 15.15 Diastereotopic Hydrogens are Not Chemically Equivalent
- 15.16 The Time Dependence of NMR Spectroscopy
- 15.17 Protons Bonded to Oxygen and Nitrogen
- 15.18 The Use of Deuterium in ^1H NMR Spectroscopy
- 15.19 The Resolution of ^1H NMR Spectra
- 15.20 ^{13}C NMR Spectroscopy
- 15.21 DEPT ^{13}C NMR Spectra
- 15.22 Two-Dimensional NMR Spectroscopy
- 15.23 NMR Used in Medicine is Called Magnetic Resonance Imaging
- 15.24 X-Ray Crystallography

Chapter 11: Reactions of Alcohols, Ethers, Amines Thiols, and Thioethers

- 11.1 Nucleophilic Substitution Reactions of Alcohols: Forming Alkyl Halides
- 11.2 Other Methods Used to Convert Alcohols into Alkyl Halides
- 11.3 Converting an Alcohol into a Sulfonate Ester
- 11.4 Elimination Reactions of Alcohols: Dehydration
- 11.5 Oxidation of Alcohols
- 11.6 Nucleophilic Substitution Reactions of Ethers
- 11.7 Nucleophilic Substitution Reactions of Epoxides
- 11.8 Arene Oxides
- 11.9 Amines Do Not Undergo Substitution or Elimination Reactions
- 11.10 Quaternary Ammonium Hydroxides Undergo Elimination Reactions
- 11.11 Thiols, Sulfides and Sulfonium Salts
- 11.12 Organizing What We Know About the Reactions of Organic Compounds

Chapter 12: Organometallic Compounds

- 12.1 Organolithium and Organomagnesium Compounds
- 12.2 The Reaction of Organolithium Compounds and Grignard Reagents with Electrophiles
- 12.3 Transmetallation
- 12.4 Coupling Reactions
- 12.5 Palladium-Catalyzed Coupling Reactions
- 12.6 Alkene Metathesis

Part 5: Carbonyl CompoundsChapter 16: Reactions of Carboxylic Acids and Carboxylic Acid Derivatives

- 16.1 The Nomenclature of Carboxylic Acids and Carboxylic Acid Derivatives
- 16.2 The Structures of Carboxylic Acids and Carboxylic Acid Derivatives
- 16.3 The Physical Properties of Carbonyl Compounds
- 16.4 Fatty Acids are Long-Chain Carboxylic Acids
- 16.5 How Carboxylic Acids and Carboxylic Acid Derivatives React
- 16.6 The Relative Reactivities of Carboxylic Acids and Carboxylic Acid Derivatives
- 16.7 The General Mechanism for Nucleophilic Addition-Elimination Reactions
- 16.8 The Reactions of Acyl Chlorides
- 16.9 The Reactions of Esters
- 16.10 Acid-Catalyzed Ester Hydrolysis and Transesterification
- 16.11 Hydroxide-Ion Promoted Ester Hydrolysis
- 16.12 How the Mechanism for Nucleophilic Addition-Elimination was Confirmed
- 16.13 Fats and oils are Triglycerides
- 16.14 Reactions of Carboxylic Acid
- 16.15 Reactions of Amides
- 16.16 Acid Catalyzed Amide Hydrolysis and Alcoholysis
- 16.17 Hydroxide-Ion Promoted Hydrolysis of Amides

- 16.18 The Hydrolysis of an Imide: A Way to Synthesize Primary Amines
- 16.19 Nitriles
- 16.20 Acid Anhydrides
- 16.21 Dicarboxylic Acids
- 16.22 How Chemists Activate Carboxylic Acids
- 16.23 How Cells Activate Carboxylic Acids

Chapter 17: Reactions of Aldehydes and Ketones / More Reactions of Carboxylic Acid Derivatives / Reactions of α,β -Unsaturated Carbonyl Compounds

- 17.1 The Nomenclature of Aldehydes and Ketones
- 17.2 The Relative Reactivities of Carbonyl Compounds
- 17.3 How Aldehydes and Ketones React
- 17.4 The Reactions of Carbonyl Compounds with Grignard Reagents
- 17.5 The Reactions of Carbonyl Compounds with Acetylide Ions
- 17.6 The Reactions of Carbonyl Compounds with Cyanide Ion
- 17.7 The Reactions of Carbonyl Compounds with Hydride Ion
- 17.8 More About Reduction Reactions
- 17.9 Chemoselective Reactions
- 17.10 The Reactions of Aldehydes and Ketones with Amines
- 17.11 The Reactions of Aldehydes and Ketones with Water
- 17.12 The Reactions of Aldehydes and Ketones with Alcohols
- 17.13 Protecting Groups
- 17.14 The Addition of Sulfur Nucleophiles
- 17.15 The Reactions of Aldehydes and Ketones with Peroxyacid
- 17.16 The Wittig Reaction Forms An Alkene
- 17.17 Designing a Synthesis IV: Disconnections, Synthons, and Synthetic Equivalents
- 17.18 Nucleophilic Addition to α,β -Unsaturated Aldehydes & Ketones
- 17.19 Nucleophilic Addition to α,β -Unsaturated Carboxylic Acid Derivatives

Chapter 18: Reactions at the α -Carbon of Carbonyl Compounds

- 18.1 The Acidity of an α -Hydrogen
- 18.2 Keto-Enol Tautomers
- 18.3 Keto-Enol Interconversion
- 18.4 Halogenation of the α -Carbon of Aldehydes and Ketones
- 18.5 Halogenation of the α -Carbon Carboxylic Acids: The Hell-Volhard-Zelinski Reaction
- 18.6 Formation of Enolate Ion
- 18.7 Alkylating the α -Carbon of Carbonyl Compounds
- 18.8 Alkylating the α -Carbon Using an Enamine Intermediate
- 18.9 Alkylating the β -Carbon: The Michael Reaction
- 18.10 An Aldol Addition Forms β -Hydroxyaldehydes or β -Hydroxyketones
- 18.11 The Dehydration of Aldol Addition Products Form α,β -Unsaturated Aldehydes and Ketones
- 18.12 The Crossed Aldol Addition
- 18.13 A Claisen Condensation Forms a β -Keto Ester

- 18.14 Other Crossed Condensations
- 18.15 Intramolecular Condensation and Intramolecular Aldol Additions
- 18.16 The Robinson Annulation
- 18.17 Carboxylic Acids with a Carbonyl Group at the 3-Position Can Be Decarboxylated
- 18.18 The Malonic Ester Synthesis: A Way to Synthesize a Carboxylic Acid
- 18.19 The Acetoacetic Ester Synthesis: A Way to Synthesize a Methyl Ketone
- 18.20 Designing A Synthesis V: Making New Carbon-Carbon Bonds
- 18.21 Reactions at the α -Carbon in Biological Systems
- 18.22 Organizing What We Know About the Reactions of Organic Compounds

Part 6: Aromatic Compounds

Chapter 19: Reactions of Benzene and Substituted Benzenes

- 19.1 The Nomenclature of Monosubstituted Benzenes
- 19.2 How Benzene reacts
- 19.3 The General Mechanism for Electrophilic Aromatic Substitution Reactions
- 19.4 The Halogenation of Benzene
- 19.5 The Nitration of Benzene
- 19.6 The Sulfonation of Benzene
- 19.7 The Friedel-Crafts Acylation of Benzene
- 19.8 The Friedel-Crafts Alkylation of Benzene
- 19.9 The Alkylation of Benzene by Acylation-Reduction
- 19.10 Using Coupling Reactions to Alkylate Benzene
- 19.11 It is Important to have More than One Way to Carry Out a Reaction
- 19.12 How Some Substituents on a Benzene Ring Can Be Chemically Changed
- 19.13 The Nomenclature of Disubstituted and Polysubstituted Benzenes
- 19.14 The Effect of Substituents on Reactivity
- 19.15 The Effect of Substituents on Orientation
- 19.16 The Effect of Substituents on pK_a
- 19.17 The Ortho-Para Ratio
- 19.18 Additional Considerations Regarding Substituent Effects
- 19.19 The Synthesis of Monosubstituted and Disubstituted Benzenes
- 19.20 The Synthesis of Trisubstituted Benzenes
- 19.21 The Synthesis of Substituted Benzenes Using Arenediazonium Salts
- 19.22 The Arenediazonium Ion as an Electrophile
- 19.23 The Mechanism for the Reaction of Amines with Nitrous Acid
- 19.24 Nucleophilic Aromatic Substitution: An Addition-Elimination Reaction
- 19.25 The Synthesis of Cyclic Compounds

Chapter 20: More about Amines: Reactions of Heterocyclic Compounds

- 20.1 More About Amine Nomenclature
- 20.2 More About the Acid-Base Properties of Amines
- 20.3 Amines React as Bases and as Nucleophiles
- 20.4 The Synthesis of Amines

- 20.5 Aromatic Five-Membered-Ring Heterocycles
- 20.6 Aromatic Six-Membered-Ring Heterocycles
- 20.7 Some Amine Heterocycles Have Important Roles in Nature
- 20.8 Organizing What We Know About the Reactions of Organic Compounds

Part 7: Bioorganic Compounds

Chapter 21: The Organic Chemistry of Carbohydrates (Optional)

- 21.1 The Classification of Carbohydrates
- 21.2 The D and L Notation
- 21.3 The Configurations of Aldoses
- 21.4 The Configurations of Ketoses
- 21.5 The Reactions of Monosaccharides in Basic Solutions
- 21.6 The Oxidation-Reduction Reactions of Monosaccharides
- 21.7 Lengthening the Chain: The Kiliani-Fischer Synthesis
- 21.8 Shortening the Chain: The Wohl Degradation
- 21.9 The Stereochemistry of Glucose: The Fischer Proof
- 21.10 Monosaccharides Form Cyclic Hemiacetals
- 21.11 Glucose Is the Most Stable Aldohexose
- 21.12 Formation of Glycosides
- 21.13 The Anomeric Effect
- 21.14 Reducing and Nonreducing Sugars
- 21.15 Disaccharides
- 21.16 Polysaccharides
- 21.17 Some Naturally Occurring Products Derived From Carbohydrates
- 21.18 Carbohydrates on Cell Surfaces
- 21.19 Artificial Sweeteners

Chapter 22: The Organic Chemistry of Amino Acids, Peptides, and Proteins (optional)

- 22.1 The Nomenclature of Amino Acids
- 22.2 The Configuration of Amino Acids
- 22.3 The Acid-Base Properties of Amino Acids
- 22.4 The Isoelectric Point
- 22.5 Separating Amino Acids
- 22.6 The Resolution of Racemic Mixture of Amino Acids
- 22.8 Peptide Bonds and Disulfide Bonds
- 22.9 Some Interesting Peptides
- 22.10 The Strategy of Peptide Bond Synthesis: N-Protection and C-Activation
- 22.11 Automated Peptide Synthesis
- 22.12 An Introduction to Protein Structure
- 22.13 How to Determine the Primary Structure of a Polypeptide or Protein
- 22.14 Secondary Structure
- 22.15 Tertiary Structure
- 22.16 Quaternary Structure
- 22.17 Protein Denaturation

Chapter 23: Catalysis (optional)

- 23.1 Catalysis in Organic Reactions
- 23.2 Acid Catalysis
- 23.3 Base Catalysis
- 23.4 Nucleophilic Catalysis
- 23.5 Metal-Ion Catalysis
- 23.6 Intramolecular Reactions
- 23.7 Intramolecular Catalysis
- 23.8 Catalysis in Biological Reactions

Notes to Instructors

None.