Revised: Fall 2016

CHM 242
Organic Chemistry II

COURSE OUTLINE

Prerequisites:

CHM 241

Course Description:

Introduces fundamental chemistry of carbon compounds, including structures, physical properties, syntheses, and typical reactions. Emphasizes reaction mechanisms. Lecture 3 hours per week.

Semester Credits: 3 Lecture Hours: 3 Lab/Recitation Hours: 0

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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.

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Required

Materials:

Textbook

Organic Chemistry, Seventh Edition, Paula Yurkanis Bruice, Pearson
ISBN: 9780321819031

The following supplementary materials are available:

1.

2.

3.

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CHM 242

Topical Description

13. Radicals ● Reactions of Alkanes

13.1 Alkanes are Unreactive Compounds
13.2 The Chlorination and Bromination of Alkanes
13.3 Radical Stability Depends on the Number of Alkyl Groups Attached to the Carbon with the Unpaired Electron
13.4 The Distribution of Products Depends on Probability and Reactivity
13.5 The Reactivity-Selectivity Principle
13.6 Formation of Explosive Peroxides
13.7 The Addition of Radicals to an Alkene
13.8 The Stereochemistry of Radical Substitution and Radical Addition Reactions
13.9 Radical Substitution of Benzylic and Allylic Hydrogens
13.10 Designing a Synthesis III: More Practice with Multistep Synthesis
13.11 Radical Reactions Occur in Biological Systems
13.12 Radicals and Stratospheric Ozone

Part 4 Identification of Organic Compounds

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 Affected 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

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 ^{1}H NMR Spectrum
15.5 The Chemical Shift Tells How Far the Signal Is from the Reference Signal
15.6 The Relative Positions of ^{1}H 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 ^{1}H 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 ^{1}H NMR Spectroscopy
15.19 The Resolution of ^{1}H 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

Part 5 Carbonyl Compounds

16. Reactions of Carboxylic Acids and Carboxylic Acid Derivatives

17. Reactions of Aldehydes and Ketones ● More Reactions of Carboxylic Acid Derivatives ● Reactions of α,β-Unsaturated Carbonyl Compounds

17.10 The Reactions of Aldehydes and Ketones with Amines
17.11 The Reactions of Aldehydes ad 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 a 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

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 AdditionForms β-Hydroxyaldehydes or β-Hydroxyketones
18.11 The Dehydration of Aldol Addition Products Form α,β-Unsaturated Aldedydes 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 of 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

19. Reactions of Benzene and Substituted Benzenes

19.1 Aromatic Compounds Are Unusually Stable
19.2 The Two Criteria for Aromaticity
19.3 Applying the Criteria for Aromaticity
19.4 Aromatic Heterocyclic Compounds
19.5 Some Chemical Consequences of Aromaticity
19.6 Antiaromaticity
19.7 A Molecular Orbital Description of Aromaticity and Antiaromaticity
19.8 The Nomenclature of Monosubstituted Benzenes
19.9 How Benzene Reacts
19.10 The General Mechanism for Electrophilic Aromatic Substitution Reactions
19.11 The Halogenation of Benzene
19.12 The Nitration of Benzene
19.13 The Sulfonation of Benzene
19.14 The Friedel-Crafts Acylation of Benzene
19.15 The Friedel-Crafts Alkylation of Benzene
19.16 The Alkylation of Benzene by Acylation-Reduction
19.17 Using Coupling Reactions to Alkylate Benzene
19.18 It is Important to Have More Than One Way to Carry Out a Reaction
19.19 Polycyclic Benzenoid Hydrocarbons
19.20 Arene Oxides

16. Reactions of Substituted Benzenes

16.1 How Some Substituents on a Benzene Ring Can be Chemically Changed
16.2 The Nomenclature of Disubstituted and Polysubstituted Benzenes
16.3 The Effect of Substituents on Reactivity
16.4 The Effect of Substituents on Orientation
16.5 The Effect of Substituents on pK_a
16.6 The Ortho-Para Ratio
16.7 Additional Considerations Regarding Substituent Effects
16.8 Designing a Synthesis IV: Synthesis of Monosubstituted and Disubstituted Benzenes
16.9 The Synthesis of Trisubstituted Benzenes
16.10 The Synthesis of Substituted Benzenes Using Arenediazonium Salts
16.11 The Arenediazonium Ion as an Electrophile

16.12 The Mechanism for the Reaction of Amines with Nitrous Acid
16.13 Nucleophilic Aromatic Substitution: An Addition-Elimination Mechanism
16.14 Nucleophilic Aromatic Substitution: An Elimination-Addition Mechanism that forms a Benzyne Intermediate

Part 7 More About Oxidation-Reduction Reactions and Amines

20. More about Oxidation-Reduction Reactions

20.1 Oxidation-Reduction Reactions of Organic Compounds: An Overview
20.2 Reduction Reactions
20.3 Chemoselective Reactions
20.4 Oxidation of Alcohols
20.5 Oxidation of Aldehydes and Ketones
20.6 Designing a Synthesis VIII: Controlling Stereochemistry
20.7 Oxidation of Alkenes to 1,2-Diols
20.8 Oxidative Cleavage of 1,2-Diols
20.9 Oxidative Cleavage of Alkenes
20.10 Designing a Synthesis IX: Functional Group Interconversion

21. More About Amines: Heterocyclic Compounds

21.1 More About Amine Nomenclature
21.2 More About the Acid-Base Properties of Amines
21.3 Amines React as Bases and as Nucleophiles
21.4 The Synthesis of Amines
21.5 Aromatic Five-Membered-Ring Heterocycles
21.6 Aromatic Six-Membered-Ring Heterocycles
21.7 Some Amine Heterocycles Have Important Roles in Nature

Part 8 Bioorganic Compounds

22. Carbohydrates

22.1 The Classification of Carbohydrates
22.2 The D and L Notation
22.3 The Configurations of Aldoses
22.4 The Configurations of Ketoses
22.5 The Reactions of Monosaccharides in Basic Solutions

22.6 The Oxidation-Reduction Reactions of Monosaccharides
22.7 Monosaccharides Form Crystalline Osazones
22.8 Lengthening the Chain: The Kiliani-Fischer Synthesis
22.9 Shortening the Chain: The Wohl Degradation
22.10 The Stereochemistry of Glucose: The Fischer Proof
22.11 Monosaccharides Form Cyclic Hemiacetals
22.12 Glucose Is the Most Stable Aldohexose
22.13 Formation of Glycosides
22.14 The Anomeric Effect
22.15 Reducing and Nonreducing Sugars
22.16 Disaccharides
22.17 Polysaccharides
22.18 Some Naturally Occurring Products Derived From Carbohydrates
22.19 Carbohydrates on Cell Surfaces
22.20 Synthetic Sweeteners

24. Catalysis

24.1 Catalysis in Organic Reactions
24.2 Acid Catalysis
24.3 Base Catalysis
24.4 Nucleophilic Catalysis
24.5 Metal-Ion Catalysis
24.6 Intramolecular Reactions
24.7 Intramolecular Catalysis
24.8 Catalysis in Biological Reactions
24.9 Enzyme-Catalyzed Reactions
24.10 The Organic mechanisms of the Coenzymes