

**ORGANIC CHEMISTRY II  
CHMB42H3  
LECTURE OUTLINE**

**LEC01: Monday 9-11 am (SW 143)**

**Instructor : Nirusha Kandeephan**

**Contact: [thavarajah@utsc.utoronto.ca](mailto:thavarajah@utsc.utoronto.ca), Phone # (416) 287-7278**

**Office Hours (S-507A): Monday 11-1 pm, Tues 2-3 pm and Wed 2-3 pm**

**Textbook: Organic Chemistry (4th Edition), Paula Yurkanis Bruice.**

**Method of Evaluation:**

**Lab – 25%**

**In class quizzes – 5%**

**Midterm Test – 25%**

**Final Exam – 45%**

**Chapter 13. Mass Spectroscopy and Infrared Spectroscopy (2 Lectures)**

- 13.1 Mass Spectrometry
- 13.2 The Mass Spectrum - Fragmentation
- 13.3 Isotopes in Mass Spectrometry
- 13.4 High Resolution Mass Spectrometry
- 13.5 Fragmentation of Functional Groups - Section omitted**
- 13.6 Spectroscopy and the Electromagnetic Spectrum - review material
- 13.7 Infrared Spectroscopy
- 13.8 Characteristic Infrared Absorption Bands
  - Students will be given Tables 13.4 and 13.5 on test/exam**
- 13.9 The Intensity of Absorption Bands
- 13.10 The Position of Absorption Bands**
  - Hooke's Law - Section omitted**
- 13.11 C-H Absorption Bands
- 13.12 The Shape of Absorption Bands
- 13.13 Absence of Absorption Bands
- 13.14 Infrared Inactive Vibrations
- 13.15 Identifying Infrared Spectra

**Chapter 14. NMR (3 Lectures)**

- 14.1 Introduction to NMR Spectroscopy
  - Note - Students are not required to memorize equations on page 578.**
- 14.2 Fourier Transform NMR
- 14.3 Shielding
- 14.4 Number of Signals in  $^1\text{H}$  NMR Spectrum
- 14.5 The Chemical Shift

- 14.6 The Relative Positions of  $^1\text{H}$  NMR Signals
- 14.7 Characteristic Values of Chemical Shifts
  - Students will be given Table 14.1 on test/exam**
- 14.8 Integration of NMR Signals
- 14.9 **Diamagnetic Anisotropy - Section omitted**
- 14.10 Splitting of Signals
- 14.11 More Examples of  $^1\text{H}$  NMR Spectra
- 14.12 Coupling Constants
- 14.13 Splitting Diagrams
- 14.14 Time Dependence of NMR Spectroscopy
- 14.15 Protons Bonded to Oxygen and Nitrogen
- 14.16 Use of Deuterium in  $^1\text{H}$  NMR Spectroscopy
- 14.17 Resolution of  $^1\text{H}$  NMR Spectra
- 14.18  $^{13}\text{C}$  NMR Spectroscopy
  - Students will be given Table 14.4 on test/exam**
- 14.19 Dept  $^{13}\text{C}$  NMR Spectra
- 14.20 **Two-Dimensional NMR Spectroscopy - Section omitted**
- 14.21 Magnetic Resonance Imaging

#### **Chapter 15 Aromaticity • Reactions of Benzene (2 Lectures)**

- 15.1 Criteria for Aromaticity
- 15.2 Aromatic Hydrocarbons
- 15.3 Aromatic Heterocyclic Compounds
- 15.4 Some Chemical Consequences of Aromaticity
- 15.5 Antiaromaticity
- 15.6 **A Molecular Orbital Description .... Section omitted**
- 15.7 Nomenclature of Monosubstituted Benzenes
  - Students should memorize the structures of toluene, phenol, aniline, benzenesulfonic acid, anisole, styrene, benzaldehyde, benzoic acid, benzonitrile.**
- 15.8 How Benzene Reacts
- 15.9 General Mechanism for Electrophilic Aromatic Substitution Reactions
- 15.10 Halogenation of Benzene
- 15.11 Nitration of Benzene
- 15.12 Sulfonation of Benzene
- 15.13 Friedel-Crafts Acylation of Benzene
- 15.14 Friedel-Crafts Alkylation of Benzene
- 15.15 Alkylation of Benzene by Acylation-Reduction

#### **Chapter 16 - Reactions of Substituted Benzenes (3 Lectures)**

- 16.1 Nomenclature of Disubstituted and Polysubstituted Benzenes
- 16.2 Reactions of Substituents on Benzene
  - See reaction summary for reactions that are covered**
- 16.3 The Effect of Substituents on Reactivity
- 16.4 The Effect of Substituents on Orientation
- 16.5 The Effect of Substituents on  $\text{pK}_\text{a}$



- 16.6 The Ortho-Para Ratio
- 16.7 Additional Considerations Regarding Substituent Effects
- 16.8 Designing a Synthesis III
- 16.9 Synthesis of Trisubstituted Benzenes
- 16.10 Synthesis of Substituted Benzenes Using Arenediazonium Salts
- 16.11 The Arenediazonium Ion as an Electrophile
- 16.12 Mechanism for the reaction of amines with nitrous acid - Section omitted**
- 16.13 Nucleophilic Aromatic Substitution Reactions - Section omitted**
- 16.14 Benzyne - Section omitted**
- 16.15 Polycyclic Benzenoid Hydrocarbons - Section omitted**
- 16.16 Electrophilic Substitution Reactions of Naphthalene ... Section omitted**

## **Chapter 17 - Carbonyl Compounds I - Nucleophilic Acyl Substitution (3 Lectures)**

- 17.1 Nomenclature
  - Note - nomenclature will not be covered in lectures, but students are responsible for learning the rules for naming - this statement applies to all the nomenclature sections in CHM B42.**
- 17.2 Structures of Carboxylic Acids and Carboxylic Acid Derivatives
- 17.3 Physical Properties of Carbonyl Compounds - Section omitted**
- 17.4 Naturally Occurring Carboxylic Acids ... - Section omitted**
- 17.5 How Class I Carbonyl Compounds React
- 17.6 Relative Reactivities of Carboxylic Acids and Carboxylic Acid Derivatives
- 17.7 General Mechanism for Nucleophilic Acyl Substitution Reactions
- 17.8 Reactions of Acyl Halides
- 17.9 Reactions of Acid Anhydrides
- 17.10 Reactions of Esters
- 17.11 Acid-Catalyzed Ester Hydrolysis
  - Hydrolysis of Esters with Tertiary Alkyl Groups (p. 695) - omitted**
- 17.12 Hydroxide-ion-Promoted Ester Hydrolysis
- 17.13 Soaps, Detergents and Micelles
- 17.14 Reactions of Carboxylic Acids
- 17.15 Reactions of Amides
- 17.16 Acid-Catalyzed Hydrolysis of Amides
- 17.17 Hydrolysis of an Imide: The Gabriel Synthesis
- 17.18 Hydrolysis of Nitriles
- 17.19 Designing a Synthesis IV: The Synthesis of Cyclic Compounds
- 17.20 Synthesis of Carboxylic Acid Derivatives
  - Activation of Carboxylate Ions for Nucleophilic Substitution Reactions in Biological Systems (pages 713-715) - omitted**
- 17.21 Dicarboxylic Acids and Their Derivatives

## **Chapter 18 Carbonyl Compounds II (2 Lectures)**

- 18.1 Nomenclature
- 18.2 Relative Reactivities of Carbonyl Compounds
- 18.3 How Aldehydes and Ketones React
- 18.4 Reactions of Carbonyl Compounds with Carbon Nucleophiles

- 18.5 Reactions of Carbonyl Compounds with Hydride Ion
- 18.6 Reactions of Aldehydes and Ketones with Nitrogen Nucleophiles  
**Note - mechanism of Wolf-Kishner reduction is omitted (but not reaction itself)**
- 18.7 Reactions of Aldehydes and Ketones with Oxygen Nucleophiles
- 18.8 Protecting Groups
- 18.9 Addition of Sulfur Nucleophiles
- 18.10 The Wittig Reaction
- 18.11 Stereochemistry of Nucleophilic Addition Reaction ... - Section omitted**
- 18.12 Designing a Synthesis V: Disconnections, Synthons and Synthetic Equivalents
- 18.13 Nucleophilic Addition to  $\alpha$ ,  $\beta$ -Unsaturated Aldehydes and Ketones
- 18.14 Nucleophilic Addition to  $\alpha$ ,  $\beta$ -Unsaturated Carboxylic Acid Derivatives - Section omitted**
- 18.15 Enzyme-Catalyzed Additions to  $\alpha$ ,  $\beta$ -Unsaturated Compounds - Section omitted**

## **Chapter 19 Carbonyl Compounds III - Reactions at the $\alpha$ -Carbon (2 Lectures)**

- 19.1 Acidity of  $\alpha$ -Hydrogens
- 19.2 Keto-Enol Tautomerization
- 19.3 How Enols and Enolate Ions React
- 19.4 Halogenation of the  $\alpha$ -Carbon of Aldehydes and Ketones
- 19.5 Halogenation of the  $\alpha$ -Carbon of Carboxylic Acids
- 19.6  $\alpha$ -Halogenated Compounds in Synthesis
- 19.7 Using LDA to Form an Enolate
- 19.8 Alkylation of the  $\alpha$ -Carbon of Carbonyl Compounds
- 19.9 Alkylation and Acylation of the  $\alpha$ -Carbon via an Enamine Intermediate - Section omitted**
- 19.10 Alkylation of the  $\beta$ -Carbon: The Michael Reaction
- 19.11 The Aldol Reaction
- 19.12 Dehydration of Aldol Addition Products: Formation of  $\alpha$ ,  $\beta$ -Unsaturated ....
- 19.13 The Mixed Aldol Addition
- 19.14 The Claisen Condensation
- 19.15 The Mixed Claisen Condensation
- 19.16 Intramolecular Condensation and Addition Reactions
- 19.17 Decarboxylation of 3-Oxocarboxylic Acids
- 19.18 The Malonic Ester Synthesis: Synthesis of Carboxylic Acids
- 19.19 The Acetoacetic Ester Synthesis: Synthesis of Methyl Ketones
- 19.20 Designing a Synthesis VI: Making New Carbon-Carbon Bonds
- 19.21 Reactions at the  $\alpha$ -Carbon in Biological Systems - Section omitted**

## **Chapter 20 More About Oxidation-Reduction Reactions (2 Lectures)**

- 20.1 Reduction Reactions
- 20.2 Oxidation of Alcohols  
**Note - omitted Swern Oxidation (bottom of page 851 - top of page 852)**
- 20.3 Oxidation of Aldehydes and Ketones



**Note - omitted Baeyer-Villiger oxidation (bottom of page 853 - top of page 854)**

- 20.4 Oxidation of Alkenes with Peroxyacids
- 20.5 Designing a Synthesis VII: Controlling Stereochemistry
- 20.6 **Hydroxylation of Alkenes - Section omitted**
- 20.7 **Oxidative Cleavage of 1,2-Diols - Section omitted**
- 20.8 Oxidative Cleavage of Alkenes
  - Note - omitted Permanganate Cleavage (page 864)**
- 20.9 **Oxidative Cleavage of Alkynes - Section omitted**
- 20.10 Designing a Synthesis VIII: Functional Group Interconversion
- 20.11 **Biological Oxidation-Reduction Reactions - Section omitted**
- 20.12 **Oxidation of Hydroquinones and Reduction of Quinones - Section omitted**

## **Chapter 22 Carbohydrates (2 Lectures)**

### **Omitted Sections**

**22.6, 22.8, 22.16, 22.19-22.21**

## **Chapter 23 Amino acids, Peptides and Proteins (2 Lectures)**

### **Omitted Sections**

**23.5, 23.6, 23.11-23.15**

## **Chapter 27 Nucleosides, Nucleotides and Nucleic Acids (1 Lecture)**

### **Omitted Sections**

**27.4, 27.5, 27.6, 27.14, 27.15, 27.16 and 27.17**