Organic Chemistry 160:336
Spring 2020, Rutgers University, Newark
Syllabus
Lecture: Tuesday and Friday 1:00-2:20 PM, Ackerson Hall 123

Professor Michal Szostak, LSC II 219
michal.szostak@rutgers.edu

Office hours: Tuesday 12:00-1:00 PM or by appointment (michal.szostak@rutgers.edu).

Course Synopsis:

Fundamental principles in organic chemistry. Synthesis and reactivity of major classes of functional groups, fundamental reaction classes, spectroscopic methods, polymer chemistry. Special attention is given to reaction mechanisms, stereoelectronic effects and the application of organic chemistry in modern research.

Prerequisites: 21:160:335 ORGANIC CHEMISTRY I OR 01:160:307 ORGANIC CHEMISTRY

Required Text:


Note that the Rutgers-Newark Bookstore and NJ Books sell a loose-leaf binder-ready version of the complete text and solution manual.

The bookstore version of the text also includes access to an optional online homework system.

Recommended Texts (Optional):

- Strategic Applications of Named Reactions in Organic Synthesis. Kurti, L.; Czako, B.
- Advanced Organic Chemistry, Part B: Reactions and Synthesis. Carey, F.; Sundberg, R.

Useful Websites:
https://www.name-reaction.com/list
https://www.organic-chemistry.org/namedreactions/
https://www.masterorganicchemistry.com/

Grading:

Three 60-minute exams will count for 67% of the course grade, and a comprehensive final exam will count for the other 33% of the course grade. The lowest score of the 60-minute exams will be dropped (or an 60-minute exam missed for any reason). Letter grades will be assigned according to the following scale (scores are percentages of the maximum possible points): A (100-85), B+ (84-80), B (70-79), C+ (69-65), C (64-55), D (54-45), F (44-0).
Class Outline:

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<td>Chapter 16: Aldehydes and Ketones</td>
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<td>Lecture 6</td>
<td>Chapter 18: Functional Derivatives of Carboxylic Acids</td>
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<td>Fri</td>
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<td>Fri</td>
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<td>Lecture 14</td>
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<td>Tue</td>
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<td>Fri</td>
<td>Mar 13</td>
<td>Lecture 16</td>
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<td>Fri</td>
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<td>Lecture 20</td>
<td>Chapter 21: Benzene and the Concept of Aromaticity</td>
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<td>Chapter 21</td>
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<td>Tue</td>
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<td>Lecture 23</td>
<td>Chapter 22: Reactions of Benzene and its Derivatives</td>
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<td>Fri</td>
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<td>Chapter 22</td>
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<td>Tue</td>
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<td>Chapter 23: Amines</td>
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<td>Fri</td>
<td>Apr 17</td>
<td>Lecture 26</td>
<td>Chapter 23</td>
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<td>Tue</td>
<td>Apr 21</td>
<td>Lecture 27</td>
<td>Chapter 24: Catalytic Carbon-Carbon Bond Formation</td>
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<td>Fri</td>
<td>Apr 24</td>
<td>Lecture 28</td>
<td>Exam 3: Chapters 21,22,23</td>
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<td>Tue</td>
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<td>Lecture 29</td>
<td>Chapter 24</td>
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<td>Fri</td>
<td>May 1</td>
<td>Lecture 30</td>
<td>Chapter 24</td>
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<td>Fri</td>
<td>May 8</td>
<td>Finals</td>
<td>Comprehensive Final Exam</td>
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Exam:

Exam will be closed book, closed note. Exam will cover lecture material, text, assigned problems and problems discussed in the class.

Molecular Models:

A small molecular model kit made by either Cochrane of Oxford or Indigo Instruments is available in the bookstore.
Homework Problems (homework will not be collected):

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<th>Problems</th>
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<td>Chapter 14</td>
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<tr>
<td>Chapter 15</td>
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<td>Chapter 16</td>
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<td>Chapter 17</td>
<td>1-6,8,10,15,17,18-22,26,28,33,35,40,48,50</td>
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<td>Chapter 18</td>
<td>1,3-10,12,16,18,19,20,22-25,27,32,35,37,41,64,66</td>
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<tr>
<td>Chapter 19</td>
<td>1-17,18,19,20,22,29,31,33,43,46,50,51,57,78</td>
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<tr>
<td>Chapter 20</td>
<td>1,2-4,5-13,14-17,19,23,28,30,32,36,50,52</td>
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<tr>
<td>Chapter 21</td>
<td>1-7,9(skip b,g),12,15-17,20,22,23,26,32,36,45,46,52abc</td>
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<tr>
<td>Chapter 22</td>
<td>1-6,8,15,16,19,20,21,22,26,28,32-35,37,40</td>
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<td>1-15,16,18,24,25,33,34,45,47,48</td>
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<tr>
<td>Chapter 24</td>
<td>1,2,4,7,10,32,33</td>
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<tr>
<td>Chapter 29</td>
<td>1-4,5abc,6,7,11,16,24,25,32,33,38</td>
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Recitation, Professor Fina Liotta:

Recitations on Wed (4:00-5:20, Ackerson 123) (Sec 02) will be used to discuss homework problems and review lecture material.

Add/Drop/Withdraw:

- Add/Drop period: January 21 - January 29
- Last day to drop with a "W": March 30
- Full Calendar (NCAS is school 21): [https://registrar.newark.rutgers.edu/registrar-spring-academic-calendar-0](https://registrar.newark.rutgers.edu/registrar-spring-academic-calendar-0)

Learning Objectives:

After completion of this course students should:

- be familiar with spectroscopic methods used in organic chemistry
- be familiar with major classes of functional groups in organic chemistry
- be familiar with fundamental reaction classes in organic chemistry
- be familiar with introduction to polymer chemistry
- be able to determine structure using spectroscopic methods
- be able to predict reactivity of functional groups
- be able to rationalize reactivity trends of functional groups
- be able to plan synthetic routes to simple organic molecules
- be able to draw roadmaps for fundamental reaction classes
- be familiar with general synthetic approaches used in organic chemistry
- be familiar with the major current state-of-the-art methods in organic chemistry

Help:
If you need assistance, study tips, or have questions about the course material or homework problems, see Dr. Szostak during his office hours, make an appointment to see him at times other than his office hours, or contact the Learning Center for other options.

The Learning Resource Center in Conklin Hall can provide various types of assistance:

1. Free Tutoring. If there are enough requests at the Learning Resource Center for tutors, free tutoring will be provided.
2. Learning Assistants. If you would like advice on how to develop better study habits and skills, make an appointment with a learning assistant at the Learning Resource Center.

Attendance Policy:

Please, review Rutgers University attendance policy, which can be found at http://policies.rutgers.edu/view-policies/academic-%E2%80%93-section-10#2

Academic Integrity Policy:

Please, review Rutgers University Academic Integrity Policy, which can be found at http://academicintegrity.rutgers.edu/academic-integrity-policy. This policy applies to all Schools and Colleges of Rutgers, the State University of New Jersey, including the Ernest Mario School of Pharmacy and the Rutgers College of Nursing.
Lecture Outlines:

Chapter 15. Organometallic Compounds
   I. Carbon-Metal Bonds
   II. Classical Organometallic Reagents
       A. Grignard Reagents
       B. Organo Lithium Reagents
       C. Gilman Reagents
   III. Reactions Involving Carbenes

Chapter 16. Aldehydes and Ketones
   I. Nomenclature
   II. Structure and Bonding
   III. Preparation of Aldehydes and Ketones
   IV. Reactions
       A. Addition Reactions
       B. The Wittig Reaction
       C. Reactions alpha to the Carbonyl Carbon
       D. Oxidations
       E. Reductions

Chapter 17. Carboxylic Acids
   I. Structure and Bonding
   II. Nomenclature
   III. Properties
   IV. Preparations of Carboxylic Acids
       A. Oxidation of Alcohols
       B. Grignard Reactions
   V. Reactions
       A. Reductions
       B. Esterification
       C. Acid Chloride Formation
       D. Decarboxylation

Chapter 18. Carboxylic Acid Derivatives
   I. Nomenclature and Examples
   II. Nucleophilic Acyl Substitution Reactions
   III. Preparations and Reactions
       A. Acid Chlorides
       B. Acid Anhydrides
       C. Esters
       D. Amides
       E. Nitriles

Chapter 13. Nuclear Magnetic Resonance (NMR) Spectroscopy
   I. Physical Basis
       A. Nuclear Magnetic Resonance
       B. Chemical Shift
C. Spin-Spin Splitting  
D. Signal Integration  

II. Interpreting Proton NMR Spectra  
   A. Index of Hydrogen Deficiency  
   B. Example  

III. Instrumentation  
IV. Topicity of Atoms or Groups  
V. Fast Chemical Exchange  
VI. Instrumentation  
VII. 13-C NMR  

Chapter 14. Mass Spectrometry  
   I. Principles and Instrumentation  
   II. Analysis of Mass Spectra  
      A. Molecular Ion  
      B. Fragmentation Patterns  
      C. Isotope Patterns  
   III. High Resolution Mass Spectrometry  

Chapter 19. Enolate Anions and Enamines (Carbonyl Condensation Reactions and Reactions of alpha-beta- Unsaturated Carbonyl Compounds)  
   I. Enolates and Enamines  
   II. Aldol Reaction  
      A. Mechanism  
      B. Use in Synthesis  
      C. Intramolecular Aldol Reactions  
   III. Condensations with Esters  
      A. Claisen Condensation  
      B. Diekmann Condensation  
      C. Crossed Claisen Condensations  
      D. Hydrolysis and Decarboxylation  
   IV. Reactions with Enamines  
   V. Acetoacetic Ester Synthesis and Malonic Ester Synthesis  
   VI. Conjugate Additions to alpha-beta- Unsaturated Carbonyl Compounds  

Chapter 20. Dienes, Conjugated Systems, and Pericyclic Reactions  
   I. Special Stability of Conjugated Dienes  
      A. Evidence from Heats of Reactions  
      B. Resonance View  
      C. Molecular Orbital View  
   II. Electrophilic Additions to Conjugated Dienes  
      A. Reaction and Mechanism  
      B. Thermodynamic vs. Kinetic Control  
   III. Pericyclic Reactions  
      A. Diels-Alder Reaction  
      B. Cope and Claisen Rearrangements  
   IV. UV-Visible Spectroscopy  
      A. Physical Basis / Alkene Example
B. Other Examples
C. Typical Use

Chapter 21. Benzene and the Concept of Aromaticity

I. Examples of Aromatic Compounds

II. Benzene
   A. Structure and Bonding Issues
   B. Bonding Models

III. Hückel's Criteria for Aromaticity
   A. The Rules
   B. Why $4n+2$?
   C. Heterocyclic Examples
   D. Polycyclic Aromatics

IV. Nomenclature
   A. Monosubstituted Benzenes
   B. Disubstituted Benzenes

V. Selected Reactions of Phenols and Reactions at Benzylic Positions
   A. Reactions of Phenols
   B. Reactions at Benzylic Positions

VI. NMR Spectroscopy of Benzene Derivatives

Chapter 22. Reactions of Benzene and its Derivatives

I. Electrophilic Aromatic Substitution Reactions
   A. Reactions of Benzene
   B. Mechanisms
   C. Directing Effects
   D. Activating and Deactivating Groups

II. Useful Reactions of Benzene Substituents

III. Nucleophilic Aromatic Substitution Reactions
   A. Addition-Elimination Mechanism
   B. Benzyne Intermediate Mechanism

Chapter 23. Amines

I. Nomenclature and Examples
   A. Aliphatic Amines
   B. Aromatic Amines
   C. Heterocyclic Amines
   D. Biological Amines

II. Structure, Bonding, and Properties

III. Preparations of Amines
   A. Alkylation of Ammonia and Amines
   B. Reductions of Amides and Nitriles
   C. From Epoxides
   D. Reductive Amination of Aldehydes and Ketones
   E. Reduction of Nitrobenzenes

IV. Reactions of Amines
   A. Alkylation and Acylation
   B. Imine and Enamine Formation
C. Two Special Elimination Reactions
D. Reactions with Nitrous Acid
E. Reactions of Aryl Diazonium Salts

Chapter 24. Catalytic C-C Bond Formation
I. Review of C-C Bond Forming Reactions
II. Palladium-Catalyzed Coupling Reactions
   A. Heck Reaction
   B. Allylic Alkylation
   C. Suzuki and Stille Coupling
   D. Sonogashira Coupling
   E. Acyl Coupling (handout only)
III. Alkene Metathesis