Organic Chemistry 160:336
Spring 2021, Rutgers University, Newark
Syllabus
Lecture: Tuesday and Friday 1:00-2:20 PM

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All lectures and lecture materials will be available for download through Canvas at the time of the regular lectures (Tue, Fri, 1:00 PM EST) and available for download for the reminder of the semester. All exams are multiple-choice exams. All exams are open-book, open-note exams.

Office hours: Wednesday 2:30-3:30 PM

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:

- Brown, Iverson, Anslyn, & Foote *Organic Chemistry*, 8th ed., and the accompanying *Student Study Guide and Solutions Manual*, (Brooks/Cole-Cengage Learning).

  Note that Cengage representative for Rutgers set up a mini-site for book purchases. The ebook rental options are for a fixed number of months from the date of purchase. http://services.cengagebrain.com/course/site.html?id=preview/4154569

  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 Test Banks:
Make sure that you cover all sample multiple-choice questions that are included in the lecture slides. Additional resources for multiple-choice questions in organic chemistry 2 are below:

https://www2.chemistry.msu.edu/faculty/reusch/VirtTxtJml/Questions/problems/indexam.htm
https://www.sanfoundry.com/1000-organic-chemistry-questions-answers/
https://global.oup.com/uk/orc/chemistry/okuyama/student/mcqs/
https://www.varsitytutors.com/organic_chemistry-practice-tests#practice-tests-section
https://www2.chemistry.msu.edu/faculty/reusch/virttxtjml/questions/problems.htm
https://www.albert.io/organic-chemistry-2

Recommended Texts (Optional):
- *Strategic Applications of Named Reactions in Organic Synthesis.* Kurti, L.; Czako, B.
- *The Art of Writing Reasonable Organic Reaction Mechanisms*. Grossman, R. B.
- *Advanced Organic Chemistry, Part B: Reactions and Synthesis.* Carey, F.; Sundberg, R.

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

Grading:

Breakdown:
Midterm 1: 25% (Feb 23, 2021)
Midterm 2: 25% (Apr 20, 2021)
Quizzes (5 in total): 20% (Jan 26, Feb 2, Feb 16, Mar 23, Apr 13)
Final: 30% (May 7, 2021)

Two midterm exams will count for 50% of the course grade (25% each), five quizzes will count for 20% of the grade and a comprehensive final exam will count for the other 30% of the grade. 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).

Note: **All exams are multiple-choice exams.**
Note: **The lowest score of the two midterm exams will be dropped.**
Note: **Everyone will receive up to 5 bonus questions on each of the midterm exams and the final.**

Exams: All quizzes, midterms and the final will consist of multiple-choice questions only. There will be no open-ended questions. Each quiz will consist of 10 multiple-choice questions (1 point per question). Each exam (midterms and final) will consist of 45 multiple-choice questions (1 point per question). Only one answer choice for each question is correct.

Bonus questions: Everyone will receive up to 5 bonus questions. That is, if 5 bonus questions are given, then the score will be normalized to 40 questions, and the 5 additional questions will be on the top of it. This means that you can simply skip the 5 questions that you do not wish to answer and still get 100%.

Class Outline:

Day	Date	Lecture	Topic
Tue	Jan 19	Lecture 1	Chapter 15: Introduction to Organometallic Compounds
Fri	Jan 22	Lecture 2	Chapter 15
Tue	Jan 26	Lecture 3	Chapter 16: Aldehydes and Ketones **Q1 (15)**
Fri	Jan 29	Lecture 4	Chapter 16
Tue	Feb 2	Lecture 5	Chapter 17: Carboxylic Acids **Q2 (16)**
Fri	Feb 5	Lecture 6	Chapter 17
Tue	Feb 9	Lecture 7	Chapter 18: Functional Derivatives of Carboxylic Acids
Fri	Feb 12	Lecture 8	Chapter 18
Tue	Feb 16	Lecture 9	Chapter 19: Enolate Anions and Enamines **Q3 (17-18)**
Fri	Feb 19	Lecture 10	Chapter 19
Tue	**Feb 23**	**Lecture 11**	**Exam 1: Chapters 15,16,17,18**
Fri	Feb 26	Lecture 12	Exam 1: overview
Tue	Mar 2	Lecture 13	Chapter 13: Nuclear Magnetic Resonance Spectroscopy
Fri	Mar 5	Lecture 14	Chapter 14: Mass Spectrometry
Tue	Mar 9	Lecture 15	Chapter 14-13
Fri	Mar 12	Lecture 16	Chapters 15-19: overview
Tue	Mar 16	Lecture 17	**No Class – Spring Break**
Fri	Mar 19	Lecture 18	**No Class – Spring Break**
Tue	Mar 23	Lecture 19	Chapter 20: Dienes, Conjugated Systems, and Pericyclic Reactions **Q4 (13-14,19)**
Fri	Mar 26	Lecture 20	Chapter 20
Tue	Mar 30	Lecture 21	Chapter 21: Benzene and the Concept of Aromaticity
Fri	Apr 2	Lecture 22	Chapter 21
Tue	Apr 6	Lecture 23	Chapter 22: Reactions of Benzene and its Derivatives
Fri	Apr 9	Lecture 24	Chapter 22
Tue	Apr 13	Lecture 25	Chapter 23: Amines **Q5 (21-22)**
Fri	Apr 16	Lecture 26	Chapter 23
Tue	**Apr 20**	**Lecture 27**	**Exam 2: Chapters 13,14,19,20,21,22**
Fri	Apr 23	Lecture 28	Exam 2: overview
Tue	Apr 27	Lecture 29	Chapter 24: Catalytic Carbon-Carbon Bond Formation
Fri	Apr 30	Lecture 30	Chapter 24
Fri	**May 7**	**Finals**	**Comprehensive Final Exam**

Exam:

All exams will be open book, open note. Exams will cover lecture material, text, assigned problems and problems discussed in the class.

Molecular Models:

A small molecular model kit made by either Cochranes of Oxford or Indigo Instruments is available in the bookstore.

Note: We reserve the right to change the syllabus at any time. All changes, as applicable, will be communicated through Canvas.

Homework Problems (homework will not be collected):

Chapter 13	2,3,5-8,9,12,15,17,19,24
Chapter 14	2,4,8,14,15,16,17,23,25,29,31,36
Chapter 15	1-6,7,8,10,12,20,21,22,23
Chapter 16	1-13,14-20,24,29,30,31,32,38,42,43,46,59
Chapter 17	1-6,8,10,15,17,18-22,26,28,33,35,40,48,50
Chapter 18	1,3-10,12,16,18,19,20,22-25,27,32,35,37,41,64,66
Chapter 19	1-17,18,19,20,22,29,31,33,43,46,50,51,57,78
Chapter 20	1,2-4,5-13,14-17,19,23,28,30,32,36,50,52
Chapter 21	1-7,9(skip b,g),12,15-17,20,22,23,26,32,36,45,46,52abc
Chapter 22	1-6,8,15,16,19,20,21,22,26,28,32-35,37,40
Chapter 23	1-15,16,18,24,25,33,34,45,47,48
Chapter 24	1,2,4,7,10,32,33
Chapter 29	1-4,5abc,6,7,11,16,24,25,32,33,38 (optional)

Recitation: Professor Fina Liotta:

Recitations on Wed (4:00-5:20 PM, email: fliotta@rutgers.edu) (Sec 02) will be used to discuss multiple-choice problems, homework problems and review lecture material.

Add/Drop/Withdraw:

- Add/Drop period: January 19 - January 27
- Last day to drop with a "W": March 22
- Full Calendar (NCAS is school 21): https://registrar.newark.rutgers.edu/registrar-spring-academic-calendar-0

All dates above are subject to change. Please check frequently from January 5-27, 2021 to keep abreast of any changes (https://registrar.newark.rutgers.edu/registrar-spring-academic-calendar-0**)**

Learning Objectives:

After completion of this course students should:

- be familiar with major classes of functional groups in organic chemistry
- be familiar with fundamental reaction classes in organic chemistry
- 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 able to determine structure using spectroscopic methods
- be familiar with spectroscopic methods used in organic chemistry
- be familiar with general synthetic approaches used in organic chemistry
- be familiar with introduction to cross-coupling 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, contact Dr. Szostak and Dr. Liotta through email, during 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.

Remote Instruction:

Students should be aware of and follow the University guidance concerning web conferencing: https://it.rutgers.edu/knowledgebase/etiquette-and-best-practices-for-web-conferencing

Prior to recording, students should notify anyone that may appear in the recording (including any residents where the recording is taking place) that the student is recording a video, in order to ensure that any recordings do not invade any third-party privacy rights.

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.

Accommodation and Support Statement

Rutgers University Newark (RU-N) is committed to the creation of an inclusive and safe learning environment for all students and the University as a whole. RU-N has identified the following resources to further the mission of access and support:

For Individuals with Disabilities: The Office of Disability Services (ODS) is responsible for the determination of appropriate accommodations for students who encounter barriers due to disability. Once a student has completed the ODS process (registration, initial appointment, and submitted documentation) and reasonable accommodations are determined to be necessary and appropriate, a Letter of Accommodation (LOA) will be provided. The LOA must be given to each course instructor by the student and followed up with a discussion. This should be done as early in the semester as possible as accommodations are not retroactive. More information can be found at ods.rutgers.edu. Contact ODS at (973)353-5375 or via email at ods@newark.rutgers.edu.

For Individuals who are Pregnant: The Office of Title IX and ADA Compliance is available to assist with any concerns or potential accommodations related to pregnancy. Students may contact the Office of Title IX and ADA Compliance at (973) 353-1906 or via email at TitleIX@newark.rutgers.edu.

For Absence Verification: The Office of the Dean of Students can provide assistance for absences related to religious observance, emergency or unavoidable conflict (e.g., illness, personal or family emergency, etc.). Students should refer to University Policy 10.2.7 for information about expectations and responsibilities. The Office of the Dean of Students can be contacted by calling (973) 353-5063 or emailing deanofstudents@newark.rutgers.edu.

For Individuals with temporary conditions/injuries: The Office of the Dean of Students can assist students who are experiencing a temporary condition or injury (e.g., broken or sprained limbs, concussions, or recovery from surgery). Students experiencing a temporary condition or injury should submit a request using the following link: https://temporaryconditions.rutgers.edu.

For English as a Second Language (ESL): The Program in American Language Studies (PALS) can support students experiencing difficulty in courses due to English as a Second Language (ESL) and can be reached by emailing PALS@newark.rutgers.edu to discuss potential supports.

For Gender or Sex-Based Discrimination or Harassment: The Office of Title IX and ADA Compliance can assist students who are experiencing any form of gender or sex-based discrimination or harassment, including sexual assault, sexual harassment, relationship violence, or stalking. Students can report an incident to the Office of Title IX and ADA Compliance by calling (973) 353-1906 or emailing TitleIX@newark.rutgers.edu. Incidents may also be reported by using the following link: tinyurl.com/RUNReportingForm. For more information, students should refer to the University's Student Policy Prohibiting Sexual Harassment, Sexual Violence, Relationship Violence, Stalking and Related Misconduct located at http://compliance.rutgers.edu/title-ix/about-title-ix/title-ix-policies/.

For support related to interpersonal violence: The Office for Violence Prevention and Victim Assistance can provide any student with confidential support. The office is a **confidential resource** and does ***not*** have an obligation to report information to the University's Title IX Coordinator. Students can contact the office by calling (973) 353-1918 or emailing run.vpva@rutgers.edu. There is also a confidential text-based line available to students; students can text (973) 339-0734 for support.

For Crisis and Concerns: The Campus Awareness Response and Education (CARE) Team works with students in crisis to develop a support plan to address personal situations that might impact their academic performance. Students, faculty and staff may contact the CARE Team by using the following link: tinyurl.com/RUNCARE or emailing careteam@rutgers.edu.

For Stress, Worry, or Concerns about Well-being: The Counseling Center has confidential therapists available to support students. Students should reach out to the Counseling Center to schedule an appointment: counseling@newark.rutgers.edu or (973) 353-5805. If you are not quite ready to make an appointment with a therapist but are interested in self-help, check out *TAO at Rutgers-Newark* for an easy, web-based approach to self-care and support: https://tinyurl.com/RUN-TAO.

For emergencies, call 911 or contact Rutgers University Police Department (RUPD) by calling (973) 353-5111.

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 19. Enolate Anions and Enamines (Carbonyl Condensation Reactions and Rections 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 Condensatsions
- 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 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 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. Huckel'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