

**Organic Chemistry 160:336 Section 2
Spring 2022, Rutgers University, Newark
Syllabus**

Lecture/Exams: Tuesday and Friday 1:00-2:20 PM, Boyden Hall 100

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

Recitation/Quizzes: Professor Fina Liotta, fliotta@rutgers.edu

Recitations: Wed (4:00-5:20, Smith Hall 220) (Sec 02) will be used for quizzes, to discuss homework problems and review lecture material.

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.

Additional 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 remainder of the semester.

Disclaimer: These lecture materials are protected by copyright laws. The copyright ownership of the lecture materials vests in either the Professor teaching the course, or to Rutgers University to the extent applicable. The copyright owner of the lecture materials grants you a non-exclusive and limited license only to use them for your own personal use during the course. Sharing them with others (including other students), reproducing, distributing, or posting any copyright protected part of the lecture materials elsewhere-including but not limited to any internet site-will be treated as a copyright violation and an offense against the honesty provisions of the Code of Student Conduct.

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 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.

Useful Websites:

<https://www.name-reaction.com/list>

<https://www.organic-chemistry.org/namedreactions/>

<https://www.masterorganicchemistry.com/>

Grading:

Midterm 1: 50%*

Midterm 2: 50%*

Quizzes (6-7 in total): bonus 5%

Final: 50%

*Two 80-minute exams will count for 50% of the course grade, and a comprehensive final exam will count for the other 50% of the course grade. The lowest score of the 80-minute exams will be dropped (or an 80-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 (79-74), 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 points on each of the midterms and the final.**

Note: **Everyone will receive up to 5% bonus of the final score from quizzes. All quizzes are administered in person at the start of recitations by Prof. Fina Liotta.**

Exams: All quizzes, midterms and the final will consist of multiple-choice questions only. There will be no open-ended questions. 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 18	Lecture 1	Chapter 15: Introduction to Organometallic Compounds
Fri	Jan 21	Lecture 2	Chapter 15
Tue	Jan 25	Lecture 3	Chapter 16: Aldehydes and Ketones
Fri	Jan 28	Lecture 4	Chapter 16
Tue	Feb 1	Lecture 5	Chapter 16
Fri	Feb 4	Lecture 6	Chapter 16
Tue	Feb 8	Lecture 7	Chapter 17: Carboxylic Acids
Fri	Feb 11	Lecture 8	Chapter 18: Functional Derivatives of Carboxylic Acids
Tue	Feb 15	Lecture 9	Chapter 18
Fri	Feb 18	Lecture 10	Chapter 19: Enolate Anions and Enamines
Tue	Feb 22	Lecture 11	Chapter 19
Fri	Feb 25	Lecture 12	Exam 1: Chapters 15,16,17,18
Tue	Mar 1	Lecture 13	Chapter 19
Fri	Mar 4	Lecture 14	Chapter 13: Nuclear Magnetic Resonance Spectroscopy
Tue	Mar 8	Lecture 15	Chapter 13
Fri	Mar 11	Lecture 16	Chapter 14: Mass Spectrometry
Tue	Mar 15	Lecture 17	No Class – Spring Break
Fri	Mar 18	Lecture 18	No Class – Spring Break
Tue	Mar 22	Lecture 19	Chapter 20: Dienes, Conjugated Systems, and Pericyclic Reactions
Fri	Mar 25	Lecture 20	Chapter 20
Tue	Mar 29	Lecture 21	Chapter 21: Benzene and the Concept of Aromaticity
Fri	Apr 1	Lecture 22	Chapter 21
Tue	Apr 5	Lecture 23	Chapter 22: Reactions of Benzene and its Derivatives
Fri	Apr 8	Lecture 24	Chapter 22
Tue	Apr 12	Lecture 25	Exam 2: Chapters 13,14,19,20,21,22
Fri	Apr 15	Lecture 26	Chapter 23: Amines
Tue	Apr 19	Lecture 27	Chapter 23
Fri	Apr 22	Lecture 28	Chapter 23
Tue	Apr 26	Lecture 29	Chapter 24: Catalytic Carbon-Carbon Bond Formation
Fri	Apr 29	Lecture 30	Chapter 24
Fri	May 6	Finals	Comprehensive Final Exam

Exams:

Exams will be closed book, closed 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.

Homework Problems (homework will not be collected):

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 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 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 (optional)	1-4,5abc,6,7,11,16,24,25,32,33,38

Add/Drop/Withdraw:

- Add/Drop period: January 18 - January 25
- Last day to drop with a "W": March 21
- Full Calendar (NCAS is school 21): <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 and Dr. Liotta during office hours, make an appointment to see them at times other than 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.

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 Outline:

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. 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