

21: 160: 336 Organic Chemistry 2, Section 1 Spring 2021

Lectures by Prof. Frank Jordan assisted by Dr. Fina Liotta in some lectures and in recitations. As of writing this syllabus, the course will be presented online, using the Rutgers Newark Blackboard. The lectures will be recorded simultaneously and will be available for viewing throughout the semester.

All exams are multiple-choice exams. All exams are open book, open-note exams.

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Office hours: Thursday 2-3:30PM

Lectures Tuesday, Friday 1:00-2:20

Recitation Thursday 11:30 AM; No Recitation on Thursday, Jan. 23, 2020

COURSE SCHEDULE

Tue JAN 19 Chapter 13: Nuclear Magnetic Resonance Spectroscopy
Fri JAN 22 Chapter 13
Tue JAN 26 Chapter 15: Introduction to Organometallic Compounds
Fri JAN 29 Chapter 16: Aldehydes and Ketones
Tue FEB 2 Chapter 16
Fri FEB 5 Chapter 16
Tue FEB 9 Chapter 17: Carboxylic Acids
Fri FEB 12 Chapter 14: Mass Spectrometry
Tue FEB 16 **Exam 1: Chapters 13,14,15,16**
Fri FEB 19 Chapter 18: Functional Derivatives of Carboxylic Acids
Tue FEB 23 Chapter 18
Fri FEB 26 Chapter 19: Enolate Anions and Enamines
Tue MAR 2 Chapter 19
Fri MAR 5 Chapter 19
Tue MAR 9 Chapter 20: Dienes, Conjugated Systems, and Pericyclic Reactions
Fri MAR 12 Chapter 20

Tue MAR 15 No Class -- Spring Break
Fri MAR 19 No Class -- Spring Break
Tue MAR 23 Chapter 21: Benzene and the Concept of Aromaticity
Fri MAR 27 **Exam 2: Chapters 17,18,19,20**
Tue MAR 30 Chapter 21
Fri APR 2 Chapter 22: Reactions of Benzene and its Derivatives
Tue APR 6 Chapter 22
Fri APR 9 Chapter 23: Amines
Tue APR 13 Chapter 23
Fri APR 16 Chapter 24: Catalytic Carbon-Carbon Bond Formation
Tue APR 20 **Exam 3: Chapters 21,22,23**
Fri APR 23 Chapter 24
Tue APR 27 Chapter 25: Biological Molecules, Carbohydrates
Fri APR 30 Chapter 25
Fri MAY 7 **Comprehensive Final Exam (All Chapters)**

Course Synopsis:

Fundamental principles in organic chemistry. Synthesis and reactivity of major classes of functional groups, fundamental reaction classes, spectroscopic methods, biological molecules. Special attention is given to reaction mechanisms, stereoelectronic effects and the application of organic chemistry in the synthesis of more complex molecules. Where applicable, the relationship of the reactions to corresponding reactions in metabolism will be mentioned.

Goals of 160:336 include the following topics:

- 1. Spectroscopic characterization of organic molecules using Nuclear Magnetic Resonance, Mass Spectrometric and UV-Visible spectroscopic methods**
- 2. Formation of C-C bonds using organometallic methods**
- 3. Chemistry of the carbonyl functional group**
Aldehydes and ketones
Carboxylic acid derivatives
- 4. Effect of conjugation on structure: aliphatic and aromatic compounds**
- 5. Effect of conjugation on reactivity: aliphatic and aromatic compounds**
- 6. Introduction to the molecules of life- time permitting Chapter 25.**

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 also 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://www.varsitytutors.com/organic_chemistry-practice-tests#practice-tests-section

<https://www2.chemistry.msu.edu/faculty/reusch/virttxtjml/questions/problems.htm>

Recommended Texts (Optional):

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

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

TEXT/ASSIGNED PROBLEMS**Homework Problems (homework will not be collected)**

Ch 13: 2,3,5-8,9,12,15,16,19,24

Ch 14: 2-4,8,14,15,16,17,23,25,28,29,31,36

Ch 15: 1-6,7,8,10,12,21,20,22,23

Ch 16: 1-13,14-20,24,29,30,31,32,38,42,43,46,61a,61c

Ch 17: 1-6,8,10,15,17,18-22,26,28,33,35,40,48,50

Ch 18: 1,3-10,12,16,18,19,20,22-25,27,32,35,37,41,64,66

Ch 19: 1-17,18,19,20,22,29,31,33,43,46,50,51,57,78

Ch 20: 1,2-4,5,7-12,14-17,19,23,30,32,36,52

Ch 21: 1-7,9(skip b,g),12,15-17,20,22,23,26,32,36,52abc

Ch 22: 1-6,15,16,19,20,21,26,28,32-35,37,40

Ch 23: 1-15,16,18,24,25,33,34,45,47,48

Ch 24: 1,2,4-7,10,32,33

Ch 25: To be announced later

MOLECULAR MODELS

A small molecular model kit made by either Cochranes of Oxford or Indigo Instruments is available in the bookstore. Note that these inexpensive kits do not include directions, so you may wish to download these [online instructions](#).

OFFICE HOURS

Dr. Jordan

Spring 2021 Office Hours on Thursday 3:30-5:00 PM (Check the [announcements](#) section for occasional changes to these times).

Or by appointment (frjordan@newark.rutgers.edu) The best way to contact Dr. Jordan is through email. He rarely checks voice mail and he is often far from a phone.

Dr. Liotta

Spring 2021 Office Hours: Thu 10-11 AM

(Check the [announcements](#) section for occasional changes to these times).

Or by appointment (fliotta@newark.rutgers.edu) The best way to contact Dr. Liotta is through email.

GRADES/EXAMS

Three 60-minute exams, of which the two top scores will count for 50% of the course grade, and a comprehensive final exam will count for the other 50% of the course grade. This will avoid any need for make-up exams, should you miss a 60-minute exam for any reason.

RECITATION

Recitations on Thursday (11:30-12:50) will be used to discuss homework problems and review lecture material. This is an integral part of the 4-credit course and Drs Jordan and Liotta reserve the right to use the time for lecture and or exam, should there be any emergencies demanding it.

HELP

If you need assistance, study tips, or have questions about the course material or homework problems, see Dr. Jordan or Dr. Liotta during their [office hours](#), meet with her in the recitation section, make an appointment to see them at times other than their 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.

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

ADD/DROP/WITHDRAW

ADD/DROP 1/19/21- 1/27/21

LAST DAY TO DROP 1/28/21

LAST DAY TO ADD 1/29/21

LAST DAY TO WITHDRAW 3/22/21

Spring Recess Begins: 3/13/2021

Spring Recess Ends: 3/21/2021

SPECIAL NOTICES

1. Students are reminded that this is a 4-credit course with three meeting times
Tue, Fri 1:00-2:20PM and Th 11:30-12:50.
Attendance of recitations is obligatory, Dr. Jordan reserves the option of lecturing in the
Th 11:30-12:50 time slot as needed in case of inclement weather requiring make-up
lecture, personal issues etc.
2. Students are urged to become familiar with the use of Blackboard as messages will be
sent via Blackboard throughout the semester.

Academic Integrity

As an academic community dedicated to the creation, dissemination, and application of knowledge, Rutgers University is committed to fostering an intellectual and ethical environment based on the principles of academic integrity. Academic integrity is essential to the success of the University's educational and research missions, and violations of academic integrity constitute serious offenses against the entire academic community. The entire Academic Integrity

Policy can be found here: <http://academicintegrity.rutgers.edu/academic-integrity-policy/>

Rutgers University Accommodation and Support Statement

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

Students with Disabilities: Rutgers University welcomes students with disabilities into all of the University's educational programs. The Office of Disability Services (ODS) is responsible for the determination of appropriate accommodations for students who encounter barriers due to disability. In order to receive consideration for reasonable accommodations, a student with a disability must contact ODS, register, have an initial appointment, and provide documentation. Once a student has completed the ODS process (registration, initial appointment, and documentation submitted) and reasonable accommodations are determined to be necessary and appropriate, a Letter of Accommodation (LOA) will be provided to the student. The student must give the LOA to each course instructor, followed by a discussion with the instructor. This should be completed as early in the semester as possible as accommodations are not retroactive.

Religious Holiday Policy and Accommodations: Students are advised to provide timely notification to instructors about necessary absences for religious observances and are responsible for making up the work or exams according to an agreed-upon schedule. The Division of Student Affairs is available to verify absences for religious observance, as needed: (973) 353-5063 or DeanofStudents@newark.rutgers.edu

Counseling Services: Counseling Center Room 101, Blumenthal Hall, (973) 353-5805 or <http://counseling.newark.rutgers.edu/>

Students with Temporary Conditions/Injuries: Students experiencing a temporary condition or injury that is adversely affecting their ability to fully participate in their courses should submit a request for assistance at: <https://temporaryconditions.rutgers.edu>

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

Gender or Sex-Based Discrimination or Harassment: Students experiencing any form of gender or sex-based discrimination or harassment, including sexual assault, sexual harassment, relationship violence, or stalking, should know that help and support are available. To report an incident, contact the Office of Title IX and ADA Compliance: (973) 353-1906 or TitleIX@newark.rutgers.edu. To submit an incident report: tinyurl.com/RUNReportingForm To speak with a staff member who is confidential and does NOT have a reporting responsibility, contact the Office for Violence Prevention and Victim Assistance: (973) 353-1918 or run.vpva@rutgers.edu.

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 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. ¹³C NMR

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 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 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 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. Dieckmann 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