CHEM 0204A/B LECTURE
Organic Chemistry II: Synthesis and Spectroscopy

Fall 2024
Professor Tom Anderson

Instructor Information

- Office location: MBH 551
- E-mail: thomasa@middlebury.edu
- Office hours (in MBH 551): Monday 12:00–1:00 PM, Tuesday 11:00 AM–12:00 PM, Wednesday 12:00–1:00 PM *and by appointment. If you have questions about material covered during a lecture, you are also welcome to ask immediately after class*

Teaching Assistants

- TBA

Course Meetings

- Lecture location/time: MBH 219, Monday and Wednesday 8:15–9:30 AM (A); 9:45–11:00 AM (B)
- Weekly optional problem sessions: TBA
- Drop-in hours: TBA

Course Description

In this course we will explore how organic molecules are made and their structures are identified. The study of organic reactions will continue from CHEM 203 with additions to alkenes and alkynes, aromatic reactions, oxidations and reductions, additional carbonyl reactions, and radical reactions. There will be an emphasis placed on strategies toward the sequential use of reactions to synthesize larger and more complex molecules. The theory and practice of mass spectrometry, UV-vis, IR, and NMR spectroscopy will also be studied as tools for the elucidation of the precise structures of organic molecules. Laboratory experiments will focus on synthetic techniques that complement the lecture material and will involve the identification of complex unknown molecules using GC-MS, IR, and NMR.

Course Information and Learning Objectives

This second semester of organic chemistry builds upon the fundamental concepts of structure and reactivity introduced in Chem 203 with the aim of expanding your understanding of chemical reactivity and cultivating skills for designing, conducting, and communicating research in synthetic organic chemistry. The lecture component of the course will focus on three topics: characterization of organic molecules through spectroscopy and spectrometry, new reactivity, and synthesis of complex organic molecules.

The learning objectives for Chem 204 are:

- Learn how to characterize organic molecules using several spectroscopic and spectrometric techniques (particularly nuclear magnetic resonance (NMR) spectroscopy)
- Practice laboratory skills and learn how to use various instrumentation
- Explore new reactivity, focusing on reactions of alkenes
- Learn strategies for organic synthesis
- Apply your understanding of chemical reactivity and synthetic strategies to design synthetic routes to organic molecules

Course Design

This course is designed to fulfill the learning objectives in a manner that promotes collaboration and inclusion within our classroom community. A vast amount of science is propelled by collaboration; the consideration of different perspectives and skillsets is deeply beneficial to the scientific process, a rationale that also applies to learning in the classroom. **In our organic chemistry course, collaboration is at the foundation** of the weekly problem sessions and in-class practice problems.

General Course Information

I. Course materials

Required:

- *Organic Chemistry: Principles and Mechanisms*, 3rd edition, Joel Karty
- *Smartwork*

The textbook is available online in the Middlebury virtual bookstore (in three format options including an ebook) and from other vendors such as Amazon.com. Smartwork access is included with purchases of the 3rd edition textbooks and can also be independently purchased for $40 at https://digital.wwnorton.com/karty3.

Recommended:

- Molecular Visions Molecular Model Kit (ISBN 978-09648837) or similar model kit
- *Study Guide and Solutions Manual*, 3rd edition, Joel Karty, Taylor Mach, and Marie Melzer

The model kit is available for purchase in the Middlebury bookstore and from other vendors such as Amazon.com. The 3rd edition solutions manual is available as an ebook and can be purchased for $40 from https://digital.wwnorton.com/karty3ssm.

Additional information

Please contact me if you have any questions about course materials or if you need financial assistance for purchasing course materials. Additionally, the 1st edition textbook, 1st edition solutions manual, and a model kit will be on reserve in the library. It is fine to use the 1st or 2nd editions of the textbook, but in that case Smartwork access is not included and will need to be purchased independently at https://digital.wwnorton.com/karty3.

II. Course website

Assignments, handouts, supplementary readings, recommended problems, grades, and the syllabus will be available on the course Canvas page.

III. Overview of assignments and due dates

All assignments are due at 11:59 PM

- **Problem sets** (written homework): due on Fridays (see schedule on p. 7)
- **Smartwork** (online homework): due weekly on Wednesdays (see schedule on p. 7)
- **Three in-class exams**, on 10/2, 11/6, and 12/11

IV. Grading information

Late work will be accepted but with an associated partial letter grade deduction per day late if there is not prior approval from the instructor (3% for 1 day late, 6% for 2 days late, etc.), except in the event of an emergency. Please reach out to me via email (thomasa@middlebury.edu) in advance of the assignment deadline, whenever possible, if you think you will need an extension.

Unless otherwise noted, assignments will be graded based on accuracy and completeness. For SmartWrok, infinite attempts are allowed with a small grade penalty (10–33% depending on the question) for each subsequent attempt.

As described in the laboratory syllabus, to pass Chem 204 you are required to complete all laboratory experiments (unless excused by the instructor) and to earn an overall lab grade above 60%.

Your overall grade is based off the distribution listed below. The numerical correlation that will be used for assigning final letter grades is also shown:

Problem Sets	25%	A	93.0–100%
SmartWork	20%	A-	90.0–92.9%
Exams (3 x 10%)	30%	B+	87.0–89.9%
Laboratory	25%	B	83.0–86.9%
		B-	80.0–82.9%
		C+	77.0–79.9%
		C	73.0–76.9%
		C-	70.0–72.9%
		D	60.0–69.9%
		F	<59.9%

If you think that there is grading error in one of your assignments, you have up to one week to submit it for a regrade.

More Information on Course Meetings

Weekly problem sessions (beginning the week of 9/16, time and location TBA)

The weekly problem sessions offer you an opportunity to work in small groups on the written problem sets. **Teaching assistants for this course will be present during the problem sessions**. I encourage you to discuss class material with your classmates and with the teaching assistants, who are happy to provide feedback on homework and other questions about course material. **Attendance at problem sessions is optional**, but I recommend that you attend these sessions and work together with your peers.

More Information on Assignments

This course involves both written homework and online homework. The written homework includes questions that aren't conducive to an online automatic grading format (such as questions with multiple correct answers), gives you practice with drawing molecules and mechanisms by hand, and is similar in structure to my exams. The online homework has its own advantages of immediate feedback, practice with electronic molecule drawing (with a format notably similar to that of chemistry drawing software ChemDraw), and reinforcement of finer but critical details like the directionality of arrows in pushing electrons.

I. Problem sets

Problem sets will be posted on Canvas one week in advance of the due date. The answers you submit must be your own work (i.e., do not copy from you peers), but you are encouraged to work together on the problem sets. The problems are designed to be challenging and encourage critical thinking.

II. Smartwork

Smartwork is an online homework platform developed by W.W.Norton (the publisher of our textbook). You might have used a similar platform in general chemistry. Assignments will be linked through Canvas. The first Smartwork assignment, which is due on Fridays (see p. 7), is a series of problems that introduces the functionalities and question types of Smartwork. Smartwork assignments will generally be available 4 days before the deadline (the assignments are generally available on Monday with a Friday deadline). The following instructions may be helpful in registering for Smartwork and completing assignments:

1. Access the class Canvas site and go to the "Getting Started with Smartwork Module"
2. Watch the 3 minute "How to Register for Smartwork Video"
3. Click on the eBook link in the "Organic Chemistry Textbook" module and follow the directions to access Smartwork. You will need to input your registration code. If you aren't sure if you have a valid registration code or have any questions, please feel free to reach out. If you don't have a registration code, you will need to purchase Smartwork access.
4. To work on assignments, click on the link corresponding to the assignment within Canvas, which takes you to the Norton website. The assignment should have the same name on the Norton website as the one listed in Canvas, and "854362" should also be present, which is our course ID. ***Please always access Smartwork assignments through Canvas; this is important because otherwise the grades do not sync with the Canvas gradebook.***

III. Exams

There will be three in-class exams in this course. Unless otherwise stated, you may not use any outside materials (e.g., your notes, the textbook, your phone, etc.) with the exception of a calculator and a molecular modeling kit. Each exam will focus on material leading up to the exam (i.e., exam 2 will focus on material covered between exam 1 and exam 2) but **all exams are cumulative**, and you are responsible for everything covered up to that point (unless otherwise noted).

Additional Course Information

Extra problems

For additional practice I recommend problems from the Karty textbook. There are many practice problems, so I recommend focusing on the concepts that you find the most challenging. I will post some recommended problems on Canvas throughout the semester.

Reserve materials

A copy of the 1st edition Karty textbook and study guide along with some other books that may be valuable to your study of organic chemistry will be on reserve in the Armstrong library and are listed below. You may come across instances where you need clarification on a concept from class or in the book. In that case I am always happy to help, and it may also be helpful to look at the explanation of that concept in a different textbook, as different textbooks use varied approaches to teaching organic chemistry. I recommend **Jones and Fleming's "Organic Chemistry"** as a secondary textbook for your studies. There are also a vast number of resources on the internet that can be useful for learning or reviewing organic chemistry.

1. Jones Jr., M. and Fleming, S. A. (2018). *Organic chemistry*, 5th Ed. New York, NY: W. W. Norton & Company.
2. Grossman, R. B. (2002). *The Art of Writing Reasonable Organic Reaction Mechanisms*, 2nd Ed. New York, NY: Springer.
3. Master Organic Chemistry: https://www.masterorganicchemistry.com/
4. LibreTexts Chemistry: https://chem.libretexts.org/

Early feedback

My primary goals for this course are for you to learn and enjoy organic chemistry and I will try to make adjustments *during the course,* when possible, to support these goals. About halfway through the semester I will ask you to complete anonymous feedback surveys in class. *I also encourage you to talk with me throughout the semester any time you have suggestions, questions, or concerns about our course.*

Department of Chemistry & Biochemistry feedback

As part of the Department of Chemistry & Biochemistry's commitment to developing an inclusive environment in which all students can participate fully and feel welcomed, we are eager to better understand the experiences of students in our courses and research labs. We welcome your anonymous feedback on your experiences in the department here:
https://forms.gle/abwCwW5TYAHrRKMZ9

College Policies and Resources

Honor Code

Plagiarism is not permitted on any assignments and information you obtain through a copyrighted source should be paraphrased and cited. It is acceptable to paraphrase and cite pieces of information but the synthesized work must be your own. For more information on the honor code, please consult the College Handbook (go/honorcode).

Unless otherwise stated, you may not work with others while taking exams and you may not use any outside materials on exams (such as your notes, the textbook, or internet resources) except for calculators and molecular model kits. You are welcome to work with your classmates and consult with myself and the teaching assistants on homework, but the work that you submit must be your own (i.e., do not copy someone else's work).

Attendance Policy

While attending the lectures is not strictly mandatory (i.e. I will not be taking attendance at the beginning of each class), I have the expectation that you will come to class if you are able to. My goal is to make class time as productive as possible for your learning of the material, and it is my hope that you will this time valuable for asking questions, practicing problems, and learning new concepts.

Generative AI Policy

The use of AI tools such as ChatGPT is not recommended for this class. It is my opinion that large language models aren't (yet?) reliable for explaining a lot of concepts in organic chemistry, or providing correct reaction mechanisms. In these cases, a well-worded Google search (or asking me) will likely provide you with more reliable information.

Disability Access and Accommodation

Students who have Letters of Accommodation in this class are encouraged to contact me as early in the semester as possible to ensure that such accommodations are implemented in a timely fashion. For those without Letters of Accommodation, assistance is available to eligible students through the Disability Resource Center (DRC). Please contact ADA Coordinators Jodi Litchfield, Peter Ploegman or Dierdre Kelly of the DRC at ada@middlebury.edu for more information. All discussions will remain confidential.

Center for Teaching, Learning, and Research (CTLR)

The CTLR provides academic support for students in many specific content areas and in writing across the curriculum through both professional and peer tutors. The Center is also the place where students can find assistance in time management and study skills. These services are free to all students. go.middlebury.edu/connect

Disability Resource Center (DRC)

The DRC provides support for students with disabilities and facilitates the accommodations process by helping students understand the resources and options available and by helping faculty understand how to increase access and full participation in courses. DRC services are free to all students.

Links

- Disability Resource Center: go/disabilityresourcecenter
- Center of Teaching, Learning and Research (CTLR): go/ctlr
- *Not Voodoo X: Demystifying Synthetic Organic Chemistry Since 2004* http://chem.chem.rochester.edu/~nvd/index.php?page=home
- Write Like A Scientist–A Guide to Scientific Communication (created by Professor Molly Costanza-Robinson): http://sites.middlebury.edu/middsciwriting/
- Link for installing ChemDraw: https://www.middlebury.edu/college/academics/chemistry-and-biochemistry/resources/chemdraw-pro
- American Chemical Society (ACS) Publications homepage: http://pubs.acs.org/
- The ACS Style Guide (Chapter 14: References, i.e. how to properly cite sources): http://pubs.acs.org/doi/10.1021/bk-2006-STYG.ch014
- Middlebury-guides and information about library research: http://www.middlebury.edu/academics/lib/research

Syllabus

The syllabus, including the readings, is an estimate of the material to be covered in each class and is subject to change. I will supply an updated syllabus as necessary throughout the semester. All readings are from the Karty textbook unless otherwise stated. Readings from other textbooks will be posted on Canvas. Readings in parentheses generally will not be the focus in class but may be helpful and interesting supplementary reading.

Keep in mind that although your exams and problem sets will be based on material covered in the lectures, you will be expected to apply your understanding of fundamental concepts to new types of problems. A few things need to be memorized in organic chemistry so that we can "speak the language" (nomenclature, drawing conventions) but for most things memorization is not an effective strategy.

I strongly recommend that you review your notes shortly after class. It is easier to clear up confusion about concepts immediately, rather than waiting until the material isn't as fresh.

Assignments and reading information for the lecture part of this course are listed on this syllabus and will also be listed on Canvas.

Tentative Fall 2024 Schedule

A semester planner in this format is available through the CTLR at go.middlebury.edu/time

	M	TU	W	TH	F
1	9/9 **Introduction; Mass spectrometry**; 15.1–15.3	9/10	9/11 **Mass spectrometry (cont'd)**; 15.5, 15.6	9/12	9/13 SmartWork
2	9/16 **IR spectroscopy** 16.1–16.6	9/17	9/18 **NMR I: introducition, shifts, and integration;** 17.1–17.4, 17.8 SmartWork	9/19	9/20 Problem Set
3	9/23 **NMR II: Characteristic chemical shifts, ^{13}C NMR;** 17.5, 17.6, 17.12	9/24	9/25 **NMR III: splitting;** 17.9, 17.10 SmartWork	9/26	9/27 Problem Set
4	9/30 **NMR IV: Structure determination;** 17.14	10/1	10/2 Exam 1	10/3	10/4 Problem Set
5	10/7 **Thermodynamics and Alkene reactivity;** 6.4, 7.8, 7.10?, 12.1–12.3	10/8	10/9 **Reactivity of alkenes and alkynes;** 12.4–12.7 SmartWork	10/10	10/11 Midterm Recess
6	10/14 **Kinetic vs thermodynamic control;** 12.9, 12.10, 11.3,	10/15	10/16 **Reactivity of alkenes (cont'd);** 13.3–13.6a, 13.9 SmartWork	10/17	10/18 Problem Set
7	10/21 **Conjugation and aromaticity;** 14.1, 14.2(?), 14.4, 14.5, 14.7, 14.8	10/22	10/23 **Conjugation and aromaticity (cont'd)** SmartWork	10/24	10/25 Problem Set
8	10/28 **Electrophilic aromatic substitution;** 24.1–24.7, 24.8	10/29	10/30 **Reactions on substituted aromatic rings;** 25.1–25.7, 25.9 SmartWork	10/31	11/1 Problem Set
9	11/4 **Redox reactions;** 20.1, 20.3–20.6, 18.3, 22.6	11/5	11/6 Exam 2	11/7	11/8 Problem Set
10	11/11 **Synthetic strategies: Planning, retrosynthetic analysis;** 10.2, 10.3, 11.1	11/12	11/13 **Synthetic strategies: C–C bond formation;** 6.2 (pre 6.2a), 11.2–11.4 SmartWork	11/14	11/15 Problem Set
11	11/18 **Synthetic strategies: C–C bond formation (cont'd);** 18.6, 20.7, 21.1	11/19	11/20 **Pericyclic reactions: The Diels–Alder reaction;** 26.1–26.5, 26.7 SmartWork	11/21	11/22 Problem Set
BR	11/25 Thanksgiving Recess (all week)	11/26	11/27	11/28	11/29
12	12/2 **Other pericyclic reactions;** 26.8, 26.9	12/3	12/4 **Radical reactions;** 27.1–27.3, 27.5 SmartWork	12/5	12/6
EX	12/9 Fall Classes End - Friday Schedule	12/10 Reading Day	12/11 Final Exams Exam 3	12/12 Final Exams	12/13 Reading Day
	12/16 Final Exams	12/17	12/18	12/19	12/20