

Faculty of Science Course Syllabus
Department of Chemistry
Chemistry 3401 (CRN 20431)
Intermediate Organic Chemistry
Winter 2020

Instructors: **Lecture:** Dr. Alex Speed; aspeed@dal.ca; Office: Chemistry 413

Office Hours: By chance, or at request by e-mail. Please familiarize yourself with Dalhousie's Scent-Free policy (link at end of syllabus) before attending class or office hours.

Laboratory: Dr. Reinaldo Moya Barrios; rbarrios@dal.ca; Office: Chemistry 1053

See Brightspace for laboratory office hours.

Lectures: Monday, Wednesday, Friday, 9:35-10:25 am Location Chemistry 223

Laboratories: 1:35-5:25. Friday Labs Start Jan 10th, Thursday Labs Start Jan 16th
Location: Sproull Organic Chemistry Laboratory (Chemistry 121-125P)

Course Description

Topics presented include aromatics, heterocycles, amines, enolate anions and other methods for forming C-C bonds, concerted reactions, carbohydrates and some heteroatom chemistry. There is a continuing emphasis on the principles of mechanistic organic chemistry. Students work independently in the laboratory on the preparation, purification, and characterization of organic compounds.

Course Prerequisites

Organic chemistry involves both a great deal of memorization and understanding. Much like a language, you must possess a memorized vocabulary (reactions), but also a correct understanding of syntax and grammar (thinking mechanistically, and knowing how and when to apply reactions) to have success in this course. You are expected to have a FLUENT command and understanding of the material from CHEM 2401 and 2402. Being able to draw correct Lewis structures, produce legible structures with reasonable geometry, evaluate resonance contributors and draw curved arrow mechanisms will be necessary for success in this course. Organic synthesis is a cumulative discipline, and it is expected that you have retained knowledge of reactions and concepts covered in preceding courses. You will be both explicitly and implicitly tested on material covered in CHEM 2401/2402.

Course Objectives/Learning Outcomes

Organic synthesis allows the synthesis of molecules that broadly impact our lives through application in healthcare, materials science, food processing and fundamental research. Organic chemistry has the reputation of being a difficult topic, however the degree of difficulty depends on how you approach the subject. While the study of organic chemistry does involve substantial memorization, you will gain the most understanding with the least amount effort from this course by seeking to understand trends in the chemistry you see, rather than treating each reaction as an isolated concept to be memorized.

Appreciating trends and patterns gives you the maximum ability to apply what you have learned to predict the outcome of reactions that are new, either to you, or to science.

In CHEM 3401, we will examine some of the most important carbon-carbon bond forming reactions, including reactions on aromatic heterocycles. An overview of chemistry for introduction and manipulation of common heteroatoms is provided. Simple stereochemical considerations are introduced. After successful completion of the course, students will be able to formulate multi-step syntheses of molecules of moderate complexity, containing multiple functional groups, with some knowledge of how to develop strategy based on considerations of reactivity.

Course Materials

- *“Organic Chemistry”* by Jonathan Clayden, Nick Greeves, Stuart Warren. Oxford University Press, 2nd Edition, 2012. This book is available at the bookstore, and will be the textbook I provide readings from.
- **A comparable textbook is available online, however I do not provide readings from it:** *“Advanced Organic Chemistry, Part B: Reactions and Synthesis”*, 5th Edition, by Carey and Sundberg, Springer, 2007.

This book is downloadable as a PDF courtesy of the Canadian Research Knowledge Network.

To Dal students on campus, this text-book is available at the following URL:

<http://www.springerlink.com/content/978-0-387-68350-8/contents/>

- for home use of this, or any other Dalhousie Library resource, modify URL to include the proxy server as follows:
<http://www.springerlink.com.ezproxy.library.dal.ca/content/978-0-387-68350-8/contents/>
- I encourage using molecular models to understand conformation and selectivity, and these will be permitted during examinations, however they are not required.
- Non-graded practice problems and their solutions will be made available on a regular basis. Successful study habits in organic chemistry typically involve actively, frequently, and repetitively practicing drawing mechanisms for the reactions under study, rather than simply reviewing the mechanism and attempting to reproduce the mechanism for the first time under evaluation.

Laboratory Materials (Required)

- Chem 3401 Laboratory Manual from academic year 2019-2020.
- Hard-covered laboratory notebook
- Safety glasses (prescription glasses that are not safety glasses are not sufficient)
- Approved lab coat

Safety Module: All students who are enrolled in a class with a laboratory component must do the Chemistry Safety Module on the Dalhousie Chemistry LON-CAPA site accessed through Brightspace in each academic year. The deadline is Jan. 12th 2020, 11:30 pm. Students who completed the module in the 2019 Fall term do not need to redo it this term. The Laboratory safety map needs to be completed in every laboratory the student works.

WHMIS: WHMIS, or the Workplace Hazardous Materials Information System, is a global harmonized system used to classify and label hazards and regulate handling procedures within industry and academic fields, especially those in science. Regardless of your chosen field of study within science being familiar with WHMIS is a significant asset. As such, the Department of Chemistry requires ALL students

participating in their laboratory programs to complete WHMIS 2015 training provided by the Environmental Health and Safety Office. This training course is provided through the Dalhousie College of Continuing Education. Upon completion of your WHMIS 2015 course you will receive a Letter of Completion (as a PDF document) via email from the College of Continuing Education (cceehs@dal.ca) within 3 business days. Please ensure that you register and complete the WHMIS course well in advance of the letter submission deadline. After you have received your Letter of Completion please upload the PDF document to the Brightspace site. Instructions on how to register for the course and upload your letter of completion can be found on the Brightspace Site. The due date to complete the 2015 WHMIS training is January 26th 2020, 11:30 pm.

Note: the WHMIS training is valid for three (3) years. If you have completed this training within the last 3 years please upload your WHMIS 2015 Course letter of completion as a PDF file as indicated on the Brightspace site.

Useful Websites

Various websites are available containing information that complements that presented in the course, or may be of use in assignments.

- **Primary literature:**

There are many journals. A small set of important chemistry journals are shown below:

American Chemical Society Journals: <http://pubs.acs.org>

Royal Society of Chemistry Journals: <http://www.rsc.org/journals-books-databases/>

Angewandte Chemie International Edition: (German Chemical Society):

[http://onlinelibrary.wiley.com/journal/10.1002/\(ISSN\)1521-3773](http://onlinelibrary.wiley.com/journal/10.1002/(ISSN)1521-3773)

Scifinder Scholar is a useful tool for searching the chemical literature

Dalhousie Scifinder Scholar: http://libraries.dal.ca/research/sciences_research/sfs.html

- **Databases**

Aldrich: Chemical Catalogue, with physical properties and select NMR spectra of compounds

<http://www.sigmaaldrich.com>

SDBS: Database of NMR, IR, MS spectra for many compounds.

http://sdbs.db.aist.go.jp/sdbs/cgi-bin/direct_frame_top.cgi

Evans' pKa Table: Convenient table of pKas

http://evans.rc.fas.harvard.edu/pdf/evans_pKa_table.pdf

Bordwell pKa database: Extensive database of pKas

<http://www.chem.wisc.edu/areas/reich/pkatable/>

Evans' Organic Problem Database: Advanced organic chemistry problems, selectable by topic, with solutions. (Note that a number of the problems here involve concepts outside the scope of this course).

<http://evans.rc.fas.harvard.edu/problems/index.cgi>

Course Assessment

Component	Weight (% of final grade)	Date
Two in-class tests	40 % (20 % each)	W, Feb 12 th ; W, Mar 18 th
Two Assignments	5 % (2.5 % each)	F, Jan 31 st ; M, Mar 9 th
Final exam	35 %	(Scheduled by Registrar)
Laboratory	20 %	(See Laboratory Manual for due dates)

A passing grade (11/20) is required in the laboratory section to pass the class. The assignments will be take-home assignments based on course material. I intend these to provide early feedback with a relatively low value to identify concepts you may struggle with in advance of the tests. Accordingly, you will obtain maximum benefit from these if you work your own, rather than in collaboration.

Conversion of numerical grades to Final Letter Grades follows the Dalhousie Common Grade Scale

A+ (90-100)	B+ (77-79)	C+ (65-69)	D	(50-54)
A (85-89)	B (73-76)	C (60-64)	F	(<50)
A- (80-84)	B- (70-72)	C- (55-59)		

Course Policies

Brief Absences: Attendance and participation are not components of evaluation in this course, so absences outside of tests or exams do not need to be accounted for. You will still be responsible for material in any lecture you missed. If you are ill or otherwise experiencing a personal emergency at the time of a midterm test, e-mail me when convenient to inform me of the situation, and fill out a Student Declaration of Absence form (available at Brightspace) at an appropriate time. Many circumstances can count as personal emergencies, and I am happy to help you to the best of my ability in accommodating unexpected life circumstances that may take priority over this course for you. While I do not generally offer make-ups for one missed midterm, in the case of a missed midterm due to illness or another prearranged situation, the weighting of the final exam will change to make up the missing marks. **Longer Term Absence:** In the case of situations that require a longer absence, please contact me to arrange accommodations to keep up with course material. The declaration of Absence form may only be used twice per class per semester, and accommodation of longer-term illnesses is best handled through involvement of the Assistant Dean (Student Affairs), Patricia Laws, from the Faculty of Science. **Missed Final Exam:** Students who are ill for the final exam and produce a medical certificate will have an opportunity to write a make-up final exam. Other absences from the final exam due to personal emergency will be accommodated at my discretion. **Accommodation:** The Student Declaration of Absence Form applies to acute illness, and is not intended as a replacement for seeking accommodation if you have learning differences that affect your ability to take an evaluation. Dalhousie provides expertise in this area: to arrange accommodations for tests or exams through the Advising and Access Services Centre, please see Accessibility on page 5. If you feel you require any assistance deciding if you need help, please let me know, and I will offer advice. **Late Assignments:** Late assignments will not be accepted after graded assignments have been returned to the class.

Course Content Includes

(Detailed readings will be assigned in class).

Part 0. Refresher on Functional Group Interconversion and Redox Chemistry

- Interconversion of carbonyl compounds – Chapter 10 (p 214-220), Chapter 23 (p 528-538), Chapter 23 (p 544-548).
- Protecting Groups (p 548-560)
- Umpolung – Class Notes

Part 1. Aromatic and Alkene Chemistry

- Electrophilic aromatic substitution – Chapter 21 (p 471-497), Chapter 29 (p723-755)
- Nucleophilic aromatic substitution – Chapter 22 (p 514-526)
- Heterocyclic Structure and Reactivity – Class Notes
- Olefination – Chapter 27 (p 656-693)
- Hydroboration – Class Notes
- Metalation/ cross coupling – Chapter 9 (p 182-190), Chapter 40 (p 1069-1078 as background, then p 1078-1098)

Part 2. Carbonyl Chemistry

- Stabilized anion alkylation – Chapter 20 (p 449-470), Chapter 25 (p 584-602)
- Conjugate addition – Chapter 22 (p 499-514), Chapter 25 (p 602-613)
- Aldol reaction – Chapter 26 (p 614-655)

Part 3. Further reactivity

- Heterocyclic synthesis – Chapter 30 (p 757-788)
- Pericyclic reactions – Chapter 34 (p 877-896)
- Sigmatropic reactions – Chapter 35 (p 909-919)
- Olefin Metathesis – Class Notes

University Policies and Statements

This course is governed by the academic rules and regulations set forth in the University Calendar and by Senate

Academic Integrity

At Dalhousie University, we are guided in all of our work by the values of academic integrity: honesty, trust, fairness, responsibility and respect (The Center for Academic Integrity, Duke University, 1999). As a student, you are required to demonstrate these values in all of the work you do. The University provides policies and procedures that every member of the university community is required to follow to ensure academic integrity.

Information: https://www.dal.ca/dept/university_secretariat/academic-integrity.html

Accessibility

The Advising and Access Services Centre is Dalhousie's centre of expertise for student accessibility and accommodation. The advising team works with students who request accommodation as a result of a disability, religious obligation, or any barrier related to any other characteristic protected under Human Rights legislation (Canada and Nova Scotia).

Information: https://www.dal.ca/campus_life/academic-support/accessibility.html

Student Code of Conduct

Everyone at Dalhousie is expected to treat others with dignity and respect. The Code of Student Conduct allows Dalhousie to take disciplinary action if students don't follow this community expectation. When appropriate, violations of the code can be resolved in a reasonable and informal manner—perhaps through a restorative justice process. If an informal resolution can't be reached, or would be inappropriate, procedures exist for formal dispute resolution.

Code: https://www.dal.ca/dept/university_secretariat/policies/student-life/code-of-student-conduct.html

Diversity and Inclusion – Culture of Respect

Every person at Dalhousie has a right to be respected and safe. We believe inclusiveness is fundamental to education. We stand for equality. Dalhousie is strengthened in our diversity. We are a respectful and inclusive community. We are committed to being a place where everyone feels welcome and supported, which is why our Strategic Direction prioritizes fostering a culture of diversity and inclusiveness

Statement: <http://www.dal.ca/cultureofrespect.html>

Recognition of Mi'kmaq Territory

Dalhousie University would like to acknowledge that the University is on Traditional Mi'kmaq Territory. The Elders in Residence program provides students with access to First Nations elders for guidance, counsel and support. Visit or e-mail the Indigenous Student Centre (1321 Edward St) (elders@dal.ca).

Information: https://www.dal.ca/campus_life/communities/indigenous.html

Important Dates in the Academic Year (including add/drop dates)

https://www.dal.ca/academics/important_dates.html

University Grading Practices

https://www.dal.ca/dept/university_secretariat/policies/academic/grading-practices-policy.html

Missed or Late Academic Requirements due to Student Absence (policy)

https://www.dal.ca/dept/university_secretariat/policies/academic/missed-or-late-academic-requirements-due-to-student-absence.html

Student Resources and Support

Advising

General Advising https://www.dal.ca/campus_life/academic-support/advising.html

Science Program Advisors: <https://www.dal.ca/faculty/science/current-students/academic-advising.html>

Indigenous Student Centre: https://www.dal.ca/campus_life/communities/indigenous.html

Black Students Advising Centre: https://www.dal.ca/campus_life/communities/black-student-advising.html

International Centre: https://www.dal.ca/campus_life/international-centre/current-students.html

Academic supports

Library: <https://libraries.dal.ca/>

Writing Centre: https://www.dal.ca/campus_life/academic-support/writing-and-study-skills.html

Studying for Success: https://www.dal.ca/campus_life/academic-support/study-skills-and-tutoring.html

Copyright Office: <https://libraries.dal.ca/services/copyright-office.html>

Fair Dealing Guidelines <https://libraries.dal.ca/services/copyright-office/fair-dealing.html>

Other supports and services

Student Health & Wellness Centre: https://www.dal.ca/campus_life/health-and-wellness/services-support/student-health-and-wellness.html

Student Advocacy: <https://dsu.ca/dsas>

Ombudsperson: https://www.dal.ca/campus_life/safety-respect/student-rights-and-responsibilities/where-to-get-help/ombudsperson.html

Safety

Biosafety: <https://www.dal.ca/dept/safety/programs-services/biosafety.html>

Chemical Safety: <https://www.dal.ca/dept/safety/programs-services/chemical-safety.html>

Radiation Safety: <https://www.dal.ca/dept/safety/programs-services/radiation-safety.html>

Scent-Free Program: <https://www.dal.ca/dept/safety/programs-services/occupational-safety/scent-free.html>