

Introductory Organic Chemistry: Structure, Concepts of Mechanisms & Spectroscopy

Dalhousie University is located in Mi'kma'ki, the ancestral and unceded territory of the Mi'kmaq. We are all Treaty people. The Elders in Residence program provides students with access to First Nations elders for guidance, counsel and support. Indigenous Student Centre (1321 Edward St) (elders@dal.ca).

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

Teaching Team: Department of Chemistry

Lecture material: Dr. Alison Thompson, she/her (CHEM2400@dal.ca)

Lab material: Gaia Aish, she/her (ochemlab@dal.ca)

Student Health and Wellness

Taking care of your health is important. As a Dalhousie student, you have access to a wide range of resources to support your health and wellbeing. Students looking to access physical or mental health and wellness services at Dalhousie in Halifax can go to the Student Health & Wellness Centre in the LeMarchant Building. In Truro, physical or mental health and wellness services are available at Health Services in the Dairy Building (Student Success Centre). The teams include: registered nurses, doctors, counsellors and a social worker. Visit dal.ca/studenthealth to learn more and book an appointment today. Students also have access to a variety of *online* mental health resources, including telephone/texting counselling and workshops/training programs. Learn more and access these resources at dal.ca/mentalhealth. Gaia and Dr. Thompson are here to support you and your mental health – please reach out to us. If we can't help directly, we can refer you to Dalhousie's expert resources.

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 Dalhousie's Strategic Direction prioritizes fostering a culture of diversity and inclusiveness.

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

Student Accessibility & Accommodation

The Advising and Access Services Centre (AASC) is Dalhousie's hub 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

A **note-taker** may be required as part of a student's accommodation. If you are interested, please contact AASC at 902-494-2836m or notetaking@dal.ca.

Student Code of Conduct

Everyone in the Dalhousie University community is expected to treat others with dignity and respect. The Code of Student Conduct allows Dalhousie University 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

CHEM2401 is governed by the academic rules and regulations set forth in the University Calendar and 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

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

Course Description

Organic chemistry is introduced through an examination of bonding, conformation and stereochemistry. Spectroscopic methods (MS, IR, ^1H and ^{13}C NMR) are used to determine the structures of compounds. Alkanes, alkenes, alkynes and alkyl halides are presented with an emphasis on the mechanisms of their reactions.

Prerequisites

- CHEM 1011.03/CHEM 1012.03 or equivalent (grade of C- or better)
- NOTE: the CHEM2402 prerequisite is CHEM2401 with a grade of C+ or better.

Learning Activities

Lecture learning

- Monday, Wednesday, Friday, 8.35-9.35am starting 8th September 2021
- Studley MCCAIN ARTS&SS AUD-2, Ondaatje Theatre (turn right in main floor foyer in McCain Building)

Lab learning

- Weekly labs starting Monday 13th September 2021 with an in-person in-lab orientation
- Sproull Organic Chemistry Laboratory 121-125P (lowest level of the Chemistry Building)

Drop-in Q&A tutorials (online, synchronous – posted afterwards on BrightSpace)

- Optional Chemistry-based help with Dr. Thompson – the main way of getting help with CHEM2401
- Using the Teams platform, Thursdays 1-2pm, weekly starting 9th September

Post-it questions (online, asynchronous)

- Post lab and lecture questions here for classmates and the teaching team (Teams platform)

Appointments (online, synchronous)

- One-on-one meetings for administrative items and support related to an individual student
- NOT chemistry-based help; strictly by appointment

Learning Objectives

Students passing CHEM2401, will be able to:

- understand and use IUPAC nomenclature rules
- draw and name organic compounds
- identify common functional groups found in organic compounds
- use VSEPR and Lewis theory to draw good/proper Lewis structures
- identify major/minor contributors for species that feature resonance stabilization
- draw and identify bonding orbital components according to hybridization theory
- use an understanding of structure and acid-base reactivity to predict pKa values
- use an understanding of structure and acid-base reactivity to predict equilibrium constants, K
- use curly/curved arrows to depict mechanisms
- use mechanisms to propose reaction coordinate diagrams
- rationalize and/or suggest suitable choices of base to effect deprotonation under precise conditions
- draw and identify constitutional, conformational and configurational isomers
- draw and identify least/most stable conformations
- draw and interpret perspective diagrams, Newman projections and Fischer projections
- predict and rationalize torsional strain and bond angle strain (ring strain)
- draw, interpret and predict stability for chair conformations of cyclohexanes
- apply Cahn-Ingold-Prelog rules to identify isomers (geometrical *E/Z*, stereochemical *R/S*)
- structurally identify organic compounds based on mass spectrometry and NMR spectroscopic data
- predict mass spectrometry and NMR spectroscopic data based on structure of organic compounds
- calculate and apply double bond equivalents in the analysis of organic compounds
- identify molecular ions in electron ionisation/electron impact (EI) mass spectrometry
- predict and rationalise the effects of C, Br and Cl isotopes in mass spectrometry
- rationalise ^1H and ^{13}C spectral information using introductory-level NMR theory
- predict and rationalise ^1H and ^{13}C chemical shifts
- predict and rationalise multiplicity patterns based on $n+1$ rules in ^1H and ^{13}C NMR spectroscopy
- predict and rationalise integrals in ^1H NMR spectroscopy
- apply considerations of structure, bonding and equilibrium to predict and rationalize reactivity
- propose reasonable curly/curved arrow-pushing mechanisms for substitution and elimination reactions
- propose reasonable curly/curved arrow-pushing mechanisms for reactions of alkenes and alkynes
- apply considerations of stereospecificity, stereoselectivity and regioselectivity to the reactions of alkyl halides and related species, alkenes and alkynes
- construct and interpret rate equations
- construct and interpret reaction coordinate diagrams
- propose and interpret synthetic sequences/routes for the preparation of complex organic species
- understand essential experimental techniques
- apply experimental techniques in a variety of lab situations
- interpret experimental results and write scientific passages

Nomenclature and Functional Groups – a self-taught topic

Based on pre-requisite material, students are expected to demonstrate a working knowledge of the nomenclature used for simple organic molecules, alongside common functional groups. Some general directions for this will be given in lectures, but **students are responsible for teaching themselves the rules and applications of chemical nomenclature**; a comprehensive description of the nomenclature rules can be found in the text-book. This material can be practiced very effectively by using the online practice assignments, as well as the exercises in the text-book. The Brightspace site includes additional resources and links. Using the IUPAC RULES, molecules with carbon chains and rings from one to ten atoms, containing the following functional groups: alkanes, alkenes, alkynes, cycloalkanes, cycloalkenes, alkyl halides, alcohols. The IUPAC rules include the groups isopropyl, sec-butyl, tert-butyl, allyl, vinyl, phenyl and benzyl, as well as stereochemical designations (*R*, *S*, *E*, *Z*). You will need to know the common, trivial names and the IUPAC names for such everyday molecules as acetone, acetic acid, methylene chloride, ethyl acetate, chloroform and carbon tetrachloride. This material represents a basic introduction to organic nomenclature and functional groups.

Materials

Lab Manual

You require the printed course lab manual, fall 2021 edition, from the bookstore. The manual explains fundamental aspects of important lab skills. During the term you will develop those skills by applying them to the experiments and activities outlined in the manual.

Safety Glasses

Safety glasses are **mandatory** for CHEM2401 labs; must have CSA-Z94-3 or ANSI Z87 rating.; available from the bookstore.

Lab Coats

100% cotton, long-sleeved lab coats are mandatory for CHEM2401 labs. Your lab coat must fit properly and must reach to near the knees. Sleeves must not be rolled up. Lab coats and safety glasses are available from the Dalhousie University bookstore, or you can provide your own if they meet standards and ratings. Lab coats should only be worn in the laboratory work area, and so must be removed when exiting the lab (even for just a few moments, or to go to the bathroom). When transporting your lab-coat, Dalhousie policy requires you to place it in secondary containment such as a dedicated bag, i.e. do not stuff it into your back-pack with other items. Dirty lab coats (not chemically dirtied, but just regular dirt from wearing) should be laundered separately from other items. Chemically soiled lab coats should be treated as such: consult your lab instructor.

Concepts in Chemistry CHEM2401 NOTES

These notes, written by the Dalhousie CHEM2401 teaching team, contain problem sets, alternative descriptions of our curriculum material, and samples of past tests and exams. Previously students have found these Notes extremely useful. Available for purchase as eText via Dalhousie bookstore and accessed from Willolabs.

Textbook

Organic Chemistry, Professor Paula Y. Bruice, 8th Ed., available for purchase as eText (online) via Dalhousie bookstore and accessed from Willolabs, or in hard copy from other suppliers

Model Kits

Some students find model kits useful to enhancing understanding of molecular bonding and structures

Brightspace

Lecture Topics and Lab resources: <https://dal.brightspace.com>

Teams

Dalhousie-supported Microsoft product for synchronous drop-in Q&A, asynchronous posts, and Appointments: accessible via the "waffle" on MyDal – login via your Dalhousie email address

LON-CAPA

<http://capa.conceptsinchemistry.ca>

Lab Learning

Laboratory work is an integral part of this class. The lab work will help you to learn and appreciate practical techniques and will help you to understand lecture topics. The detailed running of the laboratories will be handled by Gaia Aish (ochemlab@dal.ca), assisted by Teaching Assistants (TAs).

Regardless of your standing in other parts of the class, you can only get credit for CHEM2401 after you have earned credit for the laboratory (minimum score= 50%, 10/20). To pass the course students **must submit** all lab work.

No lab exemptions will be granted based on scores in the virtual 2020 lab.

Attendance is required. Due to room capacity limitations, make-up labs will not be possible. If you need to miss a lab session, contact ochemlab@dal.ca. Do not use the Student Declaration of Absence Form.

In an effort to ensure academic integrity in the lab, lab work may be analyzed for uniqueness using Dalhousie approved plagiarism software (Urkend).

Lab will begin on Monday September 13th, 2021

M: 9.35-12.25

M: 13.35-16.25

T: 10.05-12.55

T: 14.05-16.55

W: 9.35-12.25

W: 13.35-16.25

R: 10.05-12.55

F: 9.35-12.25

F: 14.05-15.55

Assessments, Requirements and Policies

Assignments, tests and exams

- In accordance with the principles of Dalhousie's Academic Integrity policies, all submissions must be your own work, and not involve input from, or the provision of answers by, other individuals or groups either in person or via web-based services.
- Term-tests and final exam (entire course – lecture, videos, assigned textbook and lab content) will be conducted "closed book".
- Lecture-based online assignments using CAPA, one for each Topic: students may complete as many of the practice assignments as they wish, as needed to become familiar with the material. All of the questions in the practice assignments database are included in the database of questions used to generate the six graded assignments, alongside many new questions. Completion of the graded assignments is "all or nothing": all six count towards the 10% allocated for this assessment component. Students may take each graded assignment twice, with the best score for each assignment counting for the overall grading scheme. Different questions will appear in the two graded assignments for any one Topic, should students decide to take two assignments. Students get one "try/attempt" per question.
- The two Term-Tests will be held during the scheduled lecture time, 08.30-09.30 AST.
- **No make-ups are available.** Students who miss a test do not need to provide documentation to justify their absence, do not need to provide a Declaration of Absence form, and do not need to inform Dr. Thompson of their absence. The best of the three overall grading options will be applied in calculating all final letter grades. Students are not required to pre-select an option.
- Students who are ill for the Final Examination must inform Dr. Thompson (CHEM2400@dal.ca) at least 8 hours **prior to the scheduled examination.**
- Only **one** Make-up Final Examination will be arranged (see the University Regulations, Calendar).
- There is no supplemental examination for CHEM2401.

Grading Options

CHEM2401 has three grading options. All grading options are calculated automatically, and the best letter grade for each student is then applied: students do not need to pre-select a grading option.

Component	Option 1 weight (%)	Option 2 weight (%)	Option 3 weight (%)
Laboratory	20	20	20
Lecture-based online assignments	0	10	10
Term-Test 1	10	0	10
Term-Test 2	10	10	0
Final exam	60	60	60

Conversion of numerical grades to final letter grades follows Dalhousie's 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)		

Fall 2021 Syllabus CHEM2401

Component	Weight (% of final grade); see above for three grading options	Date
Lab	20 (must earn at least 10/20 to pass CHEM2401)	
Online lecture-based assignment Topic 1: Functional groups and nomenclature	Maximum 10	11.59pm AST Sept 14 th 2021
Online lecture-based assignment Topic 2: Structure and bonding		11.59pm AST Sept 28 th 2021
Online lecture-based assignment Topic 3: Acidity and basicity		11.59pm AST Oct 5 th 2021
Online lecture-based assignment Topic 4: Isomerism		11.59pm AST Oct 26 th 2021
Online lecture-based assignment Topic 5: Characterisation		11.59pm AST Nov 16 th 2021
Online lecture-based assignment Topic 6: Organic reactions		11.59pm AST Dec 7 th 2021
Term-test 1	Maximum 10	8.30-9.30am AST Sep 29 th 2021
Term-test 2	Maximum 10	8.30-9.30am AST Nov 24 th 2021
Final exam	60 (must earn >40% on final exam to pass CHEM2401)	Scheduled exam period, posted by Registrar's Office

Lecture Material

See BrightSpace for learning outcomes and resources

Topic	Material	Sections in textbook, <i>Organic Chemistry</i> by Professor Paula Y. Bruice, 8 th edition
1	Functional groups and nomenclature	3.1-3., 4.2, 5.2, 5.4, 7.1, 7.2
2	Structure and bonding	Ch1, 2.12, 3.8, 3.9, 5.3, 6.2, 7.3, 8.1-8.12 plus tutorials pages 382 and 563
3	Acidity and basicity	2.1-2.9, 2.12, 7.10, 8.9-8.10 plus tutorial on page 80
4	Isomerism	3.11-3.16, 4.1-4.15, 4.17, 4.18, 6.14-6.15
5	Characterisation	5.1, 13.1-13.4, 14.1-14.14, 14.7, 14.8, 14.20, 14.21, 14.23
6	Organic reactions	<ul style="list-style-type: none"> ▪ Substitution reactions: 9.1-9.5, 9.12, 9.13, 9.15, 9.17, 10.1, 10.3, 10.6-10.7, 10.12 ▪ Elimination reactions 9.6-9.13, 9.15, 9.17, 10.4, 10.9-10.10 ▪ Reactions of alkenes 5.1-5.12, 6.1-6.9, 6.12, 6.16, 8.12 plus tutorial starting on page 225 ▪ Reactions of alkynes 7.1-7.12

Lab Assessments

Lab Report Sheets

Each week you will complete a report sheet, which consists of a single tear-out page of the lab manual.

- You will submit your Report Sheets at the beginning of next lab session.
- The report sheet will assess your understanding of your experimental results. The report sheet often requires you to demonstrate knowledge and skills that are important 'pen-and-paper' aspects of organic chemistry communication and knowledge.

Online Lab Assessments

Each week lab material will be assessed outside of your lab block in two online methods: Quizzes and Written Assignments. For each lab learning activity or experiment you will complete **either** a quiz-style assessment or short writing assignment.

- Quizzes: the Brightspace quiz function will be used to assess general understanding of lab theory, interpreting results and lab operations
- Writing Assignments: you will submit typed passages using the Brightspace file submission feature. You will be assessed on your written answers in terms of your understanding of lab theory, interpreting results, and lab operations, as well as your ability to communicate your understanding of the material in a complete and clear manner.

Week of:	Location	Lab Experience	Due Dates	
			Report Sheets In lab the week of:	Online Assessment
Sept 13 th	In-person	Activity 1. Orientation (45 mins)	none	Safety Module and WHMIS participation
Sept 20 th	In-person	Exp 1. Solubility (90 mins)	Oct 4 th	Quiz, Oct 1 st , 11:59 pm AST
Sept 27 th	Online (asynchronous)	Activity 2. ChemDraw	none	Writing, Oct 8 th , 11:59 pm AST
Oct 4 th	In-person	Exp 2. TLC (3 hours)	Oct 18 th	Writing, Oct 15 th , 11:59 pm AST
Oct 11 th	No new lab tasks	Thanksgiving	none	none
Oct 18 th	In-person	Exp 3. Recrystallization (3 hours)	Oct 25 th	Quiz, Oct 29 th , 11:59 pm AST
Oct 25 th	In-person	Exp 4. Extraction (3 hours)	Nov 1 st	Writing, Nov 5 th , 11:59 pm AST
Nov 1 st	In-person	Exp 5. Natural Products (3 hours)	Nov 15 th	Writing, Nov 19 th , 11:59 pm AST
Nov 8 th	No new lab tasks	Reading week	none	none
Nov 15 th	In-person	Exp 6. Polarimetry (3 hours)	Nov 22 nd	Quiz, Nov 26 th , 11:59 pm AST
Nov 22 th	In-person	Exp 7. NS (3 hours)	Nov 29 th	Quiz, Dec 3 rd , 11:59 pm AST
Nov 29 th	In-person	Activity 3. NMR (1 hour)	none	Writing, Dec 7 th , 11:59 pm AST

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

Research Lab Safety

- https://www.dal.ca/content/dam/dalhousie/pdf/dept/safety/lab_policy_manual_2007.pdf

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>

Dalhousie COVID-19 information and updates

- <https://www.dal.ca/covid-19-information-and-updates.html>