Chemistry
UNIVERSITY OF TORONTO

# CHM 249H: ORGANIC CHEMISTRY

**Winter 2025 Course Syllabus**

## I TEACHING TEAM

**INSTRUCTOR, COURSE COORDINATOR**
Name: Prof. Mark S. Taylor
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Research: https://sites.chem.utoronto.ca/mst/
Office: Lash Miller, LM 622A
Student hours: R4:00–5:30P (in person, LM108, Jan 9–Feb 6) or by appointment (online or in person)

Instructor biography: BSc UofT 2000; PhD Harvard 2005; Postdoc MIT; Prof. at UofT since 2007. Research interests: organic synthesis, catalysis, physical organic chemistry

**INSTRUCTOR**
Name: Prof. Andrei Yudin
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Student hours (online or in person): by appointment

**LABORATORY COORDINATOR**
Name: Professor Barb Morra
Email: barb.morra@utoronto.ca
Research: chemistry.utoronto.ca/people/directories/all-faculty/barb-morra
Student hours (in person): Tuesdays and Thursdays 9-11 AM in LM117 or by email appointment

Instructor biography: BSc and PhD Western University; Prof. at UofT since 2012. Research interests: chemistry education (including green chemistry initiatives) and organic synthesis

## II COURSE OVERVIEW

**COURSE DESCRIPTION:**

Welcome to CHM 249H: Organic Chemistry! We are glad that you have chosen to take this course and to study this important subject over the next few months. CHM 249H is designed for students with a continuing interest in chemistry, particularly those in any chemistry specialist or major program. In order to appreciate organic

chemistry, one must consider how it has impacted the world around us. Everything from pharmaceuticals, high-tech materials, polymers, fertilizers, pesticides, personal care products, and even our food, has been impacted by organic chemistry. The utility of this subject in our world is a direct result of the powerful reactions that allow chemists to design and create useful compounds with interesting structural motifs and chemical properties. These reactions are often called 'tools' within a chemist's 'toolbox', which can be used to create elaborate target molecules through multistep syntheses.

The primary objective of the CHM 249H classes is to build on the fundamentals of organic chemistry that were previously introduced to students in CHM 151Y or CHM 136H. The course will focus on several principles that revolve around the fundamental structure and bonding of organic compounds. These topics will allow us to explore the basic reactivity and mechanistic details of organic reactions. Tools that facilitate structural elucidation will also be discussed, including NMR and IR spectroscopy. Multistep organic synthesis of complex molecules will be introduced along with topics relating to medicinal chemistry.

We sincerely hope that CHM 249H will exceed your expectations: we are all here to support your learning and are very invested in your success! We would appreciate your comments and suggestions so that we can make the course as helpful and interesting as possible: do feel free to discuss any matters with the instructor, laboratory coordinator, and laboratory teaching assistants (TAs).

**STUDENT LEARNING OUTCOMES:**
Upon successful completion of this course, students will be able to:

- demonstrate an understanding of and apply the structural elucidation techniques of infrared spectroscopy and nuclear magnetic resonance spectroscopy in order to determine the atom connectivity of unknown molecules.
- recognize important classes of functional groups and use knowledge of their reactivity patterns to predict the products of organic transformations.
- interpret the fundamental principles underlying the behavior of organic compounds as nucleophiles and electrophiles.
- formulate fundamental organic reaction mechanisms by appropriately describing electron flow in order to write reasonable mechanisms for new reactions.
- apply organic reactions and their conditions in order to propose synthetic pathways for given target compounds of interest.
- safely conduct chemical experiments in the laboratory using a variety of classic techniques using modern instrumentation.
- collect, record, and interpret laboratory results.
- use problem solving and critical thinking skills to combine their theoretical knowledge with their laboratory results to solve scientific problems.
- develop effective scientific communication skills through written laboratory reports.
- gain a basic appreciation of the principles of green chemistry and sustainability.

**PREREQUISITE COURSE(S):**
This course assumes you have a fundamental and thorough understanding of content presented in CHM 151Y (Chemistry: The Molecular Science). The

combination of CHM135H (Chemistry: Physical Principles) and CHM 136H (Introductory Organic Chemistry I) – especially the latter course – is a suitable alternative prerequisite.

**READINGS:**
**Required:** The course textbook is "Organic Chemistry: Mechanistic Patterns", 2nd edition by Ogilvie, Ackroyd, Browning, Deslongchamps, Lee, and Sauer.
***Important note*: If you purchased this e-text when taking CHM136H or CHM151Y, you will still have access and can use it for this course. There is no need to purchase the e-text again!**

**If you do not already have the e-text and require access, use the following instructions to purchase it. This textbook is only available as an e-textbook** through Top Hat (www.tophat.com). You will be able read content and submit answers to practice questions using Apple or Android smartphones, tablets, or laptops. Your responses to problems will **not** be graded, despite contents being in Homework Mode. They are simply set up that way so you can complete practice questions before seeing the ideal answers. Once the semester is over, you will have access to the entirety of the textbook for future use. For more information, please refer to Top Hat's My Library article.

For instructions on how to create a Top Hat account, purchase the e-textbook, and access materials, please refer to the invitation sent to your University of Toronto email address or consult Top Hat's Getting Started Guide.

If you already have a Top Hat account, go to **https://app.tophat.com/e/180756** to be taken directly to our course. If you are new to Top Hat, follow the link in the email invitation you received or ...

- Go to https://app.tophat.com/register/student
- Click "Search by School" and input University of Toronto
- Search for our course with the following join code: 180756

Should you require assistance with Top Hat at any time please contact their Support Team directly by way of email (support@tophat.com), the in-app support button, or by calling 1-888-663-5491. Specific user information may be required by their technical support team when troubleshooting issues.

**Supplemental:** A molecular model kit will be very useful for most of the course. The "Molecular Visions" kit by Darling Models is recommended for this, as well as other undergraduate organic chemistry courses at U of T, although other model kits are helpful too. Models may be used as an aid in all assessments.

## III COURSE ORGANIZATION

CHM 249H has two instructional components – classes and laboratories – as well as a course discussion board. The classes will be delivered in person for the Winter 2025 semester. Please come prepared by having done any assigned reading and printed out the class notes posted on Quercus in advance. Questions are particularly

welcomed both during class time and after class. Laboratories are scheduled to run in person on Tuesday or Thursday mornings (depending on your PRA section). Please see experimental schedule below.

**CLASSES:** Classes will be held in person on M from 1–2 p.m. and on TR from 3–4 p.m. Lecture notes will be posted prior to the classes. Please be aware that reading the posted class notes and/or textbook, or listening to lecture recordings, is not a substitute for attending classes and taking an active approach to your learning! It is essential that you attend class in person to solidify your understanding of the fundamental course material.

List of planned topics, tentative schedule and evaluation dates:

**COURSE SCHEDULE & RELEVANT SESSIONAL DATES:**

| DATES | WEEK | PLANNED TOPIC(S) |
|---|---|---|
| Jan 6–9 | 1 | Introduction to course; IR and $^{1}$H NMR spectroscopy |
| Jan 13–16 | 2 | $^{13}$C NMR spectroscopy, Substitution reactions |
| Jan 20–23 | 3 | Substitution reactions |
| Jan 27–30 | 4 | Formation of π bonds by elimination reactions |
| Feb 3–6 | 5 | Organic synthesis, Retrosynthetic analysis |
| Feb 10–13 | 6 | Aromaticity and Electrophilic aromatic substitution; ***Term test 1: Tues 11 Feb, 3:10–4:00 PM*** |
| Feb 17–21 | – | Reading week (no classes or labs) |
| Feb 24–27 | 7 | Electrophilic and nucleophilic aromatic substitution |
| Mar 3–6 | 8 | π Bonds as electrophiles |
| Mar 10–13 | 9 | π Bonds as nucleophiles: additions to alkynes; Carbonyl-derived nucleophiles: introduction to enolate chemistry; ***Term test 2: Thurs 13 Mar, 3:10–4:00 PM*** |
| Mar 17–20 | 10 | Aldol and Claisen condensations |
| Mar 24–27 | 11 | Wittig reactions; Chemistry of 1,3-dicarbonyls |
| Mar 31–Apr 2 | 12 | Addition and conjugate addition reactions of enolates and enolate equivalents |

**LABORATORIES:**

The purpose of the mandatory CHM 249H laboratories is to introduce you to classic techniques used in the organic chemistry laboratory while using modern instrumentation. This hands-on experience will allow you to safely and effectively conduct a variety of experiments, a number of which reinforce content discussed during class time. Throughout CHM 249H you will also learn about green chemistry principles, and how they can be used in the laboratory to conduct scientific work in a safe, responsible, and sustainable way. During each experiment you will generate your own scientific data that you will collect, record, and interpret. After each experimental session you will have the opportunity to combine your theoretical knowledge with your laboratory results to solve scientific problems. These conclusions will be communicated through a series of laboratory reports. Although the majority of the reports will be relatively simple and brief, you will be given the

opportunity to engage in scientific writing activities for select experiments in order to improve your scientific writing skills.

During the semester, the laboratory sessions will take place weekly on Tuesdays (section PRA0101) or Thursdays (section PRA0201) from 8:30 a.m.–1:00 p.m. in LM 117. Please note that laboratory reports will be due one week after each experiment is performed (i.e. at the beginning of the next experiment).

*Important Notes:*

- ALL experiments will be in person.
- if you have not yet registered for a practical section on ACORN, or if you need to switch sections, please contact Professor Morra immediately (barb.morra@utoronto.ca).
- in order to be prepared for the CHM 249H laboratory experience, please complete the "CHM 249H Laboratory Check-list" posted on your CHM 249H PRA Quercus site.

**COURSE DISCUSSION BOARD:**

In addition to offered student hours, we will be using the free Piazza discussion platform that facilitates online questions and answers via the Quercus LEC section website. You are strongly encouraged to ask your content questions on this discussion board where all students can benefit. **The teaching team will be monitoring the discussion board and providing input as needed, although we expect students to be helping each other as much as possible.** Please note that posting quiz/laboratory report questions and/or sharing solutions to these questions is in violation of the University of Toronto's Code of Behaviour on Academic Matters (see the Academic Integrity section of the syllabus for more details).

**OTHER AVAILABLE SUPPORTS:**

CHM 249H is supported by the Victoria College Peer Tutoring program (www.vic.utoronto.ca/current-students/registrars-office/tutor). If you would like further support in a small-group online environment, you are also highly encouraged to investigate the Recognized Study Group (RSG) Program (https://sidneysmithcommons.artsci.utoronto.ca/recognized-study-groups/join). These are small, student-led study groups of up to eight classmates enrolled in the same course within the Faculty of Arts & Science. RSGs meet each week: more information will be announced during mid-January about this initiative.

**IMPORTANT WINTER 2025 SESSIONAL DATES:**

First day of S classes: Monday 6th January
Family Day: Monday 17th February
Winter Reading Week (no classes): Monday 17th – Friday 21th February
Last Day to Drop S Courses: Monday 10th March
Last Day of S classes: Friday 4th April
April Final Assessment Period: Wednesday 9th – Wednesday 30th April

## IV EVALUATION/GRADING SCHEME

**OVERVIEW:**
Laboratory: 40%
Term Tests (×2): 30%*
Final Examination: 30%*

**ASSESSMENT DATES & MARK BREAKDOWN:**
1. Term Test 1 (15% or 10%*, in person, Tues 11 Feb, 3:10–4:00 PM, MP134 (surnames A–Mc), SF1101 (surnames Mi–Z), written during regularly scheduled class time).

2. Term Test 2 (15% or 10%*, in person, Thurs 13 Mar, 3:10–4:00 PM, EX200, written during regularly scheduled class time).

3. Final Examination (30% or 35%*, in person, April final assessment period).

4. Laboratory (40%, throughout semester). Quality of practical work/results/submitted products and written laboratory reports (reports have 10% deducted per day late to a maximum of three days).

* If the mark on the final exam is higher than either of the two term test marks, then the weight of the final exam will be increased to 35% and the corresponding term test weight decreased to 10%.

For students missing one term test for a valid reason, the remaining term test will be worth 15% and the final examination will be worth 45%.

**Important Note about the Laboratory Assessment:**
The practical skills acquired in CHM 249H are an important aspect of this course. As such, you are required to attend at least eight (8) complete experimental sessions in order to pass this class. Students who fail to attend enough practical sessions, even if justified with documentation, will not receive credit for CHM 249H since they will not have acquired the practical skills expected of a student who has completed this course.

## V COURSE POLICIES

- Each member of this course is expected to maintain a:

(i) professional and respectful attitude during all course activities, including classes, laboratories, tutorials, and online activity.
(ii) personal calendar/schedule/organizer to ensure that all course activities are completed, and due dates are met.
(iii) collection of notes recorded independently based on concepts covered in course activities (students registered with Accessibility Services requiring a class note-taker will have access to this accommodation)

(iv) familiarity with the university policy on Academic Integrity (overleaf)

- Course website: q.utoronto.ca (in your Quercus Dashboard, click on "CHM 249H Winter 2025"). **Please check the Quercus course website regularly for**:
    - general course information
    - all laboratory information (found in the CHM 249H PRA Quercus sites)
    - class notes
    - all important announcements related to assessments and laboratories

- Email will generally be responded to within 24 hrs. on weekdays. Email will only be accepted if: (1) You send it from your utoronto.ca account; (2) You identify yourself in the email subject as a student in CHM 249H and include your name and University of Toronto student ID number. Be sure to also include your PRA section number if your inquiry is lab related; (3) No attachments are sent, unless official university correspondence is being forwarded (e.g., a letter detailing academic accommodations); (4) You are aware that organic chemistry can be talked about much more effectively through student hours rather than by email, and that sending emails is not a substitute for attending classes. The finalized student hours for each instructor will be posted at the Quercus course website and they are additionally available by appointment.

**Important: be sure to email only ONE person within the CHM 249H instructional team, depending on the nature of your concern. Please do not send emails through the Quercus internal email system: the contact information for the course instructors/laboratory coordinator is listed on p. 1.**

- The University of Toronto is committed to equity, human rights, and respect for diversity. All members of the learning environment in this course should strive to create an atmosphere of mutual respect where all members of our community can express themselves, engage with each other, and respect one another's differences. As a Course Instructor, I will neither condone nor tolerate behaviour that undermines the dignity or self-esteem of any individual in this course and wish to be alerted to any attempt to create an intimidating or hostile environment. It is our collective responsibility to create a space that is inclusive and welcomes discussion. Discrimination, harassment and hate speech will not be tolerated. If you have any questions, comments, or concerns, we encourage you to reach out to the staff in our Equity Offices.

- Laboratory reports and all pre-laboratory quiz responses are to be submitted through the CHM 249H Quercus website only. Late laboratory reports will be deducted at 10% per day (maximum of 3 days late, **after which they will not be graded**), and quiz responses will not be accepted at all after the due date/time.

- If you are absent from your studies due to illness or other reasons and unable to complete course work (e.g., a term test or an assignment) then a piece of written documentation is required. The following four items are the recognized forms of documentation:

  1. Absence Declaration via ACORN (please note the circumstances under which an absence declaration can and cannot be submitted)
  2. U of T Verification of Illness or Injury Form
  3. College Registrar's letter
  4. Letter of Academic Accommodation from Accessibility Services

  **There are no make-up term tests in CHM 249H, and there are no make-up laboratory sessions.** Students who are absent from class for any reason (e.g., COVID-19 illness, other illness or injury, family situation) and who require consideration for missed academic work should report their absence through the online absence declaration. The declaration is available on ACORN under the "Profile and Settings" menu. **Students who complete the ACORN Absence Declaration form must additionally Prof. Taylor (term tests) or Prof. Morra (laboratories) to discuss their situation within five business days of the missed piece of work. This is essential action for any consideration to be granted.**

  For extended absences and for absences due to non-medical reasons, make sure to contact your College Registrar's Office. They can help you decide between a request for an extension or other types of academic consideration.

  If you suspect or know that you have a disability that is affecting your studies, learn about the services and supports available through Accessibility Services. A disability can be physical disability, sensory disability, a learning disability, mental health disorder or a short-term disability like an injury. If you are not sure whether you have a disability, you can confidentially contact Accessibility Services withe your questions.

- **Information Regarding Use of Artificial Intelligence Tools in the Writing of Laboratory Reports:**
  Generative Artificial Intelligence (AI) technology is evolving quickly, and it is necessary to specifically address this within the context of CHM249H laboratory reports. AI tools such as ChatGPT (GPT stands for Generative Pre-trained Transformer) are large language models that have been trained on a limited dataset to generated content based on prompts and the data it has been trained on. It is important to recognize the limitations of these tools, particularly in more specialized subjects such as chemistry. Currently, ChatGPT and many similar models are only trained on freely available data and will not include information that is only accessible through payment, which includes much of the scholarly literature, textbooks, etc. (There is a lot of reliable information on the internet, but there is also a lot of junk, and

ChatGPT does not know how to tell the difference: it has no concept whatsoever of scientific accuracy). In addition, ChatGPT does not cite its sources: when asked to include citations, it will routinely reference papers that do not exist. By using ChatGPT to generate text, you run the risk of accidentally plagiarizing one of the many sources that are included as part of its training data.

Important learning outcomes from the laboratory component of CHM 249H are: (i) using problem solving and critical thinking skills to combine theoretical knowledge with laboratory results to solve scientific problems; and (ii) the development of effective scientific communication skills through written laboratory reports. The practice and repetition of writing on your own has been shown in numerous scientific reports to lead to deeper and longer lasting learning. In this course, the use of ChatGPT and/or other generative AI tools is permitted within the limitations of reviewing your own written work for additional suggestions of grammar, punctuation, etc. In this manner, the tool is educational and can help you develop better writing skills when used critically and for self-analysis. However, it is both ill-advised and prohibited to solely use these tools to attempt to write or analyze components of formal laboratory reports. As mentioned previously, the capabilities of the systems are limited, and you will not develop the scientific communication skills needed for future studies or careers. In summary, it is well established that these tools will misuse and fabricate information and referencing, which will be noticeable by your TAs and laboratory instructors and will leave you susceptible to academic discipline violations (see the "Academic Integrity" section on p. 10 of the syllabus).

- Privacy language and appropriate use of course materials: see the syllabus "Copyright" section.

- Requests for re-grading of term tests must be made within five business days of the posting of the answer guide. Only term tests written in pen will be eligible for re-grading.

## VI TECHNOLOGY REQUIREMENTS

- This course requires the use of computers, and technical issues are possible. When working on a piece of academic work, students are responsible for scheduling enough time to allow for reasonable delays due to technical difficulties to be overcome, so such issues will not be acceptable grounds for deadline extension. Particularly, maintaining an up-to-date independent backup copy of your work is strongly recommended to guard against hard-drive failures, corrupted files, lost computers, etc.

## VII INSTITUTIONAL POLICIES & SUPPORT

**ACADEMIC INTEGRITY**

Academic integrity is essential to the pursuit of learning and scholarship in a university, and to ensuring that a degree from the University of Toronto is a strong signal of each student's individual academic achievement. As a result, the University treats cases of cheating and plagiarism very seriously. The University of Toronto's Code of Behaviour on Academic Matters (governingcouncil.utoronto.ca/secretariat/policies/code-behaviour-academic-matters-july-1-2019) outlines the behaviours that constitute academic dishonesty and the processes for addressing academic offences. Potential offences include, but are not limited to:

In laboratory reports:

1. Using someone else's ideas or words without appropriate acknowledgement.
2. Submitting your own work in more than one course without the permission of the instructor.
3. Making up sources or facts.
4. Obtaining or providing unauthorized assistance on any report. **Please note that the use of websites (such as Chegg.com or the course discussion board) to post laboratory report material/questions or to post/access answers to questions is an academic offence under the University of Toronto's Code of Behaviour on Academic Matters. Alleged instances of this nature are forwarded to the Faculty of Arts & Science Student Academic Integrity office.**

On quizzes and term tests:

1. Using or possessing unauthorized aids. **Please note that the use of websites (such as Chegg.com or the course discussion board) to post quiz/term test questions or to post/access answers to questions is an academic offence under the University of Toronto's Code of Behaviour on Academic Matters. Alleged instances of this nature are forwarded to the Faculty of Arts & Science Student Academic Integrity office.**
2. Looking at someone else's answers or collaborating/discussing answers during a quiz or term test.
3. Misrepresenting your identity.

In general academic work:

1. Falsifying institutional documents or grades.
2. Falsifying or altering any documentation required by the University.

All suspected cases of academic dishonesty will be investigated following procedures outlined in the Code of Behaviour on Academic Matters. If you have questions or concerns about what constitutes appropriate academic behaviour or appropriate research and citation methods, you are expected to seek out additional

information on academic integrity from your instructor or from other institutional resources (see www.academicintegrity.utoronto.ca/).

**Plagiarism Detection**
Normally, students will be required to submit their written work (e.g., lab reports) to the University's plagiarism detection tool for a review of textual similarity and detection of possible plagiarism. In doing so, students will allow their essays to be included as source documents in the tool's reference database, where they will be used solely for the purpose of detecting plagiarism. The terms that apply to the University's use of this tool are described on the Centre for Teaching Support & Innovation web site (https://uoft.me/pdt-faq)".

**COPYRIGHT**
If a student wishes to copy or reproduce class presentations, course notes or other similar materials provided by instructors, he or she must obtain the instructor's written consent beforehand. Otherwise, all such reproduction is an infringement of copyright and is absolutely prohibited.

Audio from sections of this course, including your participation, may be recorded and will be available to students in the course for listening remotely and after each session.
Course audio recordings and materials belong to your instructor, the University, and/or other sources depending on the specific facts of each situation, and are protected by copyright. Do not download, copy, or share any course or student materials or recordings without the explicit permission of the instructor.
For questions about recording and use of audio recordings in which you may be audible, please contact your instructor.

**ACCESSIBILITY NEEDS**
Students with diverse learning styles and needs are extremely welcome in this course. The University of Toronto is committed to accessibility: if you require accommodations for a disability, or have any other accessibility concerns about the course, please contact Accessibility Services as soon as possible.

**ACCOMMODATIONS FOR RELIGIOUS OBSERVANCES**
Following the University's policies, reasonable accommodations will be made for students who observe religious holy days that coincide with the due date/time of an assignment, tutorial, class or laboratory session. Students must inform the instructor **before** the session/assignment date to arrange accommodations.

**ADDITIONAL SERVICES & SUPPORT**
The following are some important links to help you with academic and/or technical service and support:

- General student services and resources at Student Life
- Full library service through University of Toronto Libraries
- Resources on conducting online research through University Libraries Research

- Resources on academic support from the Academic Success Centre
- Learner support at the Writing Centre
- Information for Quercus Support

**ACKNOWLEDGEMENT OF TRADITIONAL LANDS**

We wish to acknowledge this land on which the University of Toronto operates. For thousands of years, it has been the traditional land of the Huron-Wendat, the Seneca and, most recently, the Mississaugas of the Credit River. Today, this meeting place is still the home to many Indigenous people from across Turtle Island and we are grateful to have the opportunity to work on this land.