Chemistry
UNIVERSITY OF TORONTO

CHM 151Y: CHEMISTRY: THE MOLECULAR SCIENCE

Fall 2021/Winter 2022 Course Syllabus

I TEACHING TEAM

COURSE COORDINATOR
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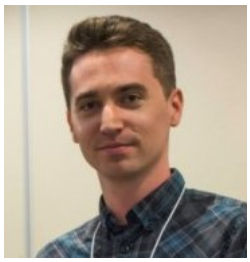

COURSE COMMUNITY DIRECTOR
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II COURSE OVERVIEW

Welcome to the Chemistry Department's special introductory course for those who enjoy chemistry and are considering specializing in the field or a related area! Within CHM 151Y we will emphasize areas that lead you to the frontiers of chemistry research while addressing important fundamental principles. Through appropriate examples, we will focus on modern topics of interest that let you know what the field has to offer from several different perspectives. These include the development of new characterization techniques, the design of organic compounds, and the properties and potential uses of advanced materials.

The first section of the course is an intensive study of the principles of structure and reactions of organic molecules, as well as an introduction to the importance of organic molecules in biological processes. The next section introduces methods of structure determination, and the properties and uses of inorganic elements including novel materials and catalysts. Finally, the last section covers the physical principles that underlie atomic molecular structure, reactivity and energy as well various applications ranging from atomic spectra to solar cells and climate change.

We hope CHM 151Y will exceed your expectations. We are here to support your learning, are very invested in your success and would appreciate your comments and suggestions so that we can make this course as helpful and interesting as possible. Do feel free to discuss any matters with the course coordinator, instructors, laboratory coordinators and tutors.

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

- describe and represent the structure and bonding in commonly encountered functional groups found in organic molecules
- apply concepts of stereochemistry and conformation to analyze the structures of acyclic and cyclic molecules
- implement principles of "arrow pushing" as applied to the description of organic reaction mechanisms
- recognize conditions required to effect functional group transformations during organic reactivity
- interpret spectroscopic data (from nuclear magnetic resonance (NMR), infra-red (IR) and mass spectroscopy (MS) measurements) to elucidate chemical structures
- apply fundamental theories of chemical bonding and notions of molecular shape in the context of inorganic chemistry
- identify and interpret general property and reactivity trends as well as some applications of the elements across the periodic table
- explain the wave-particle nature of matter and justify some of the related implications: the H-atom (energy levels, orbitals), periodic table features, molecules (bonds, energy levels, orbitals), light-matter interactions (the H-atom, chlorophyll, solar cells)
- state and use the laws of thermodynamics and some of their applications, including ideal gas processes, chemical reactions, and climate change
- analyze rates of chemical reactions (zero-, first-, second-order and Michaelis-Menten enzyme kinetics) and some related applications
- safely conduct chemistry experiments in the laboratory using a variety of fundamental techniques and 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 understanding of the principles of green chemistry and sustainability

PREREQUISITE & COREQUISITE COURSES:
This course assumes you have a fundamental understanding of high school (Grade 12) principles of chemistry and mathematics. More specifically, Chemistry SCH4U and Mathematics MHF4U + MCV4U (or their equivalent) are all *required* prerequisite courses. Working knowledge of introductory organic chemistry as outlined in the Ontario Grade 12 curriculum (more specifically the first three chapters of "Organic Chemistry" by J. McMurry, the required organic chemistry textbook for the course) is additionally assumed. Physics SPH4U (or its equivalent) is a *recommended* prerequisite course, and (PHY(131H, 132H)/(151H, 152H), MAT(135H, 136H)/137Y/157Y) are *recommended* corequisites. CHM 151Y itself is a prerequisite for all 200-level Chemistry courses that are required towards a Chemistry program of study (specialist, major or minor). The specific 200-level courses and how they are connected to each program are listed here: chemistry.utoronto.ca/current-students/second-year-chemistry-course-requirements.

REFERENCE MATERIAL:
The *required* textbook for the organic chemistry section of the course (Weeks 1 – 8 inclusive) is "Organic Chemistry, 9th Edition" by J. McMurry plus the optional accompanying Study Guide and Solutions Manual. Both of these will also be used in second year organic chemistry courses (note: *CHM 151Y students are very strongly recommended to take CHM 249H: Organic Chemistry*).

A digital version is available for purchase through the Campus eBookstore or a physical copy at the U of T Bookstore. The 8th edition of McMurry can also be used with information posted on the course Quercus website that gives the translation of the numbering of problems at the end of the chapters.

The *required* textbook for the physical and inorganic chemistry parts of the course is "Chemistry: The Molecular Nature of Matter and Change", 9th edition by M. S. Silberberg. A digital version is available for purchase through the Campus eBookstore or a physical copy at the U of T Bookstore. The Canadian edition and previous editions are all permissible versions. The student Solutions Manual is optional.

A molecular model kit will be very useful for most of the course. The "Molecular Visions" kit by Darling Models is recommended, 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 in-person and online assessments.

III HOW THE COURSE IS ORGANIZED

CHM 151Y has three instructional components to it: classes, tutorials, and laboratories. Over the course of each week, you are expected to fully participate in the various activities that are taking place.

CLASSES:
The first two weeks of classes (starting on Friday 10th September) will be live-streamed via Zoom on MWF from 12–1 p.m. Eastern Time (ET). Please note that merely reading the posted class notes and/or textbook is not a substitute for attending live classes! It is essential that you attend the synchronous classes to solidify your understanding of the fundamental course material. Zoom connection information for the first two weeks of classes will be made available on the course Quercus website. Approximate timings for coverage of course content are listed below (subject to change):

DATES	WEEK	TOPICS
Sept. 9 – Sept. 15	1	Course introduction/organization; introduction to *Organic Chemistry*
Sept. 16 – Sept. 22	2	Structure and bonding, alkanes and cycloalkanes
Sept. 23 – Sept. 29	3	Alkanes and cycloalkanes
Sept. 30 – Oct. 6	4	Stereochemistry, structure and bonding in organic molecules
Oct. 7 – Oct. 13	5	Structure and bonding in organic molecules, acids and bases
Oct. 14 – Oct. 20	6	**Test 1;** Overview of organic reactions, mechanisms, energetics
Oct. 21 – Oct. 27	7	Alkene structure & reactivity
Oct. 28 – Nov. 3	8	Alkyl halides: Parts I and II
Nov. 4 – Nov. 17	9	*Inorganic Chemistry* Part 1: Characterization of compounds (IR/MS)
Nov. 18 – Nov. 24	10	Part 2: NMR characterization of compounds
Nov. 25 – Dec. 1	11	Part 3: Combined spectral problems
Dec. 2 – Dec. 9	12	**Test 2;** Part 4: Atomic structure and periodicity
Jan. 10 – Jan. 16	13	Part 5: Chemical bonding
Jan. 17 – Jan. 23	14	Part 6: Molecular structure
Jan. 24 – Jan. 30	15	Part 7: Survey of the elements
Jan. 31 – Feb. 6	16	Part 8: Survey of the transition metals
Feb. 7 – Feb. 13	17	*Physical Chemistry* Quantum mechanics: Atomic/molecular spectroscopy
Feb. 14 – Feb. 20	18	**Test 3;** Quantum mechanics: periodic table and bonding
Feb. 28 – Mar. 6	19	Thermodynamics: 1st Law, ideal gases, 2nd Law
Mar. 7 – Mar. 13	20	Thermodynamics: Entropy and statistics, 3rd Law, thermochemistry
Mar. 14 – Mar. 20	21	Thermodynamics: Thermochemistry sample applications
Mar. 21 – Mar. 27	22	**Test 4;** Kinetics: Introduction, reaction rates and rate laws
Mar. 28 – Apr. 3	23	Kinetics: Reaction mechanisms, applications
Apr. 4 – Apr. 8	24	Kinetics: Enzyme kinetics, summary

TUTORIALS:
Tutorials begin the week of Monday 27th September **and will be offered in-person only**. These are highly interactive, smaller-group problem-solving sessions run by a teaching assistant that build on the class material that has previously been taught: as such, your attendance is extremely important. Weekly questions will be made available to students ahead of each tutorial. The times and locations of the tutorials are as follows:

TUT0101: T 10–11 a.m. ET (**Fall semester:** Sidney Smith Hall, 100 St. George Street, room SS 1074; **Winter semester:** Sandford Fleming Building, 10 King's College Road, room 2202)

TUT0201: W 1–2 p.m. ET (**Fall & Winter semesters:** McLennan Physics Building, 60 St. George Street, room MP 137)

TUT0301: F 1–2 p.m. ET (**Fall & Winter semesters:** Sidney Smith Hall, 100 St. George Street, room SS 2127)

COURSE DISCUSSION BOARD:
In addition to instructor student hours, we will be using the Ed discussion board platform that facilitates online questions and answers. Information on how to join the platform will be made available as an announcement at your Quercus LEC section website. You are strongly encouraged to ask 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/test 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).

LABORATORIES:
The purpose of the CHM 151Y laboratories is to introduce you to classical techniques used in the organic (Fall semester and physical/inorganic (Winter semester) chemistry laboratory while using modern instrumentation. This hands-on experience will allow you to conduct a variety of experiments safely and effectively. Throughout the course, you will also learn about principles of green chemistry 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 record and interpret. After each experimental session (10 in total), 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 most of the laboratory reports will be relatively simple and brief, you will be able to engage in scientific writing activities for select experiments in order to improve your scientific writing skills.

Laboratories are a mandatory component of CHM 151Y. During the Fall 2021 semester, the laboratory sessions will take place on alternate Mondays (section PRA0101) or alternate Tuesdays (section PRA0201) from 2:00 – 5:30 p.m. in the Lash Miller Building (80 St. George Street). The CHM 151Y laboratories are held in either room LM 117 or room LM 217. Please note that on weeks that you do not have a laboratory session, you will have a Course Community session (see pages 7-8).

Schedule of Experiments (Fall semester):

	Monday PRA0101	**Tuesday PRA0201**
Exp. 1: Molecular Modeling	20th September	28th September
Exp. 2: Recrystallization of a Carboxylic Acid	4th October	12th October
Exp. 3: L-Proline Catalyzed Cycloetherification of L-Linalool	18th October	26th October
Exp. 4: Acid-catalyzed Dehydration of an Alcohol	1st November	16th November
Exp. 5: Nucleophilic Substitution Reaction (S_N2)	22nd November	30th November

Notes:

- Experiment 1 will be exclusively online, while Experiments 2-10 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 the Fall semester laboratory coordinator (Professor Barb Morra) immediately (barb.morra@utoronto.ca).
- the Winter 2022 laboratories focus on experiments in physical/inorganic chemistry. A full schedule for the Winter 2022 laboratories will be published on Quercus in late December or early January.

IMPORTANT

To be prepared for the CHM 151Y laboratory experience, please complete the "CHM151Y Laboratory Check-list" posted on your CHM 151Y-PRA Quercus site. Some of the tasks will need to be completed as soon as possible (e.g., learning about the CHM 151Y lab, preparing for Experiment 1, and a list of materials you need to obtain), while other tasks need to be completed prior to Experiment 2 (e.g., logistical details, safety training, and preparing for Experiment 2).

Special Notes for Experiment 1:

An important complement to the "wet" in-person laboratories (Experiments 2-10) is a computational exercise undertaken as Experiment 1, which will give you practice in performing calculations to understand the structures and properties of some organic compounds. **Experiment 1 will be performed fully online:** this will be the first laboratory activity, with a live synchronous online meeting for it taking place on Monday 20th September for PRA101 and Tuesday 28th September for PRA201. Detailed instructions and the Zoom links will be posted on your corresponding PRA Quercus section. If you have any questions or concerns about Experiment 1, please contact the computational instructor, Dr. Mima Staikova (mima.staikova@utoronto.ca).

Note: if you register for the course after 10th September, please notify Dr. Staikova as soon as possible.

IMPORTANT FALL 2021 SESSIONAL DATES:
First Day of F & Y classes: Thursday 9th September 2021
Thanksgiving (no classes): Monday 11th October 2021
Fall Reading Week (no classes): Monday 8th – Friday 12th November 2021
Last Day of F & Y classes: Wednesday 8th December 2021
Make-Up Day: Thursday 9th December 2021
December Assessment Period: Friday 10th – Tuesday 21st December 2021

IMPORTANT WINTER 2022 SESSIONAL DATES:
First Day of S classes/Y classes resume: Monday 10th January 2022
Family Day: Monday 21st February 2022
Last Day to Drop Y Courses: Monday 21st February 2022
Winter Reading Week (no classes): Monday 21st – Friday 25th February 2022
Last Day of S & Y classes: Friday 8th April 2022
April Final Assessment Period: Monday 11th – Friday 29th April 2022
Good Friday (no classes): Friday 15th April 2022

IV EVALUATION/GRADING SCHEME

OVERVIEW:
Online homework: 10%
Laboratory: 30%
Term Tests: 40%
Final Assessment: 20%

MARK BREAKDOWN:
[a]Online homework: 10% (5 x 2% quizzes distributed throughout the Fall and Winter semesters)
[b]Laboratory: 30% (10 x 3% experiments, including written laboratory reports)
[c]Test 1: (organic: Week 6)
Test 2: (organic/inorganic: Week 12)
Test 3: (inorganic/physical: Week 18)
Test 4: (physical: Week 22)
Final Assessment: 20% (cumulative: components of organic, inorganic & physical: April 2022 final assessment period)

[a]if an unexpected technical issue occurs with a university system (e.g., Quercus services, network outage) that affects availability or functionality, it may be necessary to revise the timing or weighting of the online homework.

[b]the practical skills acquired in CHM 151Y are an integral aspect of this course. As such, you are required to attend at least 6 complete in-person laboratory sessions in order to pass CHM 151Y (Experiments 2-10 are in-person sessions). Students who fail to attend enough laboratory sessions, even if justified with a medical note, will not receive credit for CHM 151Y since they will not have acquired the practical skills required of a student who has completed this course.

[c]note that the highest test grade earned from Tests 1, 2, 3 and 4 will be weighted at 15%, with each of the remaining three tests weighted at 8.3%. Each test will be written during class time (12 – 1 p.m. ET) during Weeks 6, 12, 18 and 22. Announcements will be made at least seven days in advance of each test to confirm the actual date. Each test and the course final assessment are to be written in-person.

V COURSE COMMUNITY

CHM 151Y has a unique Course Community where the undergraduate experience in chemistry is greatly enhanced through a series of study-tip workshops, research seminars, course/program advice and social activities. Course Community meetings will run on Monday and Tuesday afternoons during weeks when laboratory time is not scheduled. These meetings are hosted by upper-year chemistry program undergraduates who have previously taken CHM 151Y. The schedule and group assignments will be posted on the CHM 151Y Quercus website, under the "Course Community" module.

Fall Semester Schedule:

- PRA0101 sessions: Monday 27th September, 25th October, 15th November, 29th November and 6th December.
- PRA0201 sessions: Monday 21st September, 19th October, 2nd November, 23rd November and 7th December.

Bonus credit towards your CHM 151Y final course grade will be applied for attendance and participation at a minimum number of Course Community sessions throughout the academic year. More details regarding this will be made available at a later date. If you have any questions pertaining to the Course Community, please contact the Community Director, Max Olson (see information on p. 2).

VI COURSE POLICIES

- Course website: q.utoronto.ca (in your Quercus Dashboard, click on "CHM 151Y Fall 2021 – Winter 2022")

  Important: please check the Quercus course website regularly (daily!) for:

  - ✓ general course information
  - ✓ class notes
  - ✓ important announcements related to all assessments, classes, laboratories, tutorials, and Course Community sessions

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

  - ✓ professional and respectful attitude during all course activities, including classes, laboratories, tutorials and online activity;
  - ✓ personal calendar/schedule/organizer to ensure that all course activities are completed, and due dates are met;
  - ✓ 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);
  - ✓ familiarity with the university policy on Academic Integrity as it pertains to CHM 151Y (see page 10)

- 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 e-mail subject as a student in CHM 151Y and include your name and University of Toronto student ID number; (3) No attachments are sent; (4) You are aware that chemistry can be discussed through an online discussion much more effectively than by email, and that email is not a substitute for attending classes. The finalized student hours for instructors and tutors will be posted on the CHM 151Y Quercus website and they are additionally available by appointment.

  Important: please be sure to email only ONE person within the CHM 151Y instructional team, depending on the nature of your concern.

- 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. The course teaching team 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.

- Aspects of this course, including your participation, *may* be recorded on video and *may* be available to students in the course for viewing remotely and after each session. Any course videos 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: for concerns about recording and use of videos in which you appear please contact your instructor. Students may not create audio or video recordings of classes except for those students requiring an accommodation for a disability, who should contact the instructor prior to beginning to record classes for written permission. Students creating unauthorized audio recording of classes violate an instructor's intellectual property rights and the Canadian Copyright Act. Students violating this agreement will be subject to disciplinary actions under the Code of Student Conduct. Course videos may not be reproduced or posted or shared anywhere other than the official CHM 151Y Quercus site and should only be used by students currently registered in the course. Recordings may be saved to students' laptop for personal use.

- Laboratory reports and online homework quizzes are to be submitted through the CHM 151Y Quercus website ONLY. Late laboratory reports will be deducted at 10% per day, and online homework will not be accepted at all after the due date/time. Please be aware that completed laboratory reports will not be accepted once graded work has been distributed to the rest of the class.

- **There are no make-up tests in CHM 151Y, and there are no make-up laboratory sessions.** Students who miss a scheduled test must contact the course coordinator, Professor Andrew Dicks (andrew.dicks@utoronto.ca) to discuss their situation. 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 are absent from more than one term test will be assessed by an individualized, cumulative online oral examination that accounts for the weight of the missed work.

VII TECHNOLOGY REQUIREMENTS

- Specific technology requirements are required to participate and learn effectively in CHM 151Y. Some guidance from the U of T Vice-Provost, Students regarding this is available here: viceprovoststudents.utoronto.ca/covid-19/tech-requirements-online-learning

- If you are new to online learning in a university environment, some general advice and tips for students is available here: onlinelearning.utoronto.ca/getting-ready-for-online

- This course requires the use of computers, and technical issues are possible. When working on a piece of work such as a laboratory report, 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 occurrences such as hard-drive failures, corrupted files, lost computers, etc. *We encourage you to spend a moment at the start of the semester to plan for what you would do if you lost access to the computer that you primarily intend to use, which will help ensure that you are prepared for this unlikely possibility.*

VIII INSTITUTIONAL POLICIES AND 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 or other online assessments:

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 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.
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 academicintegrity.utoronto.ca).

PLAGIARISM DETECTION:
Normally, students will be required to submit their course essays 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).

ACCESSIBILITY NEEDS:
Students with diverse learning styles and needs are welcome in CHM 151Y. 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. If possible, please submit your accessibility letter at the beginning of the course and not right before an assignment is due.

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 Technical Support/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.