

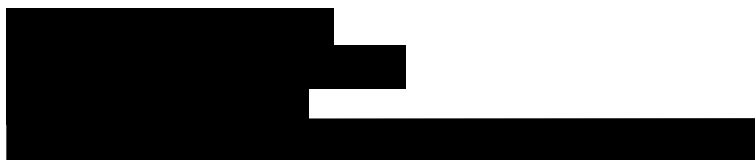
**CHEM422/ENCH422: Synthetic Organic Chemistry
Course Syllabus Winter 2025**

Course Instructor: Joshua Kofsky
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[onQ](#)

Learning Hours: 120 (36 Lecture, 12 Tutorial, 72 Private Study)

Prerequisite: CHEM223 (3.0 units)

Lectures:



Tutorials:



Attendance is not mandatory but is **highly recommended**.

Office Hours:



If this time is not sufficient, please send me an email with "CHEM422" in the subject line to set a date/time to meet. You can also post questions to the OnQ Discussion Board.

Textbooks:

There are no required textbooks for this course. Instead, we will use primary literature sources as reference material and all sources will be available in pdf format through OnQ. A selection of textbooks is provided below for your reference. Some are available as e-books through the Queen's library.

S. Warren, P. Wyatt, Organic Synthesis: *The Disconnection Approach*, Wiley: N.Y., 2008. (Intermediate). Cost: \$72.95 ([Amazon](#))

P. Wyatt, S. Warren, Organic Synthesis: *Strategy and Control*, Wiley: N.Y., 2007. (Intermediate). Cost: \$88.75 ([Amazon](#))

Carey and Sundberg, *Advanced Organic Chemistry, Part B*, Springer: N.Y., 2007. (Intermediate). Cost: \$101.90 ([Amazon](#)) or free through Queen's library (<https://link.springer.com/book/10.1007/978-0-387-71481-3>)

Wuts, P.G.M.; Greene, T.W. *Greene's Protective Groups in Organic Synthesis*, 4th Ed. Wiley-Interscience: N.Y., 2007. (Reference). Cost: \$92.95 ([Amazon](#)) or free through Queen's library (<https://onlinelibrary.wiley.com/doi/book/10.1002/0470053488>).

Smith, M.B.; March, J. *March's Advanced Organic Chemistry*, 5th Ed. Wiley-Interscience: N.Y., 2001. (Reference). Cost: \$117.23 ([Amazon](#)).

Weeks, D.P. *Pushing Electrons*, 4th Ed. Saunders: Fort Worth, TX, 2013. (Elementary). Cost: \$41.95 ([Amazon](#)).

Eliel, E.L.; Wilen, S.H.; Doyle, M.P. *Basic Organic Stereochemistry*, Wiley: Chichester, 2001 (Advanced). Cost: \$263.95 ([Amazon](#)).

Nicolaou, K.C., Snyder, S.A.; *Classics in Total Synthesis II*, Wiley-VCH: N.Y., 2003. (Advanced). Cost: \$149.00 ([Amazon](#)).

Grading Scheme

Exams:	1 Midterm, 1 Final Exam*	60%
Assignments:	4 Assignments	20%
Presentations:	1 Group Presentation	20%

Midterm: [REDACTED] worth 25-35% (whichever is better for you)

Final Exam: TBA (scheduled during April exam period*) worth 25-35% (whichever is better for you)

The midterm will be written to take approximately 2 hours to complete within a 3-hour examination period. You are allowed to bring a molecular model kit (all writing on the box must be covered or otherwise illegible). You are allowed to make a **1-page, single-sided** crib sheet that you can use during the exam. Crib sheets must be submitted through OnQ as a PDF document 24 hours prior to the start of the examination.

The final exam will be an open-book, take-home exam written to take approximately 2 hours to complete. The exam will be posted on OnQ (date and time TBA, to be scheduled during April exam period*) and you will have 24 hours from the time of posting to complete the exam. The exam must be completed independently and must be submitted through OnQ as a PDF document. There will be a grace period of 1 hour before the late penalty is applied. A late penalty of 5% per hour will be applied; submissions more than 6 hours past the submission deadline may not be accepted.

* According to Queen's policy, students should delay finalizing any travel plans until after the examination schedule has been finalized. Exams will not be moved or deferred to accommodate employment, travel/holiday plans or flight reservations.

Assignments: Can be completed individually or as groups of up to three. Assignments will be posted to OnQ approximately every 3 weeks and you will have at least 1 week to complete the assignment. Each assignment must be submitted through OnQ as a single PDF document (one per group).

Note: If students hand in assignments as a group, all students in the group will receive the same mark. If students choose to work as a group, they do not have to remain as the same group throughout the course.

Presentation: Groups of ~3 will be assigned by the course instructor. Presentations will be in class in Weeks 11-12 (March 24 – April 4). There will be group and individual components to the presentation grade (rubric will be posted to OnQ). Participation in the

question/discussion section of other groups' presentations will count toward a portion of the individual grade.

Time: 20 minutes total (15 min presentation and 5 min questions/discussion)

Topic: A total synthesis (which should highlight an important reaction) or a synthetic methodology. It should be based on a publication within the last 5 years. Topic must be approved by the course instructor.

Format: Formal presentation in groups that will be assigned by the course instructor. Presentation order will be scheduled in Week 9 (March 10-14); groups that volunteer will present first and then presentation order will be chosen at random. Presentation rubric and more details will be provided later in the course.

Key Dates: Groups assigned February 24th (Week 7); topics must be approved by March 7th (Week 8).

Tentative Course Outline

This course is an introduction to modern synthetic methods in organic chemistry. Principles of strategy in planning organic syntheses based on simple classifications of reagents and reactions and on the control of stereochemistry will be discussed. Elements of carbon skeleton assembly, functional group transformations, and disconnection approach / retrosynthetic analysis will be covered.

1 Introduction

Synthetic methods and general strategies

Efficiency in synthesis

Stereoselectivity/chirality in synthesis

2 Disconnection Approach

General principles to the disconnection approach

Electrophilic aromatic substitution

Ethers, acetals, and alcohols

1,1/1,2 and 1,3 difunctional compounds and enolate chemistry

Alkene/alkyne synthesis including Wittig, Horner-Wadsworth-Emmons and metathesis reactions

1,5 and 1,6 dicarbonyl compounds

Ring syntheses: 3-membered rings

Epoxides, aziridines, and cyclopropanes

Simmons-Smith reaction and carbene chemistry

Darzens condensation and sulfur ylide chemistry

Ring syntheses: 4-membered rings

Oxetanes and the Paterno-Buchi reaction

Azetidines and cyclobutanes

Ring syntheses: 5- and 6-membered rings

Cyclizations and cycloadditions

Baldwin's rules
Rearrangement reactions
Pericyclic reactions

3 Protecting Group Chemistry

General principles of protecting group manipulations
Selected examples of protecting group strategy in total synthesis

4 State-of-the-Art Methods

Selected examples of state-of-the-art reactions and synthetic strategies not covered above will be discussed

5 Total Synthesis of Complex Molecules

Selected examples of total syntheses will be discussed. These may include:

- Tropinone
- Menthol
- Reserpine
- Quinine
- Penicillin
- Strychnine
- Tabernosine
- Squalene
- Ibuprofen
- Sildenafil
- L-DOPA

Expected Learning Outcomes

The goal of this course is to learn about modern synthetic methods in organic chemistry and to understand the design of syntheses of complex molecules. By the end of this course, students will be able to:

- **Apply retrosynthetic analysis.** Perform retrosynthetic analysis to design efficient synthetic routes for complex organic molecules, identifying key disconnections and strategic synthetic transformations.
- **Evaluate and propose reaction mechanisms.** Predict and interpret reaction outcomes by evaluating the reactivity and conditions and use this to suggest or explain reaction mechanisms.
- **Design and optimize reaction conditions.** Identify challenges and unexpected outcomes in reactions and propose ways to optimize conditions and improve factors such as yield, selectivity, and scalability.

- **Plan a multi-step synthesis.** Using an iterative and feedback-driven approach, plan a multistep organic synthesis, integrating various synthetic methodologies to achieve the target molecule.
- **Conduct literature reviews.** Critically evaluate research articles related to synthetic organic chemistry and extract relevant information to inform research and synthesis strategies.
- **Communicate scientific concepts and problems.** Effectively communicate about synthetic organic chemistry, conveying complex synthetic strategies, results, and interpretations through written reports and oral presentations.

Important University Dates

Please visit the [Faculty of Arts and Sciences Sessional Dates website](#) for all academic deadlines.

Grading Method

All components of this course will receive numerical percentage marks. The final grade you receive for the course will be derived by converting your numerical course average to a letter grade according to Queen's Official Grade Conversion Scale:

Queen's Official Grade Conversion Scale

Grade	Numerical Course Average (Range)
A+	90-100
A	85-89
A-	80-84
B+	77-79
B	73-76
B-	70-72
C+	67-69
C	63-66
C-	60-62
D+	57-59
D	53-56
D-	50-52
F	49 and below

Late Policy

Assignments must be submitted through OnQ on or before the due date. Late assignments will be given a **penalty of 5% per day**. Extensions will be granted only in exceptional circumstances and must be discussed with the course instructor before the due date. Note that all academic consideration for missed quizzes, tests, midterms, presentations, and assignments are now processed through the faculty portal, see Academic Considerations for Students in Extenuating Circumstances section below.

Policy for Review of Graded Work

Requests for assignment regrading may be made to the course instructor 48 hours after you have received the marked copy of your assignment, but no more than 10 days later. Be sure to read your feedback carefully before you submit a review of graded work. To request that your assignment be reviewed, please include the following in your email:

- "CHEM422" or "ENCH422" in the subject line
- Your name and student number.
- The original copy of your marked assignment, attached.
- Your reason for the request:
 - The specific aspects of your assignment that you believe were not sufficiently awarded, referring to the categories of the rubric.
 - Why you believe that your assignment meets the criteria for a higher mark for each of the categories of the rubric that you indicated above. Please make explicit reference to the detailed descriptions of each category provided in the rubric.

If a review of graded work results in only a slightly different final grade, the original grade will stand. Should we find an error where marks were not assigned when they should have been or were missed in adding up the total score or were added up incorrectly resulting in a higher score than earned, the grade will be changed so that it is accurate. Grades would only increase or decrease if there was evidence of an error in marking, not simply because the regrader interprets or applies the rubric slightly differently than the original grader.

Calculator Policy

As noted in Academic Regulation 9.2, calculators acceptable for use during quizzes, tests and examinations are intended to support the basic calculating functions required by most Arts and Science courses. For this purpose, the use of the **Casio 991 series** calculator is permitted and is the **only approved calculator for Arts and Science students**. This calculator sells for around \$25 at the Queen's Campus Bookstore, Staples and other popular suppliers of school and office supplies.

Generative Artificial Intelligence (AI) Tools

Students must submit their own work and cite the work that is not theirs. Generative AI tools such as ChatGPT are only permissible when explicitly noted in the assignment instructions. In these cases, be sure to cite the material that they generate. Any other use constitutes a Departure from Academic Integrity.

Plagiarism

Presenting another's ideas or phrasings as one's own without proper acknowledgement. Examples: copying and pasting from the internet, a printed source, or other resource without proper acknowledgement; copying from another student; using direct quotations or large sections of paraphrased material in an assignment without appropriate acknowledgement; submitting the same piece of work in more than one course without the permission of the instructor(s).

Queen's Policy Statement on Academic Integrity

Queen's University is dedicated to creating a scholarly community free to explore a range of ideas, to build and advance knowledge, and to share the ideas and knowledge that emerge from a range of intellectual pursuits. Queen's students, faculty, administrators and staff therefore all have responsibilities for supporting and upholding the fundamental values of academic integrity. Academic integrity is constituted by the five core fundamental values of honesty, trust, fairness, respect and responsibility and by the quality of courage. These values and qualities are central to the building, nurturing and sustaining of an academic community in which all members of the community will thrive. Adherence to the values expressed through academic integrity forms a foundation for the "freedom of inquiry and exchange of ideas" essential to the intellectual life of the University.

The following statements from "The Fundamental Values of Academic Integrity" (2nd edition), developed by the International Center for Academic Integrity (ICAI), contextualize these values and qualities:

1. **Honesty** Academic communities of integrity advance the quest for truth and knowledge through intellectual and personal honesty in learning, teaching, research, and service.
2. **Trust** Academic communities of integrity both foster and rely upon climates of mutual trust. Climates of trust encourage and support the free exchange of ideas which in turn allows scholarly inquiry to reach its fullest potential.
3. **Fairness** Academic communities of integrity establish clear and transparent expectations, standards, and practices to support fairness in the interactions of students, faculty, and administrators.
4. **Respect** Academic communities of integrity value the interactive, cooperative, participatory nature of learning. They honor, value, and consider diverse opinions and ideas.
5. **Responsibility** Academic communities of integrity rest upon foundations of personal accountability coupled with the willingness of individuals and groups to lead by example, uphold mutually agreed-upon standards, and take action when they encounter wrongdoing.
6. **Courage** To develop and sustain communities of integrity, it takes more than simply believing in the fundamental values. Translating the values from talking points into action -- standing up for them in the face of pressure and adversity — requires determination, commitment, and courage.

Students are responsible for familiarizing themselves with and adhering to the Senate [regulations](#) concerning academic integrity, along with [Faculty or School](#) specific information. Departures from academic integrity include, but are not limited to, plagiarism, use of unauthorized materials, facilitation, forgery and falsification. Actions which contravene the regulation on academic integrity carry sanctions that can range from a warning, to loss of grades on an assignment, to failure of a course, to requirement to withdraw from the university.

Queen's [Student Academic Success Services](#) (SASS) offers a self-directed, online academic integrity module which we encourage all students to take which will help with:

- Understanding the nature of the academic integrity departure
- Understanding the expectations of and role of sources in scholarly writing
- Integrating sources into your writing (paraphrasing, quoting, summarizing)
- Understanding when and how to cite your sources
- Managing your time effectively to avoid the need for shortcuts
- Taking effective notes to ensure accuracy of source material and correct attribution

Accommodations for Disabilities

Queen's University is committed to working with students with disabilities to remove barriers to their academic goals. Queen's Student Accessibility Services (QSAS), students with disabilities, instructors, and faculty staff work together to provide and implement academic accommodations designed to allow students with disabilities equitable access to all course material (including in-class as well as exams). If you are a student currently experiencing barriers to your academics due to disability related reasons, and you would like to understand whether academic accommodations could support the removal of those barriers, please visit the [QSAS website](#) to learn more about academic accommodations or start the registration process with QSAS by clicking **Access Ventus** button at [Ventus | Accessibility Services | Queen's \(queensu.ca\)](#)

VENTUS is an online portal that connects students, instructors, Queen's Student Accessibility Services, the Exam's Office and other support services in the process to request, assess, and implement academic accommodations. To learn more go to: <https://www.queensu.ca/ventus-support/students/visual-guide-ventus-students>

Academic Considerations for Students in Extenuating Circumstances

Academic Consideration is a process for the University community to provide a compassionate response to assist students experiencing unforeseen, short-term extenuating circumstances that may impact or impede a student's ability to complete their academics. This may include but is not limited to,

- Short term Physical or Mental Illness or Injury (stomach flu, anxiety/depression, mononucleosis, concussion, broken bones, surgery, medical treatments, etc.)
- Traumatic Event/Confidential (Bereavement, serious injury, illness or required treatment for a significant other/family member or a traumatic event such as divorce, sexual assault, social injustice, etc.)
- Requirements by Law or Public Health Authorities (court dates, jury duty, requirements to isolate, etc.)
- Significant Event (varsity athletic event, distinguished event, serving in the Reserve Forces, etc.)

Queen's University is committed to providing academic consideration to students experiencing extenuating circumstances. For more information, please see the [Senate Policy on Academic Consideration for Students in Extenuating Circumstances](#).

Each Faculty has developed a protocol to provide a consistent and equitable approach in dealing with requests for academic consideration for students facing extenuating circumstances. For more information, undergraduate students in the Faculty of Arts and Sciences should consult the Faculty's webpage on [Academic Consideration in Extenuating Circumstances](#) and submit a request via the [Academic Consideration Request Portal](#). Students in other Faculties and Schools who are enrolled in this course should refer to the protocol for their home Faculty.

Students are encouraged to submit requests as soon as the need becomes apparent and to contact their instructor and/or course coordinator as soon as possible once academic consideration has been granted. Any delay in contact may limit the options available for academic consideration.

For more information on the Academic Consideration process, what is and is not an extenuating circumstance, and to submit an Academic Consideration request, please see the Faculty of Arts and Science's [Academic Consideration website](#).

Statement of the Location and Timing of Final Examinations

As noted in Academic Regulation 8.2.1, "the final examination in any class offered in a term or session (including Summer Term) must be written on the campus on which it was taken, at the end of the appropriate term or session at the time scheduled by the Examinations Office." The exam period is listed in the key dates prior to the start of the academic year in the Faculty of Arts and Science Academic Calendar and on the Office of the University Registrar's webpage. A detailed exam schedule for the Fall Term is posted before the Thanksgiving holiday; for the Winter Term it is posted the Friday before Reading Week, and for the Summer Term the window of dates is noted on the Arts and Science Online syllabus prior to the start of the course. Students should delay finalizing any travel plans until after the examination schedule has been posted. Exams will not be moved or deferred to accommodate employment, travel /holiday plans or flight reservations.

Copyright of Course Materials

Course materials created by the course instructor, including all slides, presentations, handouts, tests, exams, and other similar course materials, are the intellectual property of the instructor. It is a departure from academic integrity to distribute, publicly post, sell or otherwise disseminate an instructor's course materials or to provide an instructor's course materials to anyone else for distribution, posting, sale or other means of dissemination, without the instructor's express consent. A student who engages in such conduct may be subject to penalty for a departure from academic integrity and may also face adverse legal consequences for infringement of intellectual property rights.

Class Attendance Policy

Your presence and participation in class contributes to the knowledge and skills that you will develop throughout this course. I expect that you attend class regularly, participate in class conversations and learning activities. These types of activities provide active

engagement, promote a deeper understanding of the course content, and contribute to your success in this course.

Building a Classroom Community

University is a place to share, question, and challenge ideas. Each student brings a different set of lived experiences. You can help to create a safer, more respectful classroom community for learners by following these guidelines:

- Make a personal commitment to learn about, understand, and support your peers.
- Assume the best of others and expect the best of them.
- Recognize and value the experiences, abilities, and knowledge each person brings to the course.
- Acknowledge the impact of oppression on other people's lives and make sure your words and tone are respectful and inclusive.
- Encourage others to develop and share their ideas.
- Pay close attention to what your peers say/write before you respond. Think through and re-read what you have written before you post online or send your comments to others.
- Be open to having your ideas challenged and challenge others with the intent of facilitating growth.
- Look for opportunities to agree with one another, building on and intentionally referencing peers' thoughts and ideas; disagree with ideas without making personal attacks, demeaning, or embarrassing others.

Fostering Accessibility

All of us have a shared responsibility for fostering accessibility and promoting meaningful inclusion of those with disabilities. The [Accessibility Hub](#) at Queen's University's Human Rights & Equity Office offer a host of [tutorials](#) that provide us all with practical tips for:

- creating accessible documents, e.g., to submit to your teaching team or share with peers in peer feedback activities/in a presentation,
- emails, e.g., while communicating with group members or your teaching team, and
- meeting practices (e.g., in tutorials/labs/seminars or virtual meetings).

Academic Support

All undergraduate students face new learning and writing challenges as they progress through university: essays and reports become more complex; effectively incorporating research into writing becomes more important; the types of assignments become more diverse; managing your time and developing the skills you need to read and think critically gets more challenging. I encourage students to contact Student Academic Success Services (SASS). SASS offers many different ways to receive support:

- Free online or in-person [appointments](#) to get personalized support on writing and academic skills from expert staff and trained peers.
- [Workshops](#) and [drop-in programs](#). SASS' [Events Calendar lists events coming soon](#).
- [Online resources](#) that provide strategies for academic skills and writing development at university.

- If English is not your first language, SASS has specific resources for [English as Additional Language students](#), including weekly programs and EAL academic skills appointments. You can meet on an ongoing basis with an EAL consultant to work on your academic writing, speaking, listening, and reading skills.

Name/Pronoun

If, for whatever reason, you wish to change how your name appears in onQ and/or on class lists, please follow these steps. You may also use this process to add your pronouns to the appearance of your name.

1. Log into SOLUS.
2. Click on Personal Information tab.
3. Click on the Names tab
4. Click on the Add New Name tab
5. Choose Preferred from the Name Type drop down menu
6. Enter the name you would like to appear in onQ and/or on class lists.
7. Click Save.

Please allow 24 to 48 hours for your name to be registered within the system. If you have further questions or concerns, please contact ITS at Queen's University.