

**DEPARTMENT OF CHEMISTRY  
UNIVERSITY OF TORONTO MISSISSAUGA**

**CHM442H5S LEC0101  
Strategy & Control in Modern Drug Synthesis  
Course Outline - Winter 2024**

<b>Class Location &amp; Time</b>	Tue, 01:00 PM - 03:00 PM MN 3210
<b>Instructor</b>	Leigh Revers
<b>Office Location</b>	KN-2238
<b>Office Hours</b>	Tue, 4-5PM
<b>Telephone</b>	416 705 5735
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<b>Course Web Site</b>	<a href="https://q.utoronto.ca">https://q.utoronto.ca</a>

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### **Course Description**

Applications of advanced fundamentals to, and recent developments in, multi-step organic synthesis.

*Prerequisite:* CHM341H5 or CHM345H5

*Recommended:* CHM394H5 and CHM395H (SCI)

*Distribution Requirement:* SCI

### **Course Learning Outcomes**

#### **Topic 1: Chemoselectivity**

01. Define chemoselectivity.
02. Invoke rules governing chemoselectivity.
03. Predict when protection is needed.
04. Predict the outcome of Pinacol Rearrangements.
05. Specify conditions forming enols and enolates and their surrogates with control.
06. Recognise examples of and predict outcomes for chemoselective reactions in synthesis.
07. Design syntheses that include suitable chemoselective reaction steps.

#### **Topic 2: Regio- & Stereoselectivity in Aldol Reactions**

08. Define regioselectivity.
09. Recognise and invoke specific enol equivalents.
10. Predict outcomes of regioselective aldols.
11. Dictate whether nucleophilic attack occurs at oxygen or carbon.
12. Invoke conditions that will produce alkylation or acylation of enolates.
13. Recognise reactions of enols and enolates with other electrophiles.
14. Predict the stereochemical outcomes of Aldol reactions.

#### **Topic 3: Enone Synthesis**

15. Recognise and invoke multiple methods for enone synthesis.

#### **Topic 4: Making Carbon-Carbon Single Bonds**

16. Recognise and invoke the ortho strategy for aromatic compounds.
17. Recognise and invoke s-complexes of metals in synthesis.
18. Recognise and dictate conditions controlling the Michael Reaction.
19. Recognise and nominate the correct use of specific enol equivalents in synthesis.
20. Recognise and invoke the use of extended enolates in synthesis.
21. Recognise and invoke the use of allyl anions in synthesis.
22. Recognise and invoke the use of homoenolates in synthesis.
23. Recognise and invoke the use of acyl anions (d1 reagents) in synthesis.

#### Topic 5: Making Carbon-Carbon Double Bonds

24. Recognise and invoke the Wittig reaction for C=C bond synthesis.
25. Recognise and invoke stereoselective methods for synthesising C=C bonds.
26. Recognise and invoke the use of alkyne reduction for synthesising C=C bonds.
27. Recognise and invoke stereo-controlled vinyl anion equivalents in synthesis.
28. Recognise, predict and invoke the chemo- and regioselective use of electrophilic reagents for the synthesis of polyfunctional compounds from alkenes.

#### Topic 6: Asymmetric Synthesis

29. Define stereochemical terminology.
30. Recognise, interpret and draw stereochemical representations of compounds.
31. Recognising and predicting stereochemical control when no chirality is present at the start of a synthesis.
32. Recognising and predicting stereochemical control when chirality is present at the start of a synthesis.
33. Recognise and make use of the Chiral Pool in synthesis.
34. Recognise when chiral resolution is necessary.
35. Recognise and invoke a range of advanced synthetic techniques including but not limited to: sigmatropic rearrangements, asymmetric counterparts of the Sharpless epoxidation, Diels-Alder, and pericyclic reactions.

#### Textbooks and Other Materials

None required.

#### Assessment and Grading

Type	Description	Due Date	Weight
Assignment	3 x Weekly Assigned Synthetic Problem Sets (WASPS) [3 x 5%]	On-going	24%
Term Test	Mid-Term Written Test (MTWT)	2024-02-13	26%
Final Exam	Final Written Examination (FWE)	TBA	50%
<b>Total</b>			<b>100%</b>

#### Midterm Tests

The midterm tests will be 60 minutes in length and will take place during regularly scheduled lecture periods, starting at precisely 1:10PM. There may be a switch to online test writing in the event that a switch to online course delivery is mandated. Detailed

instructions on how to access and complete online term tests will follow *via* the course Quercus site should such an event manifest.

## Procedures and Rules

### Missed Term Work and Tests, Late Penalties, Absence Declarations, and Petitions for Special Consideration

Penalties for all term work missed or otherwise submitted late is as described in the text that follows unless valid and documented reasons exist for special consideration. Students may submit a petition for special consideration **within one week** of the due date of the missed item of term work or date of the missed test.

The ACORN absence declaration system may be used once per term, to declare an absence of up to seven consecutive calendar days (including days both before and after the date of submission), without requiring medical or other documentation. Provide the Course Instructor with a confirmation of this declaration (e.g. a screenshot) in your petition for special consideration, which contains your name, student number, absence dates, and confirmation number. For more information on the ACORN absence declaration process, and to access the form, see [here](#)

In all cases, petitions for special consideration should be based on illness or other extenuating circumstances, which are beyond one's reasonable control. Note that reasons such as vacations, family events, wedding attendance, lack of preparation, technology failure, extra-curricular commitments, and academic work in other courses are not considered to constitute extenuating circumstances beyond a student's reasonable control. If not for reasons of illness, in addition to your [ACORN](#) absence declaration, your petition for special consideration must contain supporting documentation, which can include a [U of T Verification of Extenuating Circumstances](#) form, automobile collision or police reports, a death certificate, and supporting documentation from employers, lawyers and other professional persons. Supporting documents can be submitted electronically as an attachment in your e-mail to the Course Instructor. These attachments can include screenshots, photographs, and/or scans of physical documents. Please ensure the electronic documents are legible and also ensure that you retain the original copies of all documents submitted in case you are asked to present them later. The supporting documentation included in your petition must specify the exact period that you were unable to complete your term work or term test for it to be considered. The Course Instructor will inform the student by e-mail (as per the Communications Policy herein) whether special consideration is granted following due diligence on the documentation provided. Note that false statements and/or documentation will be treated as academic offences and handled accordingly.

The penalty for late submission-defined as greater than 15 minutes past the set deadline-of term work (e.g. WASPS) is a **100% deduction**, unless a special consideration is requested and granted at the sole discretion of the course instructor, such request **not** to be unreasonably denied in circumstances of the student's illness or bereavement, or equivalent extenuating circumstances, as declared in writing to the instructor by email prior to the deadline. In the case where special consideration is granted, the mark value of the assignment will be re-assigned to an in-person oral examination covering the same topic as the missed assignment.

### Re-evaluation Requests

Requests for re-evaluation of an article of term work (e.g. test, assignment, laboratory report, etc.) must be made in writing **within 1 month** of the return of the article of term work and include a brief explanation as to why the request is being made. Term work submissions can be written in pencil; however, re-marking of term work written in pencil is not permitted. Similarly, articles of term work on which correction media has been used will be exempt from re-evaluation. Re-evaluation requests must be made to the same person that did the initial grading of the article of term work (normally, this is a Teaching Assistant). Note that the final mark assigned to a re-evaluated article of term-work may go up or down based on the outcomes of re-evaluation (in whole or in part, at the discretion of the marker). Disputes in grading subsequent to re-evaluation by the original marker may be brought forward to the Course Instructor for final adjudication. You, as a UTM student, have the right to appeal a mark beyond the Course Instructor only if the term work in question is worth at least 20% of the course mark.

### Missed Final Exam

Students who cannot complete their final examination due to illness or other serious causes must file an [online petition within 72 hours of the missed examination](#). Late petitions will **NOT** be considered. Upon approval of a deferred exam request, a non-refundable fee of \$72 is required for each examination approved.

### Laboratory Conduct: Expectations, Roles, and Responsibilities.

Not applicable to this course.

### Communications Policy

Students are welcome and encouraged to meet with the Course Instructor during the posted office hour(s). Office hours will be held in person unless online course delivery is mandated. In this event, details for connecting to office hours via Zoom will be posted on the course Quercus site. Note that virtual office hour visits will not be recorded. Visits outside of the regularly scheduled office hour(s) can be made by appointment. Correspondence by e-mail is also acceptable. In all e-mail correspondence regarding this course, please note the following:

1. Please send e-mail only from your @utoronto.ca or @mail.utoronto.ca account.
2. In the Subject line of your message, please include the course code and a brief description of the topic, e.g. "[Course code] - Request for an appointment regarding potentiometry".
3. Please include your full name and student number in all correspondence.
4. Please consult the course syllabus and course website before sending questions by e-mail
5. Students are encouraged to communicate by text message with the instructor at the number listed above.

I will endeavour to respond to e-mail within two workdays at the latest. Students are responsible for all information posted to the course [Quercus site](#) and e-mails sent by the Course Instructor, Laboratory Technicians and Teaching Assistants.

### **Student Technology Requirements and Connection Tools**

During times when a switch from in-person to online course delivery is mandated, Zoom will be used for remote course delivery (*i.e.* lectures, tutorials, and practicals) and office hours. Students are therefore expected to review and be in compliance with the University of Toronto's requirements for [online learning](#) and to register for a [UTM Zoom account](#) prior to the first course meeting. Students are also strongly encouraged to familiarize themselves with the resources available on the UTM Library's [Learn Anywhere](#) website.

### **Privacy and Use of Course Materials**

All course materials belong to the Course Instructor, the University, and/or other sources (depending on the specific facts of each situation) and are protected by copyright. In this course, you are permitted to download materials for your own academic use, but you should not copy, share, or use them for any other purpose without the explicit permission of the Course Instructor. In the event of a mandated switch to remote course delivery, this course, including your participation, will be recorded on video and will be available to students in the course for viewing remotely and after each session. 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. Do not download, copy, or share any course or student materials or videos without the explicit permission of the instructor. For questions about recording and use of videos in which you appear please contact your instructor.

### **Academic Integrity**

UTM wishes to remind students that they are expected to adhere to the [Code of Behaviour on Academic Matters](#) regardless of the course delivery method (*i.e.* in-person or online). Potential academic offences include, but are not limited to:

- Using or possessing an unauthorized aid or aids or to obtain unauthorized assistance in any academic examination or term test or in connection with any other form of academic work. Use of unauthorized aid(s) and unauthorized assistance includes working collaboratively, in-person or online, with others on assessments that are expected to be completed individually, in addition to accessing unauthorized resources (search engines, chat rooms, Reddit, *etc.*) for assessments completed online.
- Representing as one's own, any idea or expression of an idea or work of another in any academic examination or term test or in connection with any other form of academic work, *i.e.* to commit plagiarism.
- Submitting, without the knowledge and approval of the instructor to whom it is submitted, any academic work for which credit has previously been obtained or is being sought in another course or program of study in the University or elsewhere;
- Submitting any academic work containing a purported statement of fact or reference to a source which has been concocted.

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](#).

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>).

Students are permitted opt-out of using the University's plagiarism detection tool and notice of this decision must be delivered to the Course Instructor no later than the end of day on which the first class meeting occurs. This notice should be provided *via* email, as per the communication policy specified herein. In such a case, you may be asked to submit all of your rough work for an assignment and you may be required to have a short meeting with the Course Instructor to discuss your research methodology.

### **Academic Rights**

You, as a student at UTM, have the right to:

- Receive a syllabus by the first day of class.
- Rely upon a syllabus once a course is started. An instructor may only change marks' assignments by following the

University Assessment and Grading Practices Policy provision 1.3.

- Refuse to use the University's plagiarism detection tool (you must be offered an alternative form of submission).
- Have access to your Instructor for consultation during a course or follow up with the Department Chair if the Instructor is unavailable.
- Receive at least one significant mark (15% for H courses, 25% for Y courses) before the last day you can drop a course for H courses, and the last day of classes in the first week of January for Y courses taught in the Fall/Winter terms.
- Submit handwritten essays so long as they are neatly written.
- Have no assignment worth 100% of your final grade.
- Not have a term test worth 25% or more in the last two weeks of class.
- Retain intellectual property rights to your research.
- Receive all your assignments once graded.
- View your final exams. To see a final exam, you must submit an online Exam Reproduction Request within 6 months of the exam. There is a small non-refundable fee.
- Privacy of your final grades.
- Arrange for representation from Downtown Legal Services (DLS), a representative from the UTM Students' Union (UTMSU), and/or other forms of support if you are charged with an academic offence.

### **Inclusivity Statement**

You belong [here](#). The University of Toronto commits to all students, faculty, and staff that you can learn, work, and create in a welcoming, respectful, and inclusive environment. In this class, we embrace the broadest range of people and encourage their diverse perspectives. This team environment is how we will innovate and improve our collective academic success. You can read the evidence for this approach [here](#).

We expect each of us to take responsibility for the impact that our language, actions and interactions have on others. The Department of Chemical and Physical Sciences (CPS) denounces discrimination, harassment and unwelcoming behaviour in all its forms. You have rights under the [Ontario Human Rights Code](#). If you experience or witness any form of harassment or discrimination, including but not limited to, acts of racism, sexism, Islamophobia, anti-Semitism, homophobia, transphobia, ableism and ageism, please tell someone so that we can intervene. CPS takes these reports extremely seriously. You can talk to anyone you feel comfortable approaching, including your professor, teaching assistant, technician, an [academic advisor](#), our [Chairs](#), members of our [Equity, Diversity and Inclusivity Committee](#), or any staff member at our [Equity, Diversity & Inclusion Office](#).

You are not alone. Working together, we can all achieve our full potential.

### **Course Code of Conduct and Expectations**

Each member of this course is expected to maintain a:

- Professional and respectful attitude during all course activities, including lectures, labs, and online activity.
- Personal calendar/schedule/organizer to ensure that all course activities are completed and due dates are met.
- Collection of class notes recorded independently based on concepts covered in lectures and labs (students registered with Accessibility Services requiring a class note-taker will have access to this accommodation).
- Familiarity with the University's policy on Academic Integrity (see: the section entitled Academic Integrity, above, and the [Code of Behaviour on Academic Matters](#)).
- Familiarity with the University policy on Conflict of Interest and Close Personal Relationships (see: <https://www.provost.utoronto.ca/planning-policy/conflict-of-interest-close-personal-relations/>). Note that a conflict of interest arises when your personal interests conflict with your responsibilities as a student of the University. For example, if you have, or have had, a familial, sexual, or otherwise close relationship with a member of the teaching staff, you will almost inevitably be in a conflict-of-interest situation, which may affect your academic performance. Please disclose any potential conflicts-of-interest to the Course Instructor and/or Department Chair as soon as possible.
- Familiarity with the University policy on Sexual Violence and Sexual Harassment (see: <http://www.governingcouncil.lamp4.utoronto.ca/wp-content/uploads/2016/12/p1215-poshsv-2016-2017pol.pdf>). Note that sexual violence is any sexual act or act targeting a person's sexuality, gender identity or gender expression, whether the act is physical or psychological in nature, that is committed, threatened or attempted against a person without the person's consent. All members of the University community should have the ability to study, work, and live in an environment free from sexual violence and sexual harassment.

### **Equity Statement**

The University of Toronto is committed to equity and respect for diversity. All members of the learning environment in this course should strive to create an atmosphere of mutual respect. 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, you may

contact the UTM Equity and Diversity officer at [edo.utm@utoronto.ca](mailto:edo.utm@utoronto.ca) or the University of Toronto Mississauga Students' Union Vice President Equity at [vpequity@utmsu.ca](mailto:vpequity@utmsu.ca).

### Accommodations for Learning Needs

The University of Toronto Mississauga supports accommodations for students with diverse learning needs, which may be associated with mental health conditions, learning disabilities, autism spectrum, ADHD, mobility impairments, functional/fine motor impairments, concussion or head injury, blindness and low vision, chronic health conditions, addictions, deafness and hearing loss, communication disorders and/or temporary disabilities, such as fractures and severe sprains, or recovery from an operation.

If you have a learning need requiring an accommodation, we recommend that students register as soon as possible with [Accessibility Services](#).

Phone: 905-569-4699

Email: [access.utm@utoronto.ca](mailto:access.utm@utoronto.ca)

### 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, lab session, or lecture. Students must inform the instructor **before** the session/assignment date to arrange accommodations.

### Mental Health

As a university student, you may experience a range of health and/or mental health challenges that could result in significant barriers to achieving your personal and academic goals. Please note, the University of Toronto (St. George and Mississauga campuses) offer a wide range of free and confidential services that could assist you during these times.

As a CPS student, you have an [Academic Advisor](#) who can support you by advising on personal matters that impact your academics. Other resources include:

- [Accessibility Services](#)
- [Health & Wellness \(St. George\)](#)
- [Health & Counselling Centre \(UTM\)](#)
- [My Student Support Program \(MySSP\)](#)
- [Good2Talk Student Helpline](#)
- [Navi](#)

If you find yourself feeling distressed and in need of more immediate support resources, consider reaching out to the counsellors at [My Student Support Program \(MySSP\)](#) or visiting the [Feeling Distressed webpage](#).

### 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 the Mississaugas of the Credit. 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.*

### Final Exam Information

Duration: 2 hours

### Other Information

- WASPS (Weekly Assigned Synthetic Problem Sets) •

Each week (excepting the day of the MTWT and the last day of class), I will set you a series of problems during the lecture session that coincide with the current week's topics. You are vigorously encouraged to attempt all TEN WASPS. However, you may choose to submit ONLY THREE sets of your handwritten solutions for me to mark. It is entirely your decision which WASPS you wish to submit, and I will ONLY ever mark the first THREE papers you submit. A fourth WASPS submission will not be considered for credit. Regardless of which WASPS you submit, you must do so in class the week following (i.e., 7 days after the WASPS were set), and then I will reveal the answers. All submissions must be handwritten on regular letter-sized paper. Answers written on pages torn or otherwise extracted from a notebook (such as a ring-binder or spiral-bound exercise book) will not be accepted.

- FWE (Final Written Examination) •

A 2-hour final exam will be held during the campus examination period: 11-25 Apr (full details will be available on the website of the Office of the Registrar).

Last Date to drop course from Academic Record and GPA is March 11, 2024.