Chemistry
UNIVERSITY OF TORONTO

PHC320H: Medicinal Chemistry

Winter 2023 Course Syllabus

I TEACHING TEAM

INSTRUCTOR
Name: Mark A. Reed
Email: mark.reed@utoronto.ca
Office: Leslie Dan Faculty of Pharmacy, Rm 1201
Student hours: by appointment.

Instructor biography: Dr. Reed (he/him) is an Assistant Professor of Medicinal Chemistry at the department of Pharmacology and Toxicology, University of Toronto, and a Staff Scientist at Krembil, University Health Network. He has twenty years of research experience in drug discovery within both the pharmaceutical industry and academia. Dr. Reed is Director of the Center for Medicinal Chemistry and Drug Discovery at the Krembil, UHN, where his group has created and partnered several early-stage small molecule drug discovery programs in collaboration with academic researchers across UHN. Dr. Reed received his Doctor of Philosophy in synthetic organic chemistry from the University of Sussex, U.K, and postdoctoral training in organo lithium chemistry at Queens University, Canada.

TA(s)
Name: Samira Baghbanbari
Email: samira.baghbanbari@mail.utoronto.ca
Office: Leslie Dan Faculty of Pharmacy, Rm 1201
Student hours: by appointment

II COURSE OVERVIEW

COURSE DESCRIPTION:
This course is designed to provide an understanding of chemistry of drugs as they are related to small molecules and biologics, their mechanisms of action, and latest trends in the field of pharmaceuticals discovery. Various important concepts such as structure-activity relationships, drug-like properties, computer modeling, combinatorial chemistry, small molecule drugs, biologics and related aspects in relation to new drugs will be covered. After completing this course, students will be in a position to take advanced courses in medicinal chemistry, drug discovery, and specialized courses in drug development. Students will also have deeper understanding of research in drug discovery and development.

STUDENT LEARNING OUTCOMES:
On successful completion of PHC320, students will be able to:

1. Discuss various molecules as ligands to receptors, enzymes and other drug targets
2. Articulate hits, leads and properties of drug-like molecules, biological drugs and some of the latest trends in drugs
3. Explore strategies to modify drug properties, and link between chemical structures and drug properties
4. Understand and engage in medicinal chemistry and drug discovery research
5. Appreciate the multi-disciplinary nature of medicinal chemistry and drug development

PREREQUISITE COURSE(S):
This course assumes you have a basic understanding of organic chemistry, biochemistry, statistics, physics, mathematics and exposure to pharmacology.

READINGS:
Required:

1. Class notes/lectures
2. Select chapters from
   - *An Introduction to Medicinal Chemistry*, 6th Edition, Graham Patrick (ISBN#: 9780198749691), Publisher: Oxford University Press, 2017. (also check the online resources for this book at Oxford University Press website)
     This will be on Course Reserve at the Gerstein Library.
   - *Introduction to Biological and Small Molecule Drug Research and Development: theory and case studies*, C. R. Ganellin, R. Jeffries, and S. Roberts, (ISBN#: 9780123971760), Publisher: Elsevier, 2013.
     The Library owns the e-copy of this book:
     http://www.sciencedirect.com.myaccess.library.utoronto.ca/science/book/9780123971760

Supplemental: Other reference books and journals:

1. Medicinal Chemistry by Norma Dunlap and Donna M. Huryn, CRC Press, Taylor & Francis Group, 2018.
2. Principles of Medicinal Chemistry by William O. Foye, Thomas L. Lemke and David A. Williams, Lippincott Williams & Wilkins.
3. Wilson and Gisvold's Textbook of Organic Medicinal and Pharmaceutical Chemistry by Jamie N. Delgado and William A. Remers, Lippincott-Raven.
4. Burger's Medicinal Chemistry by Michael E. Wolff (5 volumes)
5. Goodman and Gilman's Pharmacological Basis for Therapeutics
6. Journal of Medicinal Chemistry (available online at www.acs.org)

III COURSE ORGANIZATION

This course is organized into 36 lecture hours. All lectures will be in-person classes scheduled for PHC320 during Winter, 2023. There will be upto 36 lecture

hours delivered for this course. Classes begin on Monday Jan 9, 2023 and end on Friday Apr 8, 2022 (A&S Calendar).

Class Room and Hours:

Hours: Mondays 4:00 p.m. to 5:00 p.m.
Tuesdays 2:00 p.m. to 4:00 p.m.

COURSE SCHEDULE & RELEVANT SESSIONAL DATES:

DATES	TOPICS
Mon Jan 9	Course introduction, syllabus, Medicinal chemistry, Drugs and drug targets
Tue Jan 10	Protein structure/function, Enzymes, Receptors/Structure/Function
Mon, Jan 16	Receptors/signal transduction, Nucleic acids; Part B: Enzymes as drug targets
Tue, Jan 17	Receptors as drug targets, Nucleic acids as drug targets, Misc. drug targets
Mon, Jan 23	Pharmacokinetics and Related topics in the context of medicinal chemistry
Tue, Jan 24	Case Study: Statins
Mon, Jan 30	Drug discovery/finding a lead
Tue, Jan 31	Drug design/Optimizing target interactions
Mon, Feb 6	**Mid-Term# 1; 4:00-5:00 PM, 25% of total grade**
Tue, Feb 7	Drug discovery/Optimizing target interactions, Drug design/access to the target
Mon, Feb 13	Drug design/access to the target
Tue, Feb 14	Getting drug to the market and relevance to medicinal chemistry
Mon, Feb 20	*No Class – Family Day*
Tue, Feb 21	*No Class – Reading Week*
Mon, Feb 27	Combinatorial and parallel synthesis
Tue, Feb 28	Computers in medicinal chemistry, and Review session
Mon, Mar 6	QSAR and related topics
Tue, Mar 7	QSAR and related topics
Mon, Mar 13	**Mid-Term# 2; 4:00-5:00 PM, 25% of total grade**
Tue, Mar 14	Case studies: Design of TK inhibitors
Mon, Mar 20	Small molecule discovery process
Tue, Mar 21	Protein therapeutics
Mon, Mar 27	Similarities/differences in biopharmaceuticals and SMDs
Tue, Mar 28	Case studies
Mon, Apr 3	Case studies
Tue, Apr 4	Review Session

Apr 11-29	**Final Exam TBD**

Important Note: It is important that all students attend all classes. Students will have access to the lecture notes before each live lecture, and can be downloaded for review before the class. It is expected that students review the class lecture and attend all live lectures; it is encouraged to ask questions and engage in discussions during the live lecture, in order to facilitate easy learning and answer any questions.

TUTORIAL OBJECTIVES: If needed, TA will be able to organize for tutorial session(s) that is mutually convenient for the student(s) and the TA, to answer any questions, discuss concepts/teachings from the class lectures, and clarify any relevant materials to this course.

LABORATORY OBJECTIVES: Not applicable.

IV EVALUATION/GRADING SCHEME

OVERVIEW:
Mid-Term Tests (x2): 50%
Final Exam: 50%

ASSESSMENT DATES & MARK BREAKDOWN:
1. Mid-Term Test 1 (25%, Monday 6th February, 2023): 60 minutes, to be written during regularly scheduled class time.

2. Mid-Term Test 2 (25%, Monday 13th March, 2023): 60 minutes, to be written during regularly scheduled class time.

3. Final Exam (50%, TBD): 120 minutes, to be confirmed in due time during the Final Assessment Period, Apr 11-29, 2023

Restricted Exams (Closed book) – Students must not refer to any materials for answering the questions during the exams. All exams' scores will be totaled, and a letter grade will be assigned at the end of the term.

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)

- 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.

- Communication with instructor and TA:
  - Please e-mail the instructor Prof. Mark Reed mark.reed@utoronto.ca for any lectures- or course- related questions.
    Please e-mail the TA, Ms Samira Baghanbari Email: samira.baghbanbari@mail.utoronto.ca with a cc to Prof. Reed, for any difficulties with the course materials, and to arrange for a tutorial lecture. Please note that this is not in lieu of any missed classes, but who need extra help after attending the relevant lecture(s).
  - Please allow 24-48 hours (excluding weekends/holidays) for any e-mail responses.
  - When you e-mail, please include your full name, student number, and identify yourself as a PHC320 student, and please use your UTORID email.
  - Please keep the language and tone of your email professional and respectful.

- Privacy language and appropriate use of course materials: https://teaching.utoronto.ca/ed-tech/audio-video/sample-statements/

- Process for requesting re-grading of course work. For mid-term tests, a request may be made to the instructor for re-grading specific answer(s). Upon regrading, marks awarded may go up, down or no change, based on review of the exam. Only one request per exam per student will be entertained.

- Policy for Missed Tests, Process for signaling course absences and requesting make-up tests or exams.
  - Students who miss a term test will be assigned a mark of zero for that test unless they satisfy the following conditions:
  - Students who miss a term test for reasons beyond their control may, no later than one week after the missed test, submit a request to the instructor for special consideration explaining the reason for missing the test, and attaching appropriate documentation, such as the Verifications of Illness or Injury form (www.illnessverification.utoronto.ca).

- If a request with documentation cannot be submitted within one week, the instructor may consider a request to extend the time limit.
- A student whose explanation is accepted will be entitled to one of the following considerations:
  a) Where practicable, the student may be offered the opportunity to do a make-up test.
  b) Where a make-up test is not practicable or the student's circumstances do not permit a make-up test, the instructor may allocate the percentage weight of the test to any combination of the remaining term work and/or final exam in the course.
  c) If the student misses the remaining term work for acceptable reasons, the full percentage weight of the missed work may be allocated to the final exam.
  d) In courses where the mid-term test is the only marked work in the course other than the final examination, an initial make-up test opportunity normally must be given.
- No student is automatically entitled to a second make-up test opportunity. The instructor and/or department will determine what accommodation is appropriate for a student who misses a make-up test for legitimate reasons.
- A student who misses a term test cannot subsequently petition for late withdrawal from the course without academic penalty on the grounds that he or she has had no term work returned before the drop date

VI TECHNOLOGY REQUIREMENTS

- To attend in-person lectures, students do not need any technology. But for accessing materials from Quercus, other online activities and for online lectures if in-person lectures are not possible, technology will be required.
- Specific guidance from the U of T Vice-Provost, Students regarding student technology requirements is available here: https://www.viceprovoststudents.utoronto.ca/covid-19/tech-requirements-online-learning/
- Advice for students more broadly regarding online learning is available here: https://onlinelearning.utoronto.ca/getting-ready-for-online/

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 virtual 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 virtual 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, term tests and final exam:

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/).

Use of Plagiarism Detection Tools

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).

COPYRIGHT
Students may not create audio recordings of classes with the exception of those students requiring an accommodation for a disability, who should speak to the instructor prior to beginning to record lectures.

Students creating unauthorized audio recording of lectures 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 course Quercus site and should only be used by students currently registered in the course. Recordings may be saved to students' laptop for personal use.

Because recordings will be provided for all lectures, students may not create additional audio or video recordings without written permission from the instructor. Permission for such recordings will not be withheld for students with accommodation needs.

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. More information regarding this is available here: https://teaching.utoronto.ca/ed-tech/audio-video/copyright-considerations/

ACCESSIBILITY NEEDS
Students with diverse learning styles and needs are 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 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.