



CHMD47H3: Advanced Bio-Organic Chemistry

Winter 2022 Syllabus

University of Toronto at Scarborough

Dear Students,

Welcome to Advanced Bio-Organic Chemistry! This course aims to teach biochemical reactions in the context of organic chemistry. This course will build on the topics from the third-year Bio-Organic Chemistry course (CHMC47H3) and introduce current developments in enzymatic reactions, mechanism-based inhibitors, bio-catalysis in organic chemistry, biological probes, nucleic acid nanotechnology, and nucleic acid therapeutics. Primary literature will be used extensively, and experiential learning is an integral part of this course. Students will explore the applications of bio-organic chemistry in healthcare and industrial settings as part of an experiential learning project. The lectures with active learning components are once a week for three hours, and you are strongly encouraged to attend all the lectures.

Pre-requisites: Successful completion of Biochemistry I (BIOC12H3), Biochemistry II (BIOC13H3), and Bio-Organic Chemistry (CHMC47H3).

Exclusions: CHM447H Bio-Organic Chemistry

Course Learning Outcomes:

- Use critical thinking skills to connect chemical principles, laws, and theories of fundamental reactions in biochemical systems.
- Understand the interdisciplinary aspects of chemistry in real-life applications through experiential learning projects that expose students to health care and industrial settings.
- Explain the role of chemistry in addressing social and economic issues.
- Explore a new area of research in Bio-Organic chemistry and communicate the knowledge gained in oral and written format to both scientists and lay audience.

Course Instructor:

Prof. Nirusha Thavarajah, HBSoc., MEd., LL.M. (IP), Ph.D.

Office Room Number: EV554

Email: nirusha.thavarajah@utoronto.ca

Office Hours: Tuesdays & Wednesdays 12:00-1:00 pm

Lecture Schedule: Thursdays 1:00-4:00 pm, AA206. Lectures will be streamed synchronously via Zoom until the end of January. Updates on the lecture format (in-person or online) for the remainder of the term will be announced later. Please check the class announcements regularly for updates.

Text Book: There are no required textbooks for this course. Primary literature will be used extensively in this course. Class notes will be available in Quercus for each module.

Email Policy:

Please use the following guidelines when sending emails:

- i. Use your "utoronto.ca" email account for all your correspondence. If other accounts (Yahoo, Gmail, Hotmail, etc.) are used, your email may be filtered out as spam and thus not be received.
- ii. Put "*CHMD47*" in the subject line followed by the reason for the email and use professional language with a formal greeting.
- iii. Sign the email with your first and last name. Include your student ID number after your name.

Every effort will be made to respond to student emails within 36 hours (M-F), provided that the above protocol is followed.

Website:

CHMD47H3 maintains a Quercus webspace, which archives various course-related information, including grades, class announcements, lectures, and lab materials. In addition, class emails will be sent periodically to your "utoronto.ca" email account. **To log in**, go to: <https://q.utoronto.ca>. First, log in using your UTORid username and password. Then click on the CHMD47H3 link.

Announcements:

Official announcements regarding the test schedule, material covered for each test, and other important information will be posted on the CHMD47H3 course website. It is your responsibility to check these postings regularly for important announcements.

Accessibility:

Students with diverse learning styles and needs are welcome in this course. In particular, if you have a disability/health consideration that may require accommodations, please feel free to approach me and/or the *AccessAbility* Services Office as soon as possible. I will work with you and *AccessAbility* Services to achieve your learning goals in this course. Enquiries are confidential. The UTSC *AccessAbility* Services staff (located in S302) are available by appointment to assess specific needs, provide referrals and arrange appropriate accommodations (416) 287-7560 or ability@utsc.utoronto.ca.

Online Tutorials:

Recorded video tutorials with adaptive learning exercises will be posted for each module. Students must watch the videos and complete the adaptive learning exercises and problem sets by the set due dates.

Assessment and Grading Practices:

Graded Work	Weight (%)
Tutorial Assignments (three problem sets in total, 5% each)	15
Experiential Learning Project	20
Term Test I	25% combined: One will be worth 10% and the other 15%. The term test with the higher grade will be assigned to be 15%, while the term test with the lower grade will be assigned 10% of your final grade.
Term Test II	
Final Exam	40
Final Mark	100

To pass the course, you **MUST** achieve either a combined average of 50% from both term tests **OR** the final exam (and receive a final over all grade of 50+, of course!).

Tutorial Assignments

There will be three tutorial assignments in total. Each assignment will cover questions from 3-4 modules. The format of the assignments and the due dates will be announced soon.

Experiential Learning Project

This EDI integrated experiential learning assignment is designed to help students practice equity, diversity, and inclusion (EDI) integrated learning by building relationships with community partners, unlearning pre-existing ideas and developing innovative ideas, engaging in peer assessment, reflection, and goal setting. This assignment has three phases: relationship building with a community partner, blending in-class learning with experiential learning, and engaging in peer assessment, reflection, and goal setting.

Term-Test and Exam Policy:

Term-Tests

There will be two-term tests that will count as 25% of your final grade. One will be worth 10% and the other 15%. The term test with the higher grade will be assigned to be 15%, while the term test with the lower grade will be assigned 10% of your final grade. These tests will be

written outside of class time. The exact date and time will be announced as soon as this information is made available from the registrar. To ensure you pass the course, you should aim to have a combined average of 50% or greater from both term tests.

Final Exam

There will be a cumulative exam written during the end-of-semester exam period. The exact date and time will be announced as soon as they are available. Please note that if you miss the Final Exam, you must petition the Registrar's Office to write a make-up exam in the next formal exam period. Check the UTSC Calendar for instructions and deadlines.

Format: Multiple choice and short answer questions will be used to test students' understanding of theoretical concepts and their application in proposing synthesis and mechanisms of important biochemical reactions. This assessment will test students' critical thinking, problem-solving, and written communication skills.

MISSED EVALUATIONS (TERM TESTS & ASSIGNMENTS)

Please follow the procedures outlined below for missed term work due to illness, emergency, or other mitigating circumstances for missed term work.

Notes:

- The following reasons are not considered sufficient for missed term work: travel for leisure, weddings, personal commitments, work commitments, human error.
- Missed Final Exams are handled by the Registrar's Office and should be declared on eService: <http://www.utsc.utoronto.ca/registrar/missing-examination>
- Instructors cannot accept term work any later than five business days after the last day of class. Beyond this date, you would need to file a petition with the Registrar's Office: <https://www.utsc.utoronto.ca/registrar/term-work>

Accommodations for Illness or Emergency, Religious Conflicts

For missed work due to ILLNESS, EMERGENCY, or RELIGIOUS CONFLICTS please complete the following process:

1. Complete the **Request for [Missed Term Work Form](#)**
2. **Declare your absence** on [ACORN](#) (Profile & Settings > Absence Declaration)

Deadline: You must complete the above form **within five business days** of the missed work.

Accommodations for Academic Conflicts, Time Zone Conflicts

For missed term work due to an ACADEMIC CONFLICT (i.e., two quizzes or tests scheduled at the same time), please complete the following process:

1. Complete the **Request for [Missed Term Work Form](#)** choosing "Other" as your reason for missed work and explaining the conflict in the space provided.

Deadline: You should report the conflict **at least two weeks (10 business days) before the date of the activity** or as soon as possible if it was not possible to identify the conflict earlier.

Note: Multiple assignments due on the same day are not considered conflicts. Accommodations may only be possible in the case of quizzes and tests that are both scheduled during the same discrete period. Back-to-back tests/quizzes are not considered conflicts.

Note: Students are responsible for keeping their course timetables conflict-free. Students who choose to register in two synchronous courses with overlapping lecture/tutorial/lab schedules may not necessarily be accommodated.

After submitting your documentation:

You are responsible for checking your Quercus course announcements daily, as accommodations may be time-critical.

You should continue to work on your assignments to the best of your ability, as extension accommodations may be as short as one business day, depending on the nature of the illness/emergency.

Suppose an accommodation has been granted, but you cannot meet the conditions of the accommodation (ex. you need a longer extension, or you missed a make-up test). In that case, you will need to repeat the missed term work procedure and submit additional forms to request further accommodation. Note that an opportunity to write a second make-up test may not be provided in the case of a missed make-up test.

Completion of this form does not guarantee that accommodations will be made. The course instructor reserves the right to decide what accommodations (if any) will be made. However, failure to adhere to any aspect of this policy may result in a denial of your accommodation request.

Missed Accommodations

Suppose an accommodation is granted, but a continued illness/emergency prevents you from meeting your accommodation requirements. In that case, you must repeat the missed term work procedure to request additional accommodations.

Academic Integrity:

Academic integrity is one of the cornerstones of the University of Toronto. It is critically important both to maintain our community which honours the values of honesty, trust, respect, fairness, and responsibility, and to protect you, the students within this community, and the value of the degree towards which you are all working so diligently.

According to Section B of the University of Toronto's Code of Behaviour on Academic Matters <http://www.governingcouncil.utoronto.ca/policies/behaveac.htm> which all students are expected to know and respect, it is an offence for students to:

- To use someone else's ideas or words in their own work without acknowledging that those ideas/words are not their own with a citation and quotation marks, i.e., to commit plagiarism.
- To include false, misleading, or concocted citations in their work.
- To obtain unauthorized assistance on any assignment.
- To provide unauthorized assistance to another student. This includes showing another student completed work.
- To submit their own work for credit in more than one course without the permission of the instructor.
- To falsify or alter any documentation required by the University. This includes, but is not limited to, doctor's notes.
- To use or possess an unauthorized aid in any test or exam.

There are other offences covered under the Code, but these are by far the most common. Please respect these rules and the values which they protect. Offences against academic integrity will be dealt with according to the procedures outlined in the Code of Behaviour on Academic Matters.

Plagiarism Detection Tool:

"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 website (<https://uoft.me/pdt-faq> **(Links to an external site.)**)."

CHMD47H3 Lecture Schedule (*Tentative):

Note: Suggested readings from primary literature and class notes will be posted under each lecture module.

Week	Topic(s)
1	Protein Folding and Structural Evolution
2	Hemoglobin: Protein Function in Microcosm
3	Rates of Enzymatic Reactions
4	Enzymatic Catalysis
5	Types of Inhibitors & Designing a Mechanism-Based Inhibitor
6	Signal Transduction & Transport Through Membranes
Feb 22nd- Feb 25th	Reading Week
7	Alternate Pathways of Carbohydrate Metabolism
8	Biocatalysis in Organic Synthesis
9	Small Biological Probes
10	Nucleic Acid Nanotechnology
11	Nucleic Acids in Medical Applications
12	Current Developments in Nucleic Acid Therapeutics
April 9 th - April 12 th	Study Break
April 13 th - April 29 th	Final Exam Period

Lecture Topics and Learning Outcomes

1. Protein Folding and Structural Evolution
 - i. Understand protein renaturation and the determinants of protein folding
 - ii. Develop an understanding of protein dynamics
 - iii. Learn about amyloidogenic proteins and conformational diseases
2. Hemoglobin: Protein Function in Microcosm
 - i. Be able to have a deeper understanding of the hemoglobin structure, function, and mechanism
 - ii. Develop an understanding of allosteric regulation
 - iii. Learn about abnormal hemoglobin and molecular basis of Sickle-Cell Anemia
3. Rates of Enzymatic Reactions
 - i. Develop a strong foundation on chemical kinetics and enzyme kinetics
 - ii. Understand the effects of pH on enzyme catalysis
 - iii. Learn about bisubstrate reactions
 - iv. Explain key catalytic mechanisms
4. Enzymatic Catalysis
 - i. Learn about catalytic mechanisms
 - ii. Be able to explain the role of lysozyme and serine proteases
 - iii. Develop an understanding of drug design
5. Types of Enzyme Inhibition Mechanisms & Designing a Mechanism-Based Inhibitor
 - i. Be able to explain competitive, uncompetitive and mixed inhibition
 - ii. Learn about mechanism-based inhibitors
 - iii. Understand the key concepts in developing mechanism-based inhibitors
6. Signal Transduction & Transport Through Membranes
 - i. Understand the thermodynamics of transport
 - ii. Learn about the kinetics and mechanisms of transport
 - iii. Develop an understanding of neurotransmission
7. Alternate Pathways of Carbohydrate Metabolism
 - i. Learn about the gluconeogenesis pathway
 - ii. Develop an understanding of the biosynthesis of oligosaccharides and glycoproteins
 - iii. Be able to explain the key steps in the pentose phosphate pathway
8. Bio-catalysis in Organic Synthesis
 - i. Learn about the development of unique biocatalysts for specific reactions
 - ii. Develop an understanding of single-step biotransformation
 - iii. Be able to explain the application of multienzyme reactions

9. Small Biological Probes

- i. Learn about the biological probes for heritable diseases, cancer, and infectious diseases
- ii. Understand the design and sensing mechanisms of nitrobenzoxadiazole based synthetic probes

10. Nucleic Acid Nanotechnology

- i. Learn about the development of nucleic acid-based nanodevices that can act as molecular switches in vivo
- ii. Begin to learn about the current developments of nucleic acids based high precision sensors.
- iii. Understand nucleic acid-based applications in non-biological applications such as in electronics

11. Nucleic Acids in Medical Applications

- i. Learn about the key concepts in nucleic acid medicine
- ii. Develop an understanding of nucleic acid aptamers
- iii. Begin to learn about the emerging applications of nucleic acids in medical imaging and neuroscience

12. Current Developments in Nucleic Acid Therapeutics

- i. Understanding the application of nucleic acids for drug delivery
- ii. Learn about routes and mode of action for nucleic acid therapeutics
- iii. Develop an understanding of specific clinical applications of nucleic acid therapeutics