



# CHMD47H3: Advanced Bio-Organic Chemistry

## Winter 2024 Syllabus

### University of Toronto Scarborough

**Commitment to Equity, Diversity, and Inclusion:** *“The University of Toronto Scarborough 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. UTSC does not condone discrimination or harassment against any persons or communities.”*

**Land Acknowledgement:** *“I (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.”*

Dear Students,

Welcome to Advanced Bio-Organic Chemistry!

This course aims to teach biochemical reactions in the context of organic chemistry. It will build on the topics from the third-year Bio-Organic Chemistry course (CHMC47H3) and introduce current developments in enzymatic reactions, mechanism-based inhibitors, biological probes, nucleic acid nanotechnology, and nucleic acid therapeutics. Primary literature will be used extensively, and experiential learning is integral to 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.

#### **COURSE INSTRUCTOR:**

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

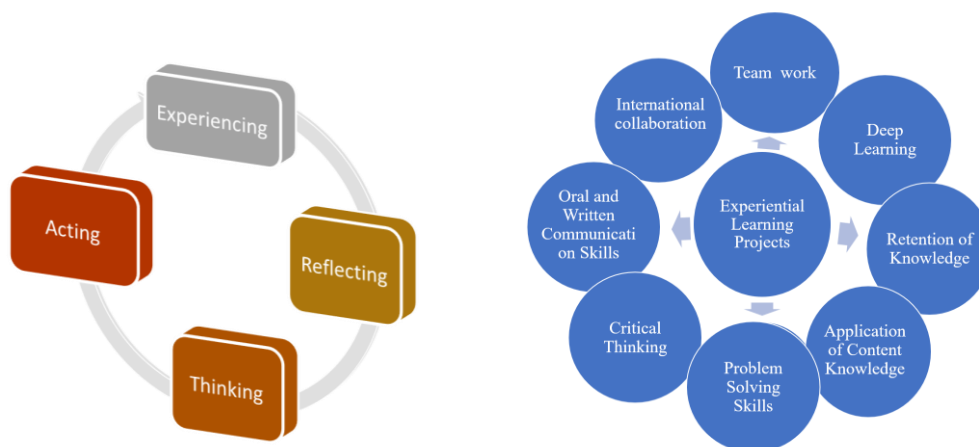
Email: [nirusha.thavarajah@utoronto.ca](mailto:nirusha.thavarajah@utoronto.ca)

Office Hours will be held in SW 155 Mondays and Wednesdays from 12:30-2:00 pm

**COURSE LEARNING OUTCOMES:**

By the end of the course, students will be able to:

- Use analytical, critical thinking, and problem-solving 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 interdisciplinary and international experiential learning projects that expose students to research, 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 scientists and lay audiences.



a) The Cyclic Process of Experiential Learning

(b) The Skill-Based Learning Outcomes

**LECTURE SCHEDULE:** Thursdays 1:00-4:00 pm, Location: TBA

**ACTIVE LEARNING:**

b) **Team Concept Maps/Flow Charts:** Students will be assigned to online study groups to create concept maps/ flow charts on the assigned lesson (s). This strategy is intended to teach collaborative learning. Additional details will be posted on the course Quercus.

c) **Peer Instructions:** Students will be assigned to work in groups to participate in class discussions.

d) **Lecture format:** Each lecture will begin with a **“Bridging tool.”** The bridging tool is intended to stimulate your interest and help you see the real-world application of that day’s lesson. I use videos, animations, demonstrations, images, and artifacts as bridging tools. Based on the bridging tools, we will have an actively engaging discussion on the **learning objectives** for that day. This is followed by a **pre-assessment discussion question** (5 min) (not for grading) to test your background knowledge on the subject and a **participatory lesson**. Students will be

assigned groups to participate in all activities designed for active learning, such as team concept maps/flow charts, the “Chalk Board” game, “Web Quests,” and the course learning outcome poster at the end of the term. Each lecture will have a **post-assessment (5 min) discussion question** (or lecture summaries to be submitted online) at the end to assess the learning outcomes. The lecture will conclude with a lesson summary and a question for the following lesson. *I strongly encourage you to attend all the lectures to engage in the participatory lessons!*

**TEXTBOOK:** 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. AccessAbility Services staff (located in Rm AA142, Arts and Administration Building) are available by appointment to assess specific needs, provide referrals and arrange appropriate accommodations at 416-287-7560 or email [ability.uts@utoronto.ca](mailto:ability.uts@utoronto.ca). The sooner you let us know your needs, the quicker we can assist you in achieving your learning goals in this course.”

**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 (two problem sets in total, 5% each)	10
Weekly Primary Literature Discussion & Presentations (Additional details on the assignment will be posted on Quercus)	10
Experiential Learning Thesis Project Due Date: March 15 <sup>th</sup> 2024	10
Experiential Learning Thesis Presentation Due Date: March 21 <sup>st</sup> , March 28 <sup>th</sup> & April 4 <sup>th</sup> , 2024	5
Term Test I	10
Term Test II	15
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 overall grade of 50+).

**TUTORIAL ASSIGNMENTS:**

There will be two 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 on Quercus.

**EXPERIENTIAL LEARNING THESIS PROJECT AND PRESENTATION:**

This EDI-integrated interdisciplinary and international experiential learning assignment is designed to help students practice equity, diversity, and inclusion (EDI) integrated learning by

building relationships with community and international partners, unlearning pre-existing ideas, developing innovative ideas, and engaging in peer assessment, reflection, and goal setting. This assignment has three phases: relationship building with a community or international partner, blending in-class learning with experiential learning and engaging in peer assessment, reflection, and goal setting.

The thesis of this project for all will be due on March 15<sup>th</sup>. Students will be divided into three groups according to the alphabetical order of their last name to present during class time on March 21<sup>st</sup>, March 28<sup>th</sup> and April 4<sup>th</sup>. Additional details on the project description, rubric, and guidelines of this project will be posted under the experiential learning project module on Quercus.

### **PLAGIARISM DETECTION TOOL: OUR ORIGINAL**

“Normally, students will be required to submit their course essays to the University’s plagiarism detection tool to review textual similarity and detect 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.**)).”

### **Generative AI (ChatGPT) Policies and Notes**

As you are probably aware, generative AI software is becoming more readily available. These tools are extremely useful and can also be time saving. For example, they could be used to help you check your grammar and spelling or to help you create an outline. However, we strongly encourage you not to generate your entire assignment using these tools. They do not provide references and the sources they are using cannot be validated easily. Writing skills are an important part of your university education and experience and while it can be challenging, it is also among the most important and transferable skill that you will acquire during your university studies.

### **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 15%, while the 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 the registrar makes this information available. 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 essential 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 insufficient for missed term work: travel for leisure, weddings, personal commitments, work commitments, and 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.**

It would be best if you continued 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 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.



**CHMD47H3 LECTURE SCHEDULE (\*TENTATIVE):**

<b>Week</b>	<b>Topic(s)</b>
1	Protein Folding and Structural Evolution
2	Hemoglobin and Myoglobin: Structure and Mechanism
3	Rates of Enzymatic Reactions
4	Enzymatic Catalysis
5	Types of Inhibitors & Designing a Mechanism-Based Inhibitor
6	Signal Transduction & Transport Through Membranes
<b>Feb 17<sup>th</sup> - Feb 23<sup>rd</sup></b>	<b>Reading Week</b>
7	Alternate Pathways of Carbohydrate Metabolism
8	Small Biological Probes (Special Topic)
9	Small Biological Probes (Special Topic)
10	Nucleic Acid Nanotechnology (Special Topic)
11	Special Topics: Student Presentations
12	Special Topics: Student Presentations
April 9 <sup>th</sup> -11 <sup>th</sup>	Study Break
April 12 <sup>th</sup> -26 <sup>th</sup>	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 and Myoglobin: Structure and Mechanism
  - i. Be able to have a deeper understanding of the hemoglobin and myoglobin structure, function, and mechanism
  - ii. Develop an understanding of allosteric regulation
  - iii. Learn about abnormal hemoglobin and the molecular basis of Sickle-Cell Anemia
  
3. Rates of Enzymatic Reactions
  - i. Develop a strong foundation in 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. Small Biological Probes (Special Topics)

- 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

9. Nucleic Acid Nanotechnology (Special Topics)

- 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 electronics