Chemistry
UNIVERSITY OF TORONTO

CHM416H/1104H: Separation Science

Course Syllabus – Fall 2024

I TEACHING TEAM

INSTRUCTORS:

Name: David C. Stone (Instructor/coordinator)
Email: david.stone@utoronto.ca
Office: Lash Miller Building Room LM219
Student hours: as posted on Quercus*

Name: J. Rafael Montenegro Burke (Co-instructor)
Email: rafa.montenegro@utoronto.ca
Office: Donnelly Centre for Cellular + Biomolecular Research Room 302
Student hours: as posted on Quercus*

* Student hours will typically be in person, but can be delivered online on an *ad hoc* basis – contact the instructor to schedule this when needed

II COURSE OVERVIEW

COURSE DESCRIPTION:

"Separation Science" is a senior level undergraduate/graduate course within the analytical chemistry lecture series, building on prior content in both CHM217 and CHM317. It is concerned with all aspects of the chemical and physical separation of substances, with particular emphasis on separation as a tool for chemical identification and measurement. The course will assume familiarity with fundamental physical chemical concepts such as solubility, molecular structure and physical properties, and the fundamental concepts behind basic gas and liquid chromatographic instruments and operation.

This course provides theoretical and practical background useful for engaging in cutting-edge chemical separations in chemistry, biology, medicine, engineering, research, and industry. In addition to all types of chromatography, it will discuss electrophoresis and related techniques, a host of miscellaneous separation (e.g., TLC, FFF, CF) and extraction (e.g., dialysis and filtration, LLE, SPE) modalities, and materials and instrumentation for each of these techniques.

STUDENT LEARNING OUTCOMES:

At the end of this course, successful students will be able to:

- critically evaluate which chemical separations methods are most appropriate to solve a particular separations problem

- critically evaluate which chemical extraction methods are most appropriate to solve a particular extraction problem
- understand standard separations and extraction nomenclature, to be able to interpret literature reports and application notes
- understand the advantages and disadvantages of the various materials and instrumentation options that are available for modern chemical separations and extractions
- understand the theoretical underpinnings of retention and efficiency in various separations modes, allowing for rapid and efficient optimization of resolution
- apply linear solvent strength theory to predict retention in high-performance liquid chromatography

PREREQUISITE COURSE:

This course assumes a basic familiarity with analytical chemistry techniques for instrumental analysis. This typically means successful completion of CHM317H as a prerequisite course, but exceptions may be granted by the instructor.

READINGS:

Students may consult any of the following texts. Please note that the last title is available (on an unlimited basis to all students) electronically in the library:

- *Principles of Instrumental Analysis*, Skoog, Holler and Crouch (CENGAGE)
- *Quantitative Chemical Analysis,* Harris and Lucy (MacMillan)
- *Analytical Chemistry 2.1,* Harvey (online via libretexts.org)
- *Introduction to Modern Liquid Chromatography*, Snyder, Kirkland, Dolan (Wiley)

III COURSE ORGANIZATION

CLASS TOPICS & SCHEDULE:

Classes will be held in-person on Tuesdays and Thursdays from 3:00 – 4:00 PM Eastern Time Zone in University College room 261, beginning on September 3rd and ending on November 28th.

The following outline is **provisional**, and subject to change during the semester:

1. General course introduction and discussion of evaluation methods
2. Principles of separation, including macro- and semimicro separation techniques
3. Chromatography: methods, modes, theory, and common features
4. Gas chromatographic techniques and advanced sampling methods
5. Analytical and preparatory scale liquid chromatographic techniques
6. Supercritical fluid chromatography
7. Gel and capillary electrophoresis
8. Modern applications of chromatography-mass spectrometry, including interfacing, ionization, tandem MS, and application to biochemical/biological analysis

COURSE WEBSITE:

The most detailed and up-to-date information about the course is posted on the course website, which can be found by logging in to your Quercus account at https://q.utoronto.ca.

You are advised to check the course website often, as content (summarized below) will be updated regularly.

IV EVALUATION/GRADING SCHEME

OVERVIEW:

Please note that since this course is cross-listed, there are separate grading schemes for undergraduate and graduate participants:

CHM416	**CHM1104**
Two problem sets, worth 20% each	Two problem sets, worth 20% each
Public science essay, 20%	In-class presentation, 20%
Final exam, 40%	Research essay, 40%

There will be a standard policy of 5% of the maximum mark per day lateness past the deadline, which will be publicized ahead of the assignment. Students needing an extension for any reason should contact the instructor setting the assignment no later than 24 hours before the published due date. (See also the policy on absences below).

Note that the undergraduate final exam may be at any time during the scheduled faculty examination period of **Dec. 6th-23rd 2024**, but the exact date and time will not be known until the full exam timetable is published in November.

V COURSE POLICIES

GENERAL:

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. The course instructor will neither condone nor tolerate behaviour that undermines the dignity or self-esteem of any individual in this course and wishes 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 are encouraged to reach out to the staff in the university's Equity Offices.

EXPECTATIONS:

Each member of this course is expected to maintain a:

- professional and respectful attitude during all course activities, including classes, term tests, virtual laboratory exercises, and online activities
- personal calendar/schedule/organizer to ensure that all course activities are completed, and due dates are met
- 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)
- familiarity with the university policy on Academic Integrity

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

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ABSENCES

The in-person classes will (generally) not be recorded or available asynchronously. Students should endeavour to attend all classes in-person. Undergraduate students should consult the relevant rules and regulations in the Faculty of Arts and Science Calendar for information about missed final exams.

In the event of an absence due to illness or other reasons that affect the completion and submission of term work, written documentation is required. The following four items are the recognized forms of documentation:

1. Absence Declaration via ACORN (please note the circumstances under which an absence declaration can and cannot be submitted)
2. U of T Verification of Illness or Injury Form
3. College Registrar's letter
4. Letter of Academic Accommodation from Accessibility Services

Students who complete the ACORN Absence Declaration form must additionally contact the course coordinator to discuss their situation within five business days of the missed piece of work. This is essential action for any consideration to be granted.

For extended absences and for absences due to non-medical reasons, make sure to contact your College Registrar's Office. They can help you decide between a request for an extension or other types of academic consideration.

If you suspect or know that you have a disability that is affecting your studies, learn about the services and supports available through Accessibility Services. A disability can be physical disability, sensory disability, a learning disability, mental health disorder or a short-term disability like an injury. If you are not sure whether you have a disability, you can confidentially contact Accessibility Services with your questions.

USE OF GENERATIVE AI IN ASSIGNMENTS:

The use of ChatGPT and/or other generative AI tools is permitted in writing **solely** as a tool to review your own work for grammar, spelling, and clarity, and **must be declared on the title page of your submission**.

CONTACT WITH INSTRUCTOR:

Instructors will endeavour to respond to emails within 24 hours, with the exception that we will not generally read or respond to emails sent on weekends or public holidays until the next business day.

REGRADING OR REWEIGHTING OF ASSIGNMENTS:

Requests for regrading an assignment must be made within 2 days of receiving the graded work. Reweighting of assignments on an individual basis will only be considered for students with a documented absence (see above).

VI TECHNOLOGY REQUIREMENTS

Specific guidance from the U of T Vice-Provost, Students regarding student technology requirements is available here: https://www.viceprovoststudents.utoronto.ca/student-policies-guidelines/tech-requirements-online-learning/

Advice for students writing online assessments (quizzes etc.): https://studentlife.utoronto.ca/task/online-exams-and-tests/

This course requires the use of computers, and technical challenges are possible. When completing academic work, students are responsible for scheduling enough time to allow for reasonable delays due to technical difficulties to be overcome, so such issues will not be acceptable grounds for deadline extension. Particularly, maintaining an up-to-date independent backup copy of your work is strongly recommended to guard against hard-drive failures, corrupted files, lost computers, etc.

VII INSTITUTIONAL POLICIES & SUPPORT

ACADEMIC INTEGRITY:

You are encouraged to discuss course content and to work problem-sets and old tests with your classmates. ***However, the assignments that will be graded in this course (including the virtual laboratory exercises and term tests) must be completed by you and you alone, according to the university's policies on 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 (https://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:

- Using someone else's ideas or words without appropriate acknowledgement
- Submitting your own work in more than one course without the permission of the instructor
- Making up sources or facts
- Obtaining or providing unauthorized assistance on any report
- Using websites (such as Chegg.com) to post course material/questions/answers
- Looking at someone else's answers or collaborating/discussing during a test
- Misrepresenting your identity
- Falsifying institutional documents or grades
- 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 https://www.academicintegrity.utoronto.ca/).

COPYRIGHT:

If a student wishes to copy or reproduce course notes or other course materials (outside of standard use for course activities), 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://library.utoronto.ca/copyright/remote-instruction-copyright-consider-ations.

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. Students must inform the instructor ***well before the assignment date*** to arrange accommodations.

ADDITIONAL SERVICES & SUPPORT:

- 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:

The Teaching Team acknowledges the 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.