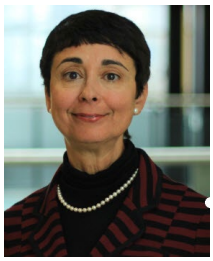
Chemistry
UNIVERSITY OF TORONTO

Leslie Dan Faculty of Pharmacy

JFFK112H/PHC401H: Drug Transport Across Biological Membranes

Winter 2024 Course Syllabus

I TEACHING TEAM



INSTRUCTOR
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TA
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Student hours: As needed, contact by email.

II COURSE OVERVIEW

COURSE DESCRIPTION:
This course primarily concerns the molecular, kinetic, and clinical aspects of drug permeation across biological cell membranes. This is a half course approved by the Graduate Departments of Pharmaceutical Sciences, Pharmacology, and Institute of Medical Sciences (JFFK 112H). This course is also offered to students enrolled in the Pharmaceutical Chemistry program, Department of Chemistry, Faculty of Arts and Sciences (PHC401H).

STUDENT LEARNING OUTCOMES:
1. To define and understand the structure and dynamics of cell membrane permeability barriers.

2. To understand the role of membrane protein components, membrane channels and pores in the transmembrane diffusion of specific molecules and ions.

3. To review the models (i.e., *in vitro,* and *in vivo*) and experimental strategies for the study of drug transport.

4. To describe the molecular and functional characteristics of several solute carrier (SLC) transporters as well as ATP-binding cassette (ABC) membrane–associated transporters.

5. To describe the molecular and functional characteristics of drug transporters members of the SLC and ABC families in mammalian tissues.

6. To review the molecular regulation of drug transport and modifications of membrane structure and function in disease states.

7. To discuss and understand the clinical significance of drug transport across biological membranes.

PREREQUISITE COURSE(S):
Knowledge of basic organic chemistry, biochemistry, and biological sciences is highly recommended.

READINGS:
Recommended Textbook: **You G and Morris ME. Drug Transporters: Molecular Characterization and Role in Drug Disposition, 3rd Edition**. **John Wiley and Sons, Inc. New Jersey, 2022. ISBN:9781119737551**
This textbook is available to students through the University of Toronto library at: https://librarysearch.library.utoronto.ca/permalink/01UTORONTO_INST/14bjeso/alma991107151725906196

III COURSE ORGANIZATION

This course is organized by weeks. In-person lectures will be held in Room PB255 on Tuesdays 9:00am-11:00am, Leslie Dan Faculty of Pharmacy.

COURSE SCHEDULE & RELEVANT SESSIONAL DATES:

DATES	WEEK	TOPICS
Jan. 9th	1	**Lecture 1: Molecular Mechanisms of Drug Transport Processes** 9:00-11:00am Course Introduction *Dr. R. Bendayan*
Jan. 16th	2	**Lecture 2: Models and Experimental Strategies for Study of Drug Transport** 9:00-10:00am In vitro techniques *Dr. R. Bendayan* 10:00-11:00am In vivo techniques *Dr. C. Cummins*
Jan. 23rd	3	**Lecture 3: Typical Transporters - ABC Efflux Transporters** 9:00-11:00am Lecture *Dr. R. Bendayan*
Jan. 30th	4	**Lecture 4: Typical Transporters – SLC Glucose Transporters** 9:00-11:00am Recorded Lecture *Dr. M. Silverman*
Feb. 6th	4	**Midterm Exam in-person (Room PB255)**
Feb. 13th	5	**Lecture 5: Organ-on-a-Chip and Organoids** 9:00-10:00am Lecture *Dr. C. Simmons*
Feb. 20th	6	**Reading Week – No Class**
Feb 27th	7	**Lecture 6: Regulation of Drug Transporters** 9:00-10:00am Lecture *Dr. C. Cummins*

		10:00-11:00am Student Presentations
Mar. 5th	8	**Lecture 7: Diversity of Polymorphisms in Drug Transporters** 9:00-10:00am Student Presentations 10:00-11:00am Lecture *Dr. R. Kim*
Mar. 12th	9	**Lecture 8: Drug Transport in the Brain** 9:00-10:00am Lecture *Dr. R. Bendayan* 10:00-11:00am Student Presentations
Mar. 19th	10	**Lecture 9: Drug Transport in the Liver** 9:00-10:00am Lecture *Dr. S. Pang* 10:00-11:00am Student Presentations
Mar. 26th	11	**Lecture 10: Drug Transport in Male/Female Genital Tract** 9:00-10:00am Lecture *Dr. R. Bendayan* 10:00-11:00am Student Presentations
Apr. 2nd	12	**Discussion of Term Projects** 9:00-10:00am *Dr. R. Bendayan*

IV EVALUATION/GRADING SCHEME

OVERVIEW:
Midterm Exam: 25%
Oral Presentation: 30%
Written Term Project: 35%
Participation: 10%

ASSESSMENT DATES & MARK BREAKDOWN:

a) A short midterm exam (questions with short answers) covering the basic material will be given to students at the end of the first four sections **(25%**). This exam will be given before the course drop date.

b) Each student taking this course will have to prepare an oral presentation (15min and 5-10min discussion) on a published article related to one of the topics presented **(30%)**. Students will select the article and have it approved by the course coordinator. Copies of the article will be distributed to the class one week before the presentation. The student performance for the oral presentations will be evaluated using a scoring sheet that will be filled by the course coordinator and the course TA. Student presentations will take place in-person.

c) Each **undergraduate** student will have to prepare a written term project (5 pages, plus additional list of references and 2 pages of appendices) on a topic related to the field of drug transport **(35%).** Each **graduate** student will have to prepare a grant proposal (following the CIHR format) on a topic related to the field of drug transport (5 pages max, plus list of references and a scientific summary page) (**35%**).

d) Attendance is mandatory and class participation will be evaluated **(10%).**

V COURSE POLICIES

- Each member of this course is expected to maintain a:

(i) professional and respectful attitude during all course activities.
(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: Responses to emails can be expected within 24-48 hrs on weekdays.

- Privacy language and appropriate use of course materials: Please see the copyright section of this syllabus.

- Policy for late assignment submissions: 5% will be deducted daily after the posted due date.

- Submission methods: Please submit assignments via email unless directed otherwise through Quercus.

- Process for requesting re-grading of course work: By email request.

- Process for signaling course absences and requesting make-up tests or exams, if applicable: By email request.

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/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/
- This course requires the use of computers, and technical issues are possible. When working on a piece of 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

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:

On quizzes and term tests:

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/).

Plagiarism Detection
"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)".

Course Policy on Use of Artificial Intelligence Tools (e.g. ChatGPT):
The goal of technical writing is to report clearly (easily understood), accountably (accurate and honest reporting), and transparently (not trying to hide or obscure data or procedural errors). Artificial intelligence tools can assist in this regard, provided the tools are used in ethical ways:

- Students ***cannot not*** use artificial intelligence tools for taking tests, preparing for the oral critique of research papers and/or preparation of the final assignments (reviews and and/or research proposals) assignments, in this course.
- **Students are ultimately accountable for the work they submit.**
- If you have any questions about the use of AI applications for course work, please speak with the instructor.

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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.

Student Presentation Topics:

1. Efflux Transporters (Kidney)
2. Efflux Transporters (GI/Liver)
3. Organic Anion Transporting Polypeptides
4. Organic Anion Transporters
5. Organic Cation Transporters
6. Glucose Transporters
7. Amino Acid Transporters
8. Nucleoside Transporters
9. GI/Liver/Kidney Transporters
10. Drug Transporters in the Placenta
11. Regulation of Drug Transport
12. Drug Transporters and Disease States
13. Drug Transporters in the Central Nervous System
14. Drug Transporters in the Male or Female Genital Tract
15. Polymorphisms in Drug Transporters