Department of Biology Course Outline

Course Number 4151, Course Name Membrane Transport
Fall Term

Course Description

Official Calendar Course Description

Study the fundamental molecular and biophysics of membrane transport. Areas to be stressed include molecular structural-function relationships and biophysical mechanisms critical for membrane transport. There will be two lectures per week. The course is taught in one term and is worth three credits.

Prerequisites

Prerequisites from Calendar Course Description

Suggested prerequisites including SC/BIOL 2020 3.00, SC/BIOL 2021 3.00. SC/BIOL 3010 3.00 and SC/BIOL 3110 3.00 are strongly recommended. Students should have a sound understanding of the fundamentals and principles of chemistry. Familiarity of the principles of thermodynamics and concepts related to chemical kinetics would be extremely helpful.

Course Instructors and Contact Information

Name and contact information of course director, lab director and other important people associated with course administration. Office hours, any other related information.

Course Director: Peter Backx
Office: Room 354 Farquaharson
Phone: x33858
Email: pbackx@yorku.ca
Online/remote by appointment via email

Schedule

Lectures on Tuesday and Thursday 1:-2:30 PM

Lectures will be synchronous and all lectures are recorded live (by Zoom). All recorded lectures are available through eClass.

Technology Requirements

To gain full benefit from the synchronous and asynchronous zoom lectures, students should have access to high speed internet and have computers equipped with audio capability (microphone). This will allow the student to stream online lectures and fully utilize zoom video conferencing software.
In class questions/answer/survey technologies will be used occasionally.
Laboratories (and lectures) will involve the use of a (freely available) software package called **PyMol**. Instructions for the download and use of PyMol will be provided along with the educational keys to access the software. The software can be found at: https://pymol.org/2/
Instructions for using a computer language called Python will be provided as well to assist in completing homework assignments (i.e. numerical calculations) and to illustrate some concepts.

Evaluation

In class quizzes (4): 20%
Midterm (TBA: 20%
Final exam: 20% (TBA)
Literature review: 10% (due at the end of term)
Homework Assignments: 30%.
Total = 100%

Homework Assignments
There will be 4 homework assignments. These will will involve the use of **PyMol** to illustrate how to visualize molecular structures and problem solving to reinforce lecture material. Many problems illustrate key concepts of the course and access to web-based python computer programs are available. PyMol is used to visualize 3D structures of transporters. Course-specific Python programs (available through Google's CoLab Project) are available to assist students in understanding broad transporter concepts. Specifically, about 10 programs are available to illustrate concepts such as energetics/directions of reactions/transport, kinetics of conformational changes of transporters, concepts of net transport, drug actions on transporters etc

Literature Reviews
Paper are submitted as e-copy via eClass.
Topics can be selected by the students. Some examples are:
Group 1 topics: Discuss/summarize mutations of transport proteins that cause a known disease
Group 2 topics: Discuss current understanding of permeation mechanisms
Group 3 topics: Current understanding of molecular structures in transport proteins and their relationship to function
Group 4 topics: Mechanisms of gating in ion channels
Group 5 topics: Mechanisms of coupled transport in Solute Carrier Transporters
Group 6 topics: Mechanisms of regulation of activity/function of a specific channels or class of channels
** Papers are checked for originality (turnitin.com) and submissions not meeting current standards may receive a grade of zero.

Notes: Course website: http://eclass.yorku.ca

NOTE: Final course grades may be adjusted to conform to Faculty grade distribution profiles.

Important Dates

Midterm Test (TBA) Duration: 1 hour and 20 minutes.

Home assignments are typically due 2 weeks after being available or as instructed/needed.

Literature review are submitted 2 days after the final exam via eClass.

Drop Deadline: TBA (last day to drop without course on transcript)
Course Withdrawal: TBA (course still appears on transcript with 'W")

****NOTE:** for additional important dates such as holidays and reading days please refer to the "Important Dates" section of the Registrar's Website at http://registrar.yorku.ca/enrol/dates

Learning Outcomes

- Exposure to ongoing advances in the molecular structures of membrane proteins
- Understand relationships between molecular structure and function
- Using biophysical principles to understand the mechanisms underlying membrane transport
- Become familiar with the scientific language and concepts used to understand membrane transport
- Be competent in reading literature describing transport mechanisms

Course Content

TENTATIVE LECTURE SCHEDULE/PLAN

Week 1: General Structure and Biochemical Composition of Membranes

Week 2: Biophysical Consequences of Membrane Biochemistry:
How permeability depends on size and polarity of substances

Week 3: The need for protein-based specialized transport systems
Structure of (membrane) proteins and introduction to their evolution
Vesicular transport systems and their application to gene therapy, vaccines and drug delivery

Week 4: Non-selective (passive) transport across membrane by small hydrophobic substances/drugs
Introduction to diffusion principles and links to chemical kinetic schemes
Consideration of membrane properties in drug design

Weeks 5-6 Selective (and non-selective) membrane transport using channels
Combining diffusion with selective movement
Water Transport: passive movement and via Aquaporins
Physiology of water transport

Weeks 7-9 Ion channels: voltage-gated, ligand gated, strain-gated, photon gated
Concept of electrical potentials and electrodiffusion
Concepts of gating and conformational changes in proteins (ligand- and voltage
- dependent control (i.e. gating) and links to chemical kinetic schemes
Potassium channel structure function
Sodium and calcium channel structure function

Weeks 10-11 Solute Transporters: Facilitated diffusion, coupled transport (symporters, exchangers, pumps). A discussion of chemical "evolution" of membrane transporter proteins involving gene duplication leading to key symmetry features
Introduction to Michaelis-Menton (Chemical Kinetic Schemes) for understanding Solute Transporters. Differences between electrogenic and non-electrogenic transport
GLUT transporters, Na-glucose transporters, Na/Ca exchangers are discussed in detail

Weeks 12: Solute Transporters: ABC Transporters (big cargo transporters, drug resistance)

Resources

Required Texts: none

Recommended textbooks:
Channels, Carriers, and Pumps: An Introduction to Membrane, 2nd Edition, WD Stein & T Litman
(This book can be purchased on Amazon as hardcopy or as a kindle edition).
The book is also available as an ebook via the YorkU library using the following link:
https://ocul-yor.primo.exlibrisgroup.com/permalink/01OCUL_YOR/q36jf8/alma991011358829705164

*Ion channels in excitable membrane*s, 3rd Edition, B Hille (This book should be available at Steacie)

Membrane structural biology_ with biochemical and biophysical foundations, Mary Luckey

Cellular Biophysics Vol1 and 2, TF Weiss

Other reading materials (papers) will be added via the eClass website

** This book by Stein and Litman will be used extensively (especially in the first half of the course). Many figures in lectures will come from this book.

Website: eClass
Please check the BIOL 4151 on the eClass website (https://www.yorku.ca/eclass/ or https://www.eclass.yorku.ca) regularly basis for course updates/postings. Course announcements from the eClass site will send notices via email (so check your email account regularly)**.**

eClass Discussion Boards
The Discussion Board will be available as requested. Questions related to course/lecture materials will be posted (anonymously) on the Discussion Board, with the expectation that students in the course can have the opportunity to respond and discuss.

Be sure to read the other threads before you post a question to see if your question has already been answered.

When posting, be clear specific and professional (see Netiquette guidelines posted on eClass).

Discussions are monitored. Messages containing personal attacks, inappropriate language, or other disrespectful contents will be removed. Irrelevant material will also be removed. Follow the York University Student Code of Conduct http://www.yorku.ca/oscr/codeofrr.html

If you notice any inappropriate threads please contact the Course Director.

Disclaimer: While eClass moderators / instructors will attempt to remove (or edit) objectionable/inappropriate material as quickly as possible, it is not always possible to review every post. All posts made on the forums express the views and opinions of the author and not the moderators / instructors (except for posts by these people) and they cannot be held liable.

Experiential Education and E-Learning

A good deal of information related to the topics discussed in class is available on the web. Students are encouraged to find course-related material on the web.

Other Information

Links for websites illustrating the concepts in class will often be provided in the lectures and in the notes.

Course Policies

Students are expected to attend the midterm and all quizzes. Only medical-related absences will be considered and must be supported with York University approved documentation requirements. If documentation is accepted, the percent weighting of the course assets will be adjusted at the discretion of the course director. Generally, if the midterm is missed, the weight of the final will be adjusted to 40%. The weighting of quizzes will be adjusted also as needed. Any medical documentation should be submitted to the instructor or via the departmental online document submission system: http://science.apps01.yorku.ca/machform/view.php?id=84113

Email and discussion forum etiquette/policies: Use only your my.yorku.ca email for all course

correspondence. Emails received from non-yorku email addresses may not receive a response

Please include your full name and student number in all email communications, etc.

THERE WILL BE NO CONSIDERATION GIVEN FOR LATE AND MISSED ASSIGNMANTS.

University Policies

Academic Honesty and Integrity
York students are required to maintain the highest standards of academic honesty and they are subject to the Senate Policy on Academic Honesty (http://secretariat-policies.info.yorku.ca/policies/academic-honesty-senate-policy-on/). The Policy affirms the responsibility of faculty members to foster acceptable standards of academic conduct and of the student to abide by such standards.
There is also an academic integrity website with comprehensive information about academic honesty and how to find resources at York to help improve students' research and writing skills, and cope with University life. Students are expected to review the materials on the Academic Integrity website at - http://www.yorku.ca/academicintegrity/

Access/Disability
York University is committed to principles of respect, inclusion and equality of all persons with disabilities across campus. The University provides services for students with disabilities (including physical, medical, learning and psychiatric disabilities) needing accommodation related to teaching and evaluation methods/materials. These services are made available to students in all Faculties and programs at York University.
Student's in need of these services are asked to register with disability services as early as possible to ensure that appropriate academic accommodation can be provided with advance notice. You are encouraged to schedule a time early in the term to meet with each professor to discuss your accommodation needs. Please note that registering with disabilities services and discussing your needs with your professors is necessary to avoid any impediment to receiving the necessary academic accommodations to meet your needs.
Additional information is available at the following websites:
Counselling & Disability Services - http://cds.info.yorku.ca/
Counselling & Disability Services at Glendon - http://www.glendon.yorku.ca/counselling/personal.html
York Accessibility Hub - http://accessibilityhub.info.yorku.ca/

Ethics Review Process
York students are subject to the York University *Policy for the Ethics Review Process for Research Involving Human Participants.* In particular, students proposing to undertake research involving human participants (e.g., interviewing the director of a company or government agency, having students complete a questionnaire, etc.) are required to submit an *Application for Ethical Approval of Research Involving Human Participants* at least one month before you plan to begin the research. If you are in doubt as to whether this requirement applies to you, contact your Course Director immediately.

Religious Observance Accommodation
York University is committed to respecting the religious beliefs and practices of all members of the community, and making accommodations for observances of special significance to adherents. Should any of the dates specified in this syllabus for an in-class test or examination pose such a conflict for you, contact the Course Director within the first three weeks of class. Similarly, should an assignment to be completed in a lab, practicum placement, workshop, etc., scheduled later in the term pose such a conflict, contact the Course director immediately. Please note that to arrange an alternative date or time for an examination scheduled in the formal examination periods (December and April/May), students must complete an Examination Accommodation Form, which can be obtained from Student Client Services, Student Services Centre or online at
http://www.registrar.yorku.ca/pdf/exam_accommodation.pdf (PDF)

Student Conduct in Academic Situations

Students and instructors are expected to maintain a professional relationship characterized by courtesy and mutual respect. Moreover, it is the responsibility of the instructor to maintain an appropriate academic atmosphere in the classroom and other academic settings, and the responsibility of the student to cooperate in that endeavour. Further, the instructor is the best person to decide, in the first instance, whether such an atmosphere is present in the class. The policy and procedures governing disruptive and/or harassing behaviour by students in academic situations is available at - http://secretariat-policies.info.yorku.ca/policies/disruptive-andor-harassing-behaviour-in-academic-situations-senate-policy/