THE UNIVERSITY OF BRITISH COLUMBIA
School of Biomedical Engineering
Faculties of Applied Science and Medicine

BMEG 250: Cellular Physiology & Biophysics

2019W Syllabus

COURSE INFORMATION

Instructor:	Vikramaditya G. Yadav
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Phone:	(604) 827 2706
Office Hours & Location:	Thursdays, 2:30 – 3:30 pm Office: CHBE 207
Teaching Assistant Info:	Roza Vaez Ghaemi (ghaemi@chbe.ubc.ca) Nastaran Taleghani (ntal760@mail.ubc.ca) Edbert Yeung (edyeung3233@gmail.com) *Office hours by appointment only*
Pre-Requisites:	BMEG 245
Co-Requisites:	None

LECTURE DATES | TIMES | ROOMS

Lecture:	Mondays, Wednesdays & Fridays, 9:00 – 10:00 am LSC 1003
E-Laboratory:	Mondays, 1:00 – 2:00 pm (both sections) MCLD 202 *The e- laboratory will take place from January 6 – March 9*
Laboratory:	Mondays, 12:00-1:00 pm (Section 1), 1:00-2:00 pm (Section 2) CHBE 294 *The wet laboratory demonstrations will take place from March 16 – 30*

COURSE DESCRIPTION

This course expands understanding about cellular structure and investigates fundamental mechanisms of membrane transport, signal transduction, muscle mechanochemistry and neurotransmission. Structure and hierarchical organization up to the level of tissues are also studied using light and electron microscopy. The course will also focus on mathematical modeling and simulation these biological systems and phenomena and introduce students to industry-standard tools for analyses of biological data, computational drug discovery and numerical methods.

LEARNING OBJECTIVES

After the course, students will be able to:

- Explain the relationship between cellular structure and function
- Describe and illustrate how light and electron microscopy works
- Relate biophysical chemistry to cellular structure, as well as cellular interactions within tissues
- Describe the structure and biochemical properties of membrane lipids
- Differentiate the biochemical properties, roles and structures of phospholipids, glycolipids and cholesterol
- Describe and use the concept of membrane potentials to explain and graphically model transport into and outside the cell
- Explain and differentiate between the physiology of passive diffusion, facilitated diffusion, co-transport and counter-transport
- Relate membrane excitability to the physiology and function of ionotropic and metabotropic channels
- Derive mathematical models that describe the activity of enzymes
- Determine and model mechanisms of enzyme inhibition
- Model gene circuits and signal transduction cascades
- Explain how intracellular signaling cascades are initiated in response to extracellular stimuli
- Define mechanochemistry and use it to explain excitation and contraction of muscle tissue
- Define molecular machines and describe some prominent applications in cellular bioengineering
- Model how drugs are delivered to their site of action and optimize transdermal drug patches

COURSE ORGANIZATION / STRUCTURE

The assessment strategy for this course is typical of many engineering courses, as we routinely assess students on the basis of their ability to recall and apply relevant facts and theories, to perform calculations correctly, and to be able to communicate technical information effectively.

Laboratory exercises give the students a chance to develop microscopy and other skills that are foundational for future studies in biomedical engineering. It also allows the students to experience the real-life manifestations of what they have studied theoretically in the classroom. Emphasis in the lab is on the correct use of equipment, and the students' ability to use the equipment to report in an appropriate manner their laboratory findings.

Assignments allow students to practice and apply newly learned knowledge and skills. In this course, they frequently involve the description and explanation of physical, chemical and biological models of the cell, its components and its biological functions. The topics in this course build upon each other and rely on student mastery of certain physical, chemical and biological foundations. Therefore, it is critical that students be given opportunity to evaluate their understanding throughout the course. Giving some weight to these assignments encourages students to practice the material covered in the course consistently throughout the term, which improves the overall outcome for the students.

Midterm exams give students an opportunity to demonstrate their knowledge in a controlled testing environment and may include a combination of calculation based problems and illustration of knowledge of relevant facts. It will assess the students' understanding of the fundamental concepts

before moving on to more complicated material, providing early feedback to the students and instructor so that misconceptions can be corrected or problems can be addressed.

The cumulative final exam allows us the ability to verify that students have mastered a majority of the material covered in the class, again in a controlled environment where it is clear that the work is that of an individual student. Some problems on the final exam may serve to assess only one of the stated learning outcomes and others may serve to assess a multiple learning outcomes in combination, thus giving the ability to assess the capacity of the students to solve both simple and complex problems.

STUDENT EVALUATION

Evaluation Method	Percentage of Final Grade
Assignments (5 in total)	20%
Midterm examination	20%
Term project	20%
Final Exam	40%
TOTAL	**100%**

Details about term project: We are using this module to introduce the students to computational drug discovery. Last year, we optimized a drug lead and evaluated its binding to the dopamine D1 receptor. This year, we will be targeting the design of novel anti-viral agents to target the MERS coronavirus. The project involves classroom exercises and wet laboratory demonstrations. Students will be introduced to introductory bioinformatics tools such as sequence determination, BLAST and multiple sequence alignments. We will then look at protein modeling techniques such as threading. Finally, students will be introduced to molecular docking and analysis of biological thermodynamic data. The wet laboratory components will focus on enzyme assays and how in silico data is verified through wet laboratory experiments. Students will learn to use Marvin, PyMol and Chimera during the course of the project.

LATE POLICY

Students are expected to submit their assignments on the stipulated deadlines. Late submissions will lose 50% of the points allotted for that exercise.

COURSE MATERIALS

Textbook: R. Phillips et al., Physical Biology of the Cell, 2nd Ed.

Purchase of the textbook in electronic or physical format is recommended since all examinations will subscribe to an open notes format.

Course notes: All in-class lecture slides and discussions will also be uploaded to the course's Canvas site

TENTATIVE COURSE SCHEDULE

Week	Description
1	Introduction to physical biology and cellular structures
2	Biochemical building blocks, recap of organic chemistry, chemical structures and bonding
3	Cellular structure and organelles, compartmentalization of cellular physiological functions
4	Investigating cell and tissue structure using light & electron microscopy
5	Mechanotransduction and introduction to rate processes in biology
6	Systems of differential equations and stability analyses
	Midterm examination
7	Introduction to numerical methods and simulation, programming in Python
8	Modeling and simulating gene networks and signal transduction pathways
9	Enzyme kinetics, inhibition and cooperativity
10	Diffusion and mass transport in biological systems, facilitated transport across membranes
11	Co-transport, counter-transport, ion pumps, diffusion of macromolecules and random walks
12	Structure and models of cellular membranes, membrane potentials
13	Protein-protein interactions
	Final examination

UBC POLICY ACADEMIC INTEGRITY

The academic enterprise is founded on honesty, civility, and integrity. As members of this enterprise, all students are expected to know, understand, and follow the codes of conduct regarding academic integrity. At the most basic level, this means submitting only original work done by you and acknowledging all sources of information or ideas and attributing them to others as required. This also means you should not cheat, copy, or mislead others about what is your work. Violations of academic integrity (i.e.,

misconduct) lead to the breakdown of the academic enterprise, and therefore serious consequences arise and harsh sanctions are imposed. For example, incidences of plagiarism or cheating may result in a mark of zero on the assignment or exam and more serious consequences may apply if the matter is referred to the President's Advisory Committee on Student Discipline. Careful records are kept in order to monitor and prevent recurrences.

For more information, see: http://www.calendar.ubc.ca/vancouver/index.cfm?tree=3,286,0,0

ACADEMIC CONCESSION

The University is committed to supporting students in their academic pursuits. Students may request academic concession in circumstances that may adversely affect their attendance or performance in a course or program. Students who intend to, or who as a result of circumstance must, request academic concession must notify their instructor, dean, or director as specified in the link below. http://www.calendar.ubc.ca/vancouver/index.cfm?tree=3,48,0,0

Students seeking academic concession due to absence from the final exam for any reason must apply to Engineering Student Services (ESS) within 72 hours of the missed exam. This is a standard practice for all final examinations at UBC.

For more information, see: http://students.engineering.ubc.ca/enrolment/faq/

STATEMENT ON UNIVERSITY'S VALUES AND POLICIES

UBC provides resources to support student learning and to maintain healthy lifestyles but recognizes that sometimes crises arise and so there are additional resources to access including those for survivors of sexual violence. UBC values respect for the person and ideas of all members of the academic community. Harassment and discrimination are not tolerated nor is suppression of academic freedom. UBC provides appropriate accommodation for students with disabilities and for religious, spiritual and cultural observances. UBC values academic honesty and students ae expected to acknowledge the ideas generated by others and to uphold the highest academic standards in all of their actions. Details of the policies and how to access support are available here: senate.ubc.ca/policies-resources-support-student-success.

LAND ACKNOWLEDGMENT

This course is held on the UBC Point Grey (Vancouver) campus, which sits on the traditional, ancestral, unceded territory of the xʷməθkʷəy̓əm (Musqueam) First Nation.