Course Syllabus

Jump to Today

Course Objectives

Develop a quantitative understanding of cellular and molecular function using engineering approaches. This course applies biophysical concepts and mathematical techniques to provide the skills needed to quantitatively analyze and ultimately design cellular systems.

Course Content

Chemical Kinetics and Equilibria

- 01 - Basic methods and nomenclature, Law of Mass Action
- 02 - Enzyme kinetics and inhibition
- 03 - Blood: O2 and CO2 transport

Diffusion at Cellular and Molecular scales

- 04 - Diffusion
- 05 - Entropy

Simulating Chemical Kinetics

- 06 - Glycolytic oscillations

Membrane Physiology

- 07 - Membrane structure and ion transport
- 08 - Membrane potential and electrodiffusion
- 09 - Resting potential & pump-leak model
- 10 - Excitable membranes and action potentials

Cell Cytoskeleton and Molecular Motors

- 11 - Dynamics of cytoskeletal components
- 12 - Motors and muscle

Topics in Cellular Physiology and Engineering

- Cell Culture
- Micro- and Nano-scale surface engineering
- Microscopy of Cells and Molecules
- Cellular Biomechanics

Assessment

- 40% Homework assignments (roughly biweekly, 5 total, best 4 counted)
- 30% Mid-term exam 1
- 30% Mid-term exam 2

Requests for regrades must be made within a week of release of scores. Please see the posted answer key (in the Courseworks "Modules" section) before requesting a regrade. Requests are made through the Gradescope platform. We will consider the whole question, not limited to any specific subpart, in determining a regrade.

Final grades for graduate, undergraduate, and CVN students will be determined on separate scales.

Scheduling and modalities for all assessments will be subject to University, School, and Department policies in place at that time.

Homework assignments

- Each student is required to submit an individual solution for each assignment. Students are encouraged to discuss the homework assignments, but the submitted solutions must reflect individual effort; incidences of submissions being tainted by plagiarism will be reviewed and referred to the appropriate Academic Dean.
- Assignments will be administered through Gradescope.
  To access the assignments, go into Gradescope and click on that HW. Clicking on the "Submit" or "Resubmit" buttons will bring up a window that allows you to download the assignment in .pdf form. A copy of the assignment will also be put into the Modules, along with an answer key that will be available after grades are released.
- Solutions must be done neatly on 8.5" X 11" paper or electronic equivalent, portrait orientation. Homeworks will be submitted electronically. Do ***not*** include your name or identifying information on submitted assignments.
- Unless other arrangements are made 24 hours in advance, late homework will discounted 25% per day.
- One extension of four days (including weekends) will be allowed for one homework assignment. This does not have to be arranged in advance of the deadline, and will be applied to one of the counted HWs.

Exams

- Mid-term exams will be timed and held during the scheduled class period. The format and logistics will be announced.
- Late or make-up exams must be approved and scheduled with Prof. Kam at least 24 hours prior to the scheduled exam time. An unexcused absence from an exam will result in a grade of zero on that

exam.

- In the event exams are transitioned to a remote format, these rules will be updated.
- Allowed materials: Course books, your notes, class notes.
- Prohibited materials include: worked problems from past exams.
- Computers / tablets are allowed only for accessing your own course notes and textbooks.
- Generative AI / Search tools are not allowed for exams.
- A scientific calculator capable of logarithms/exponentials is needed for exams. Graphing calculators are allowed but not needed.

Generative AI

- All submitted solutions are to represent the original work of each individual student.
- Generative AI tools can be used to formulate and approach homework assignments. However, all submitted assignments will be reviewed as the product of an individual's effort.
- Generative AI / Search tools are not allowed for exams.
- We will also follow the University's **Generative AI Policy (https://provost.columbia.edu/content/office-senior-vice-provost/ai-policy)** .

Academic Conduct

- Instances of academic dishonesty will be referred to the appropriate academic Dean.

Communications

Courseworks/Canvas:

- The primary site of information exchange.
- Lecture materials and notes, along with a tentative course schedule, can be found in the Modules section. The same materials are available through the Files section.
- The Discussions section will be available for use, and checked regularly by Prof. Kam and the TAs.

Textbooks

1. “Medical Physiology”, Boron & Boulpaep, ISBN 9781455743773.
    1. Columbia electronic resource, 2017 edition: **https://clio.columbia.edu/catalog/ebs10703398e (https://clio.columbia.edu/catalog/ebs10703398e)**

2. Coursepack containing sections from the following texts. Digital delivery version is available.
    1. J Keener and J Sneyd, “Mathematical Physiology”, Springer, 1998, Ch. 1 & 2. ISBN: 0387983813
        1. Columbia electronic resource, 1998 edition: **https://clio.columbia.edu/catalog/ebs331248e (https://clio.columbia.edu/catalog/ebs331248e)**
        2. Columbia electronic resource, 2009 edition: **https://clio.columbia.edu/catalog/ebs470080e (https://clio.columbia.edu/catalog/ebs470080e)**
    2. P Nelson, “Biological Physics”, Freeman and Company, 2004, Ch. 4 & 12. ISBN: 0716743728
3. This course requires MATLAB for computational modeling of chemical kinetics. SEAS has provided access to a student version of MATLAB, through the Mathworks website. For more information, please see:
   https://cuit.columbia.edu/content/matlab (https://cuit.columbia.edu/content/matlab)

Course Summary:

Date	Details	Due