Graduate Program in Biochemistry and Molecular Biophysics

Chair

- Tobin R. Sosnick

Professors

- Erin J. Adams
- Francisco Bezanilla
- Glyn Dawson, Pediatrics
- Geoffrey Greene, Ben May Department for Cancer Research
- Chuan He, Chemistry
- Robert J. Keenan
- Stephen B. H. Kent
- Anthony A. Kossiakoff
- David Kovar, Molecular Genetics & Cell Biology
- Marvin W. Makinen
- Stephen Meredith, Pathology
- Keith Moffat
- Tao Pan
- Eduardo Perozo
- Joseph A. Piccirilli
- Rama Ranganathan
- Phoebe A. Rice
- Benoit Roux
- Alex Ruthenburg, Molecular Genetics & Cell Biology
- Nancy B. Schwartz, Pediatrics
- James A. Shapiro
- Tobin R. Sosnick
- Joseph Thornton, Human Genetics

Associate Professors

- Ronald S. Rock
- D. Allan Drummond

Assistant Professors

- Demet Arac-Ozkan
- Jingyi Fei
- Engin Ozkan
- Minglei Zhou
- Juan Mendoza, Pritzker School of Molecular Engineering

Emeritus Faculty

- Wolfgang Epstein
- Theodore L. Steck
- Edwin W. Taylor

The biochemistry and molecular biophysics graduate program is a highly interdisciplinary program of study offered by the Department of Biochemistry and Molecular Biology. The program forges a scientific culture of collaboration across the physical and biological sciences and among diverse laboratories. In this environment, students will have the opportunity to engage in research that aims to understand biological processes at the molecular level. The program is designed to encourage students to pursue research interests at the biological-physical sciences interface using diverse approaches such as structural and chemical biology, molecular and single molecule biophysics, combinatorial mutagenesis, protein engineering and RNA and DNA protein recognition.
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Admission
For information about applying to our graduate program, please visit our website at http://bcmb.uchicago.edu (http://collegecatalog.uchicago.edu).
BCMB 30800. Single Molecule Biochemistry. 100 Units.
This course presents a series of advanced case studies designed to familiarize students with current single molecule research. Topics include: motor proteins and the cytoskeleton, nucleic acid processing enzymes, ion channels, and force spectroscopy and macromolecule folding.
Instructor(s): R. Rock, F. Bezanilla Terms Offered: Spring

BCMB 31100. Evolution of Biological Molecules. 100 Units.
The course connects evolutionary changes imprinted in genes and genomes with the structure, function and behavior of the encoded protein and RNA molecules. Central themes are the mechanisms and dynamics by which molecular structure and function evolve; how protein/ RNA architecture shapes evolutionary trajectories, and how patterns in present-day sequence can be interpreted to reveal the interplay data of evolutionary history and molecular properties. Core concepts in macromolecule biochemistry (folding and stability of proteins and RNA, structure-function relationships, kinetics, catalysis) and molecular evolution (selection, mutation, drift, epistasis, effective population size, phylogenetics) will be taught, and the interplay between them explored.
Instructor(s): A. Drummond, J. Thornton Terms Offered: Winter
Prerequisite(s): Comfort with basic computer programming (course will use Python and R); undergraduate biology, chemistry, calculus, and introductory statistics.
Equivalent Course(s): HGEN 31100, ECEV 31100

BCMB 31200. Molecular Biology I. 100 Units.
Nucleic acid structure and DNA topology; methodology; nucleic-acid protein interactions; mechanisms and regulation of transcription in eu-bacteria, and of replication in eu-bacteria and eu-karyotes; mechanisms of genome and plasmid segregation in eu-bacteria.
Instructor(s): L. Rothman-Denes Terms Offered: Winter
Equivalent Course(s): MGCB 31200, DVBI 31200

BCMB 31300. Molecular Biology-II. 100 Units.
The content of this course covers the mechanisms and regulation of eu-karyotic gene expression at the transcriptional and post-transcriptional levels. Our goal is to explore research frontiers and evolving methodologies. Rather than focusing on the elemental aspects of a topic, the lectures and discussions highlight the most significant recent developments, their implications and future directions.
Instructor(s): J. Staley, A. Ruthenburg, H.C. Lee Terms Offered: Spring
Prerequisite(s): Molecular Biology I (MGCB 31200) or by special permission of an instructor
Equivalent Course(s): MGCB 31300, DVBI 31300

BCMB 31358. Simulation, Modeling, and Computation in Biophysics. 100 Units.
This course develops skills for modeling biomolecular systems. Fundamental knowledge covers basic statistical mechanics, free energy, and kinetic concepts. Tools include molecular dynamics and Monte Carlo simulations, random walk and diffusion equations, and methods to generate random Gaussian and Poisson distributors. A term project involves writing a small program that simulates a process. Familiarity with a programming language or Mathlab would be valuable.
Instructor(s): B. Roux Terms Offered: Winter
Prerequisite(s): BIOS 20200 and BIOS 26210-26211, or consent from instructor
Equivalent Course(s): CPNS 31358, BIOS 21358

BCMB 31400. Genetic Analysis of Model Organisms. 100 Units.
Fundamental principles of genetics discussed in the context of current approaches to mapping and functional characterization of genes. The relative strengths and weaknesses of leading model organisms are emphasized via problem-solving and critical reading of original literature.
Equivalent Course(s): DVBI 31400, MGCB 31400, HGEN 31400

BCMB 31600. Cell Biology I. 100 Units.
Eukaryotic protein traffic and related topics, including molecular motors and cytoskeletal dynamics, organelle architecture and biogenesis, protein translocation and sorting, compartmentalization in the secretory pathway, endocytosis and exocytosis, and mechanisms and regulation of membrane fusion.
Instructor(s): A. Turkewitz, B. Glick Terms Offered: Autumn
Equivalent Course(s): MGCB 31600, HGEN 31600, DVBI 31600

BCMB 31700. Cell Biology II. 100 Units.
This course covers the mechanisms with which cells execute fundamental behaviors. Topics include signal transduction, cell cycle progression, cell growth, cell death, cancer biology, cytoskeletal polymers and motors, cell motility, cytoskeletal diseases, and cell polarity. Each lecture will conclude with a dissection of primary literature with input from the students. Students will write and present a short research proposal, providing excellent preparation for preliminary exams.
Instructor(s): M. Glotzer, D. Kovar Terms Offered: Winter
Prerequisite(s): For undergraduates: Three quarters of a Biological Sciences Fundamentals sequence.
Equivalent Course(s): MGCB 31700, DVBI 31700, BIOS 21238

BCMB 31900. Introduction to Research. 100 Units.
Lectures on current research by departmental faculty and other invited speakers. A required course for all first-year graduate students.
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Instructor(s): Staff Terms Offered: Autumn, Winter
Equivalent Course(s): DVBI 31900, MGCB 31900, GENE 31900, HGEN 31900

BCMB 32200. Biochemistry of Biomolecules. 100 Units.
This course covers the properties of proteins, RNA, and DNA, as well as their interactions. We emphasize the interplay between structure, thermodynamics, folding, and function at the molecular level. Topics include cooperativity, linked equilibrium, hydrogen exchange, electrostatics, diffusion, and binding.
Instructor(s): T. Sonic
Equivalent Course(s): BIOS 21328, BPHS 31000

BCMB 32300. Structure and Function of Membrane Proteins. 100 Units.
This course will be an in-depth assessment of the structure and function of biological membranes. In addition to lectures, directed discussions of papers from the literature will be used. The main topics of the courses are: (1) Energetic and thermodynamic principles associated with membrane formation, stability and solute transport (2) membrane protein structure, (3) lipid-protein interactions, (4) bioenergetics and transmembrane transport mechanisms, and (5) specific examples of membrane protein systems and their function (channels, transporters, pumps, receptors). Emphasis will be placed on biophysical approaches in these areas. The primary literature will be the main source of reading.
Instructor(s): E. Perozo Terms Offered: Autumn
Equivalent Course(s): MGCB 32300

BCMB 32600. Methods in Structural Biology. 100 Units.
This course aims to provide students with the theoretical and applied knowledge on the use of modern structural biology methods, namely x-ray crystallography, cryo-electron microscopy and nuclear magnetic resonance spectroscopy. The course includes lectures and hands-on laboratory sessions, including a data-collection visit to the synchrotron at Argonne National Lab, collection of microscopy images at the Advanced Electron Microscopy Facility at UChicago, and data collection at our local NMR facility. The lectures will include x-ray diffraction theory, strategies to solve the phase problem, principles of electron microscopy and optics, single particle analysis, tomography, various NMR techniques and structure calculations from 3D spectra, model building and validation, and recent advances. The laboratory sessions will take registered students from sample preparation to model refinement and building using state-of-the-art experimental and computational tools. Basic knowledge of protein chemistry (as provided in BCMB 30400) strongly recommended.
Instructor(s): Minglei Zhao, Engin Özkan, Stephen Meredith, Joseph Sachleben Terms Offered: Spring 2019

BCMB 32800. Introduction to Data Science in Biochemistry and Biophysics. 100 Units.
This course will introduce students to exploratory computational data analysis in biochemistry. We will begin with exploration of example datasets in the R programming language for statistics. We will cover approaches to wrangle data into shape for analysis, to develop models that explain trends in data sets, and finally to refining our graphical presentation and preparing analysis reports and figures for publication. A middle segment will cover best practices with tooling and workflows, including navigating the shell in Linux/Unix/BSD systems. Finally, we will introduce students to the Julia programming language, which is useful for more complex problems where expressiveness and performance matter. The course will follow a lecture format, with live, in class exercises.
Instructor(s): Ronald Rock Terms Offered: Spring

BCMB 39800. Selected Reading Topics: Biochemistry & Molecular Biology. 100 Units.
Subject matter for individual tutorial-based study is selected through prior consultation and is given under the guidance of a faculty member. The student and faculty member must indicate at time of registration whether the course will be taken on a letter grade or pass/fail basis.
Instructor(s): Staff Terms Offered: Summer, Autumn, Winter, Spring
Prerequisite(s): Consent of Department and Instructor

BCMB 39900. Intro To Research: BCMB. 300.00 Units.
Subject matter for individual tutorial-based study is selected through prior consultation and is given under the guidance of a faculty member. The student and faculty member must indicate at time of registration whether the course will be taken on a letter grade or pass/fail basis.

BCMB 40100. Research in Biochemistry and Molecular Biology. 300.00 Units.
The student conducts original investigation under the direction of a faculty member. The research is presented and defended as a dissertation in candidacy for the degree of Doctor of Philosophy.
Instructor(s): Staff Terms Offered: Summer, Autumn, Winter, Spring
Prerequisite(s): Completion of course requirements and Preliminary Examination at the Ph.D. level and approval of Chairman of the Department.

BCMB 70000. Advanced Study: Biochemistry & Molecular Biology. 300.00 Units.
Advanced Study: Biochemistry & Molecular Biology