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
- Demet Arac-Ozkan

Assistant Professors
- 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.
Admission

For information about applying to our graduate program, please visit our website at http://bcmb.uchicago.edu (http://collegecatalog.uchicago.edu).

Degrees

DOCTOR OF PHILOSOPHY

A Ph.D. program requires generally 4 to 6 years of study. In the first year, students engage in course work and small research projects in several laboratories to become acquainted with the department. Also during the first year there are many opportunities to attend departmental seminars and the Graduate Student Seminar Series and to participate in the visits of invited speakers. In the summer quarter of the first year students engage in the preliminary examination, in which they develop, write, and defend an original research proposal. After successful completion of the preliminary examination, students choose a research advisor, carry out their Ph.D. research in the advisor’s laboratory, and write and orally defend a thesis.

Four of the following courses are required:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
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<tbody>
<tr>
<td>BCMB 30400</td>
<td>Protein Fundamentals</td>
<td>100</td>
</tr>
<tr>
<td>BCMB 31600</td>
<td>Cell Biology I</td>
<td>100</td>
</tr>
<tr>
<td>BCMB 30600</td>
<td>Nucleic Acid Structure and Function</td>
<td>100</td>
</tr>
<tr>
<td>BCMB 31200</td>
<td>Molecular Biology I</td>
<td>100</td>
</tr>
<tr>
<td>BCMB 32200</td>
<td>Biophysics of Biomolecules</td>
<td>100</td>
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Protein Fundamentals (Fall), Biophysical Properties of Biomolecules (Spring), one course in Cell Biology, and one of the following: Nucleic Acids Structure and Function OR a course in Molecular Biology.

Two additional courses (BCMB 31900 – Introduction to Faculty Research, also called “Faculty All Stars” and BCMB 31800 – Current Seminar Topics in Biochemistry and Molecular Biology) are required. The introduction to faculty research course is not for credit; however, BCMB 31800 is for ½ credit. Each student is required to be a teaching assistant for a total of two quarters in their third and fourth years of residence.

The preliminary examination in BMB consists of a written research proposal that is prepared and submitted during the summer quarter of the first year (the fourth quarter in residence). Students (including ISTP students interested in joining BMB) will be permitted to take the preliminary examination only after all course and grade requirements have been met. The exam consists of a concise written research proposal and an oral defense of the proposal. Students are expected to demonstrate their ability to 1) identify a scientific problem, 2) propose experiments to address the problem, 3) interpret potential outcomes from the experiments, and 4) frame the question and results in a broader scientific context. In addition, students are evaluated on their ability to convey their ideas clearly in the written proposal and to defend the proposal orally. The chairperson of each exam committee will then contact the student regarding the outcome of their exam and provide written feedback. Two outcomes are possible: Pass or Revisions Needed. If revisions are required, the student will have the opportunity to respond to the committee’s concerns and either revise portions of the proposal or re-write the entire proposal as indicated by the committee. In these cases, students will need to write a cover letter addressing the concerns of the committee and the changes that have been made. In addition, students may be required to re-defend the revisions orally with part or all of the exam committee. If a student is asked to re-write and re-defend the entire proposal, an additional faculty member will be added to the exam committee. Inadequate performance on a second exam is grounds for dismissal from the program. For continuation in the program, students must successfully pass the Preliminary Examination by the end of the fifth quarter of full-time residence as a graduate student in biochemistry and molecular biology.

During the second year, students select a thesis advisor and begin laboratory research. To complete the Ph.D. degree, they must prepare, under the general direction of an appointed doctoral committee, a dissertation based upon their original research. A public seminar describing the results of the dissertation research must be presented and the dissertation must be successfully defended before the doctoral committee.

BIOCHEMISTRY AND MOLECULAR BIOLOGY COURSES

BCMB 30400. Protein Fundamentals. 100 Units.
The course covers the physical chemical phenomena that define protein structure and function. Topics include: three-dimensional structures of proteins; the principles of protein folding, molecular motion and molecular recognition; protein evolution, design and engineering; enzyme catalysis; regulation of protein function; proteomics and systems biology. Undergraduates are highly recommended to take BIOS 20200 (Introduction to Biochemistry) or equivalent before taking this course.
Instructor(s): E. Ozkan, J. Piccirilli, D. Arac Terms Offered: Autumn
Equivalent Course(s): HGEN 30400, MGCB 30400
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.
Instructor(s): Staff Terms Offered: Autumn,Winter
Equivalent Course(s): MCGB 31900, HGEN 31900, GENE 31900, DVBI 31900

BCMB 32200. Biophysics 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): BPHS 31000, BIOS 21328

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 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 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: Autumn Spring Summer Winter
Prerequisite(s): Completion of course requirements adn 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