

GRADUATE PROGRAM IN BIOPHYSICAL SCIENCES

Chair

- Tobin R. Sosnick

WEBSITE ([HTTP://BIOPHYSICS.UCHICAGO.EDU/](http://biophysics.uchicago.edu/))

The Graduate Program in Biophysical Sciences is designed to transcend traditional departmental boundaries for the purpose of training scientists who will excel at addressing biological problems using quantitative and physical approaches. The program, which grants a Ph.D. degree from both the Biological and Physical Science Divisions, serves the needs of students who have strong backgrounds in the physical sciences and are intrigued by the interface of the physical, biological and computational sciences. Dual mentorship is a fundamental component of the program. Each student chooses a pair of dissertation advisors from across our diverse faculty and fully participates in both of these research groups.

The participating faculty in the program are drawn from The Physical and The Biological Sciences Divisions, and Argonne National Laboratory and hold appointments in:

DEPARTMENTS & COMMITTEES

- Ben May Dept. for Cancer Research
- Biochemistry & Molecular Biology
- Chemistry
- Computer Science
- Ecology and Evolution
- Geophysical Sciences
- Human Genetics
- Mathematics
- Medicine
- Microbiology
- Molecular Genetics and Cell Biology
- Neurobiology
- Organismal Biology and Anatomy
- Pathology
- Physics
- Statistics

INSTITUTES & CENTERS

- Inst. for Biophysical Dynamics
- Inst. for Genomics & Systems Biology
- James Franck Institute
- Materials Research Science & Engineering Center
- Pritzker Institute for Molecular Engineering
- Center for Physics of Evolving Systems
- Quantum Leap Challenge Institute
- Center for Living Systems

CURRICULUM

The curriculum assumes that entering students are well-grounded in the physical sciences. During the first year, students are expected to take one class per quarter from both the Biological Sciences Division and the Physical Sciences Division (6 courses total). The Biological Organization Series consists of courses chosen to rapidly teach the fundamental biology necessary to enter a laboratory and begin serious interdisciplinary research. To build upon students' strengths in the physical sciences, the first year includes three courses chosen from a list of graduate courses offered in Chemistry or Physics. The curriculum can be modified to fit the strengths and weaknesses in a student's background.

Students undertake a series of laboratory rotations as part of the process of identifying a dissertation topic. These rotations are usually performed during the Winter and Spring Quarters during the first academic year.

INTERDISCIPLINARY PRACTICAL TRAINING

One of the unique advantages of the program is the 3 quarter laboratory course: From Production to Measurement and Analysis. In this intense, 16 hour a week course students deeply explore a series of important current instruments and techniques while carrying out the systematic characterization of several genes and their expressed proteins. The genes are chosen from the long list of "unknown ORFs" - open reading frames that have been predicted by genome sequencing projects, but have never been examined further.

The laboratory course is managed by a full-time course director who works closely with the students to provide experimental and intellectual continuity. The laboratory course covers (1) sample preparation and high throughput selection methods (e.g. engineering, expression, synthesis, and labeling of proteins and nucleic acids) and high throughput selection methods (phage display, in vitro selection); (2) measurement (spectroscopy and imaging including single molecule methods, NMR, x-ray diffraction, and mass spectrometry, etc.); and (3) computational approaches (extracting information from large data sets, bioinformatics, simulation and modeling). Although it is impossible to cover all biophysical methods, the process of mastering a subset of the important techniques gives students the confidence and foundation to build in any direction.

The first section of this course is the four-week Biological Research Immersion, which starts in late August and ends before the start of Fall Quarter. The course continues through the Autumn and Winter Quarters.

The program in Biophysical Sciences is an inherently collaborative training program, and the foundation of collaboration is the ability to coherently express complex ideas. As part of the laboratory course, students are expected to give frequent presentations, both oral and written: Analysis of recent papers, background preparation before research seminars, overviews of upcoming experimental techniques, experimental proposals, and presentations of results. As a group, students also participate in two large projects during the year - building an advanced optical instrument from basic components, and writing a software package to simulate a biological process.

DUAL MENTORSHIP

In order to truly bridge the expertise and approach of two scientific fields it is necessary to fully participate in both. The research program each professor maintains is a vibrant and dedicated research group whose members share in the daily successes and frustrations of their related questions. It is this shared intellectual exertion that moves a subject forward, and it is this environment that most efficiently teaches the deepest understanding. In our experience, this dual mentorship creates an unparalleled learning structure and will lead to the development of unimagined science.

For a list of trainers and their affiliations, details about admissions, and current information about this new and innovative program, see <http://biophysics.uchicago.edu/>

COURSE REQUIREMENTS AND GRADING POLICY

The didactic portion of the required curriculum is intended to be accomplished in the first year of the program. This curriculum includes the Lab Course, three graduate level biological sciences selectives and three graduate physical sciences selectives, including a course in molecular biophysics. Appropriate selective courses are determined on an individual basis after consultation with the Curriculum Director and may vary based on the student's preparation and research plan. Students must maintain a GPA of 3.0 in courses taken towards fulfillment of didactic course requirements.

BIOPHYSICAL SCIENCES COURSES

BPHS 30900. Electronic Instrumentation in Biophysics. 100 Units.

The purpose of this course is to acquire a basic knowledge of linear circuit analysis, analog and digital electronics with practical applications in instrumentation used in electrophysiology and biophysical research. Lectures are complemented with practical laboratories that include building and analysis of circuits and simulations in computers. Students are asked to design and build a practical instrument at the end of the course. Grading is based on class and laboratory participation, a test and on the construction of a practical device.
Instructor(s): Bezanilla, Francisco Terms Offered: Autumn
Equivalent Course(s): NEUR 30900, BCMB 30900

BPHS 31000. 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. Sosnick Terms Offered: Spring
Equivalent Course(s): BCMB 32200, BIOS 21328

BPHS 33000. Ethical tools for research and mentoring. 50 Units.

Ethical considerations of research for advanced graduate students in the Biophysical Sciences graduate program.

BPHS 35001. Synthesis and Modification. 200 Units.

This course is 20 hours per week of intensive training in research in the biological sciences, intended for first year students in the Biophysical Sciences Program who typically have majored in one of the physical sciences and

want to pursue a PhD project at the interface between the physical and biological sciences. The course continues through Winter quarter.

Instructor(s): A. Hammond Terms Offered: Autumn, Winter

Note(s): Open to first year BPHS students only

BPHS 35002. Synthesis and Modification. 200 Units.

BPHS 39800. Topics: Research in Biophysical Sciences. 300.00 Units.

Laboratory Rotations

BPHS 39900. Introduction to Research: BPHS. 300.00 Units.

Qualifying Examination Preparation

BPHS 40100. Research in Biophysical Sciences. 300.00 Units.

PhD Thesis Research

BPHS 40500. Research Presentations. 50 Units.

BPHS 47300. Genomics and Systems Biology. 100 Units.

This lecture course explores technologies for high-throughput collection of genomic-scale data, including sequencing, genotyping, gene expression profiling, and assays of copy number variation, protein expression and protein-protein interaction. In addition, the course will cover study design and statistic analysis of large data sets, as well as how data from different sources can be used to understand regulatory networks, i.e., systems. Statistical tools that will be introduced include linear models, likelihood-based inference, supervised and unsupervised learning techniques, methods for assessing quality of data, hidden Markov models, and controlling for false discovery rates in large data sets. Readings will be drawn from the primary literature. Evaluation will be based primarily on problem sets.

Instructor(s): Yang Li Sebastian Pott Joshua A. Weinstein Terms Offered: Spring

Prerequisite(s): Three quarters of a Biological Sciences Fundamentals sequence including BIOS 20171, BIOS 20187 or BIOS 20235 and STAT 23400 or BIOS 26210 and BIOS 26211

Note(s): CB.

Equivalent Course(s): CABI 47300, IMMU 47300, BIOS 28407, HGEN 47300

BPHS 70000. Advanced Study: Biophysical Sciences. 300.00 Units.

Advanced Study: Biophysical Sciences

