

# BIOCHEMISTRY

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Courses offered by the Department of Biochemistry have the subject code BIOC, and are listed in the "Biochemistry (BIOC) Courses" section of this bulletin.

Biochemistry is a department within the School of Medicine, with offices and labs located in the Beckman Center for Molecular and Genetic Medicine at the Stanford Medical Center. Courses offered by the department may be taken by undergraduate, graduate, and medical school students.

Advanced courses offered in more specialized areas emphasize recent developments in biochemistry, cell biology, and molecular biology. These courses include the physical and chemical principles of biochemistry, enzyme reaction mechanisms, membrane trafficking and biochemistry, molecular motors and the cytoskeleton, mechanisms and regulation of nucleic acid replication and recombination, the biochemistry of bacterial and animal viruses, the molecular basis of morphogenesis, the molecular and cell biology of yeast, and the structure and function of both eukaryotic and prokaryotic chromosomes.

Opportunities exist for directed reading and research in biochemistry and molecular biology, utilizing the most advanced research facilities, including those for light and electron microscopy, chromatography and electrophoresis, protein and nucleic acid purification, rapid kinetic analysis, synthesis and analysis, single molecule analyses using laser light traps, microarray generation and analysis and computer graphic workstation facilities for protein and nucleic acid structural analysis. Ongoing research utilizes a variety of organisms, from bacteria to animal cells.

## GRADUATE PROGRAM IN BIOCHEMISTRY

### DOCTOR OF PHILOSOPHY IN BIOCHEMISTRY

Requirements for the M.S. and Ph.D. degrees are described in the "Graduate Degrees" section of this bulletin. The department does not offer undergraduate degrees.

The Department of Biochemistry offers a Ph.D. program which begins in the Autumn Quarter of each year. The program of study is designed to prepare students for productive careers in biochemistry; its emphasis is training in research, and each student works closely with members of the faculty. In addition to the requirement for a Ph.D. dissertation based on original research, students are required to complete six advanced courses in biochemistry and related areas among the 135 total units required for the Ph.D. Selection of these courses is tailored to fit the background and interests of each student. A second requirement involves the submission of two research proposals which are presented by the student to a small committee of departmental faculty members who are also responsible for monitoring the progress of student curricular and research programs, and a journal club presentation. All Ph.D. students are expected to participate actively in the department's seminar program, and students are encouraged to attend and to present papers at regional and national meetings in cellular biochemistry and molecular biology. Teaching experience is an integral part of the Ph.D. curriculum and is required for the degree.

The Department of Biochemistry offers an M.S. degree only to students already enrolled in the Ph.D. program. Students should contact the Graduate Studies adviser for more details.

Those applying for graduate study should have at least a baccalaureate degree and should have completed work in cell and developmental biology, basic biochemistry and molecular biology, and genetics. Also required are: at least one year of university physics; differential and integral calculus; and analytical, organic, inorganic, and physical chemistry. The department is especially interested in those applicants who have research experience in biology or chemistry. Students must submit an application, including transcripts and letters of recommendation, by December 2.

Applications should be submitted at <http://gradadmissions.stanford.edu>. Applicants are notified by March 27 of decisions on their applications. Stanford University requires scores from the Graduate Record Examination (GRE) (verbal, quantitative, and analytical), and applicants are encouraged to submit scores from the GRE Subject Test in either biochemistry, biology, or chemistry. Applicants should take the October GRE exam.

All applicants are urged to compete for non-Stanford fellowships or scholarships, and U.S. citizens should complete an application for a National Science Foundation Predoctoral Traineeship. Students are provided with financial support to cover normal living expenses; Stanford tuition costs are paid. Applicants for admission to the department are considered without regard to race, color, creed, religion, sex, age, national origin, or marital status.

Postdoctoral research training is available to graduates who hold a Ph.D. or an M.D. degree. Qualified individuals may write to individual faculty members for further information.

At present, the primary research interests of the department are the structure and function of proteins and nucleic acids, the biochemistry and control of development processes, molecular motors and the cytoskeleton, the trafficking of proteins between membrane-bound organelles, the control and regulation of gene expression, bioinformatics/protein structure design, and the application of microarrays to problems in human health and disease.

## BIOCHEMISTRY (BIOC) COURSES

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For information on undergraduate and graduate programs in the Department of Biochemistry, see the "Biochemistry" section of this bulletin.

### UNDERGRADUATE COURSES IN BIOCHEMISTRY

#### BIOC 118Q. Genomics and Medicine

Stanford Introductory Seminar. Preference to sophomores. Knowledge gained from sequencing human, bacterial, and viral genomes and implications for medicine and biomedical research. Novel diagnoses (chips, SNPs and gene expression) and treatment of diseases including gene therapy, stem cell therapy, and rational drug design. Ethical implications of stem cell therapy and uses of genetic information. Use of genome and disease databases to determine gene function in disease, diagnosis, and potential treatments. See <http://biochem118.stanford.edu/>. GER:DB-EngrAppSci

3 units, Aut (Brutlag, D)

#### BIOC 199. Undergraduate Research

Students undertake investigations sponsored by individual faculty members. Prerequisite: consent of instructor.

1-18 units, Aut (Staff), Win (Staff), Spr (Staff), Sum (Staff)

## GRADUATE COURSES IN BIOCHEMISTRY

Primarily for graduate students; undergraduates may enroll with consent of instructor.

### **BIOC 201. Advanced Molecular Biology**

Literature-based lectures and discussion on rapidly developing frontiers in chromosome structure and function and modern insights into the control of gene expression. Emphasis is on experimental approaches and insights. Topics include chromosome organization, novel modes of transcriptional control, RNA-based mechanisms for controlling gene expression and emerging translational regulatory mechanisms. Prerequisite: undergraduate molecular biology.

*5 units, not given this year*

### **BIOC 210. Advanced Topics in Membrane Trafficking**

The structure, function, and biosynthesis of cellular membranes and organelles. Current literature. Prerequisite: consent of instructor.

*3 units, not given this year*

### **BIOC 215. Frontiers in Biological Research**

(Same as DBIO 215, GENE 215.) Literature discussion in conjunction with the Frontiers in Biological Research seminar series hosted by Biochemistry, Developmental Biology, and Genetics in which distinguished investigators present current work. Students and faculty meet beforehand to discuss papers from the speaker's primary research literature. Students meet with the speaker after the seminar to discuss their research and future direction, commonly used techniques to study problems in biology, and comparison between the genetic and biochemical approaches in biological research.

*1 unit. Aut (Harburv, P; Tan, M; Villeneuve, A), Win (Harbury, P; Tan, M; Villeneuve, A)*

### **BIOC 218. Computational Molecular Biology**

(Same as BIOMEDIN 231.) Via Internet. For molecular biologists and computer scientists. Representation and analysis of genomes, sequences, and proteins. Strengths and limitations of existing methods. Course work performed on web or using downloadable applications. See <http://biochem218.stanford.edu/>. Prerequisites: introductory molecular biology course at level of BIO 41 or consent of instructor.

*3 units, Aut (Brutlag, D), Win (Brutlag, D), Spr (Brutlag, D)*

### **BIOC 220. Chemistry of Biological Processes**

(Same as CSB 220.) The principles of organic and physical chemistry as applied to biomolecules. Goal is a working knowledge of chemical principles that underlie biological processes, and chemical tools used to study and manipulate biological systems. Prerequisites: organic chemistry and biochemistry, or consent of instructor.

*4 units, Spr (Wandless, T; Herschlag, D; Chen, J), alternate years, not given next year*

### **BIOC 221. The Teaching of Biochemistry**

Required for teaching assistants in Biochemistry. Practical experience in teaching on a one-to-one basis, and problem set design and analysis. Familiarization with current lecture and text materials; evaluations of class papers and examinations. Prerequisite: enrollment in the Biochemistry Ph.D. program or consent of instructor.

*3 units, Aut (Staff), Win (Staff), Spr (Staff), Sum (Staff)*

### **BIOC 224. Advanced Cell Biology**

(Same as BIO 214.) For Ph.D. students. Current research on cell structure, function, and dynamics. Topics include complex cell phenomena such as cell division, apoptosis, compartmentalization, transport and trafficking, motility and adhesion, differentiation, and multicellularity. Current papers from the primary literature. Prerequisite for advanced undergraduates: BIO 129A,B, and consent of instructor.

*2-5 units. Win (Kopito, R; Pfeffer, S; Nelson, W; Theriot, J; Straight, A)*

### **BIOC 225. Interdisciplinary Approaches to Cell Biology: the Role of the Cytoskeleton**

The molecular basis of energy transduction leading to movements generated by microfilament-based and microtubule-based motors. Forms of myosin, dynein, and kinesin and their roles in the cell as a model for understanding the structural, biochemical, and functional

properties of biological machines. Topics: structure of the molecular motors and their accessory proteins; regulation of the function of motile assemblies; functions of molecular motors in cells; spatial and temporal controls on the formation of motile assemblies in cells. Experimental approaches: genetic analysis, DNA cloning and expression, reconstitution of functional assemblies from purified proteins, x-ray diffraction, three-dimensional reconstruction of electron microscope images, spectroscopic methods, high-resolution light microscopy, and computational approaches. Prerequisites: basic biochemistry and cell biology.

*3 units, not given this year*

### **BIOC 228. Computational Genomic Biology**

(Same as BIOMEDIN 228.) Application of computational genomics methods to biological problems. Topics include: assembly of genomic sequences; genome databases; comparative genomics; gene discovery; gene expression analyses including gene clustering by expression, transcription factor binding site discovery, metabolic pathway discovery, functional genomics, and gene and genome ontologies; and medical diagnostics using SNPs and gene expression. Recent papers from the literature and hands-on use of the methods. Prerequisites: introductory course in computational molecular biology or genomics such as BIOC 218, BIOMEDIN 214 or GENE 211.

*3 units, Win (Brutlag, D)*

### **BIOC 230. Molecular Interventions in Human Disease**

For M.D. students who intend to declare a concentration in molecular basis of medicine, MSTP students, and Ph.D. students. Advanced medical biochemistry focusing on cases where molecular-level research has led to new medical treatments or changes in the understanding of important diseases. Different topics each week explore the underlying molecular basis of a variety of diseases and the reasons for success and failure in molecular approaches to treatment. Student-led discussions dissect papers from the primary medical and scientific research literature.

*2-3 units, Aut (Theriot, J; Harbury, P)*

### **BIOC 236. Biology by the Numbers**

(Same as APPPHYS 136.) Skillbuilding in biological quantitative reasoning. Topics include: biological size scales from proteins to ecosystems; biological time scales from enzymatic catalysis and DNA replication to evolution; biological energy, motion, and force from molecular to organismic scales; mechanisms of environmental sensing from bacterial chemotaxis to vision. Prerequisite: Physics 21, 41, or consent of instructor.

*3 units, Win (Theriot, J; Fisher, D)*

### **BIOC 238. Computational Proteomic Biology**

(Same as BIOMEDIN 238.) Application of computational protein analysis to biological problems. Topics include: protein sequence analysis and comparison including protein sequence databases, amino acid composition, protein alignment, protein motifs, protein families, and probabilistic models of families; protein structure including structure comparison and superposition methods, structural motifs, and structure and domain databases; protein structure prediction including secondary structure, homology modeling, threading, and ab initio structure prediction; protein-protein interaction databases and protein-protein interaction prediction; and protein-DNA interaction motifs and protein-ligand docking. Prerequisite: An introductory course in computational biology such as BIOC 218, BIOMEDIN 214, or SBIO/BIOPHYS 228. Via Internet in Spring.

*3 units, not given this year*

### **BIOC 241. Biological Macromolecules**

(Same as BIOPHYS 241, SBIO 241.) The physical and chemical basis of macromolecular function. Forces that stabilize biopolymers with three-dimensional structures and their functional implications. Thermodynamics, molecular forces, and kinetics of enzymatic and diffusional processes, and relationship to their practical application in experimental design and interpretation. Biological function and at the level of individual molecular interactions and at the level of complex processes. Case studies. Prerequisites: introductory biochemistry and physical chemistry or consent of instructor.

*3-5 units. Aut (Herschlag, D; Puglisi, J; Garcia, K; Ferrell, J; Block, S; Weis, W)*

**BIOC 257. Currents in Biochemistry**

Seminars by Biochemistry faculty on their ongoing research. Background, current advances and retreats, general significance, and tactical and strategic research directions.

*1 unit, Aut (Spudich, J)*

**BIOC 278. Systems Biology**

(Same as BIOE 310, CS 278, CSB 278.) Complex biological behaviors through the integration of computational modeling and molecular biology. Topics: reconstructing biological networks from high-throughput data and knowledge bases. Network properties. Computational modeling of network behaviors at the small and large scale. Using model predictions to guide an experimental program. Robustness, noise, and cellular variation. Prerequisites: background in biology and mathematical analysis.

*3 units, Aut (Covert, M; Dill, D; Brutlag, D; Ferrell, J)*

**BIOC 298. Biochemistry Consulting Service**

Students are presented with requests for advice from faculty and students in the biological sciences and Medical School encountering experimental and analytical problems in their research. Students work with the instructor and other biochemistry faculty to propose solutions. May be repeated for credit.

*3 units, Aut (Brown, P), Win (Brown, P), Spr (Brown, P), Sum (Brown, P)*

**BIOC 299. Directed Reading in Biochemistry**

Prerequisite: consent of instructor.

*1-18 units, Aut (Staff), Win (Staff), Spr (Staff), Sum (Staff)*

**BIOC 399. Graduate Research and Special Advanced Work**

Allows for qualified students to undertake investigations sponsored by individual faculty members.

*1-18 units, Aut (Staff), Win (Staff), Spr (Staff), Sum (Staff)*

**BIOC 459. Frontiers in Interdisciplinary Biosciences**

(Same as BIO 459, BIOE 459, CHEMENG 459, CHEM 459, PSYCH 459.) Students register through their affiliated department; otherwise register for CHEMENG 459. For specialists and non-specialists. Sponsored by the Stanford BioX Program. Three seminars per quarter address scientific and technical themes related to interdisciplinary approaches in bioengineering, medicine, and the chemical, physical, and biological sciences. Leading investigators from Stanford and the world present breakthroughs and endeavors that cut across core disciplines. Pre-seminars introduce basic concepts and background for non-experts. Registered students attend all pre-seminars; others welcome. See <http://biox.stanford.edu/courses/459.html>. Recommended: basic mathematics, biology, chemistry, and physics.

*1 unit, Aut, Win, Spr (Robertson, C)*