

# Biochemistry

Courses offered by the Department of Biochemistry are listed under the subject code BIOC on the (<http://explorecourses.stanford.edu/CourseSearch/search?view=catalog&catalog=&page=0&q=BIOC&filter-catalognumber-BIOC=on>) Stanford Bulletin's (<http://explorecourses.stanford.edu/CourseSearch/search?view=catalog&catalog=&page=0&q=BIOC&filter-catalognumber-BIOC=on>) ExploreCourses web site (<http://explorecourses.stanford.edu/CourseSearch/search?view=catalog&catalog=&page=0&q=BIOC&filter-catalognumber-BIOC=on>).

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 undergraduates as well as 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, using 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 uses a variety of organisms from bacteria to animal cells.

## Doctor of Philosophy in Biochemistry

Requirements for the M.S. and Ph.D. degrees are described in the "Graduate Degrees (<http://exploreddegrees.stanford.edu/graduatedegrees>)" 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 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 for admission in the following Autumn Quarter.

Applications should be submitted at the Office of Graduate Admissions (<http://gradadmissions.stanford.edu>) web site. Applicants are notified by March 31 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 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.

*Emeriti: (Professors): Robert L. Baldwin, Paul Berg, Douglas L. Brutlag, David S. Hogness, A. Dale Kaiser, I. Robert Lehman*

*Chair: Suzanne R. Pfeffer*

*Professors: Steven Artandi, Philip Beachy, Patrick O. Brown, Gilbert Chu, Ronald W. Davis, James E. Ferrell, Jr., Daniel Herschlag, Peter Kim, Mark A. Krasnow, Suzanne R. Pfeffer, James A. Spudich, Julie A. Theriot*

*Associate Professors: Pehr A. B. Harbury, Aaron F. Straight*

*Assistant Professors: Onn Brandman, Rhiju Das, Rajat Rohatgi, Julia Salzman, Ellen Yeh*

*Courtesy Professors: Chaitan S. Khosla, Sharon Long*

## Courses

### **BIOC 109A. The Human Genome and Disease. 3 Units.**

The variability of the human genome and the role of genomic information in research, drug discovery, and human health. Concepts and interpretations of genomic markers in medical research and real life applications. Human genomes in diverse populations. Original contributions from thought leaders in academia and industry and interaction between students and guest lecturers. Students with a major, minor or cotermin in Biology: 109A/209A or 109B/209B may count toward degree program but not both.

Same as: BIO 109A, BIOC 209A, HUMBIO 158

**BIOC 109B. The Human Genome and Disease: Genetic Diversity and Personalized Medicine. 3 Units.**

Continuation of 109A/209A. Genetic drift: the path of human predecessors out of Africa to Europe and then either through Asia to Australia or through northern Russia to Alaska down to the W. Coast of the Americas. Support for this idea through the histocompatibility genes and genetic sequences that predispose people to diseases. Guest lectures from academia and pharmaceutical companies. Prerequisite: Biology or Human Biology core. Students with a major, minor or cotermin in Biology: 109A/209A or 109B/209B may count toward degree program but not both. Same as: BIO 109B

**BIOC 118Q. Genomics and Medicine. 3 Units.**

Preference to sophomores. Knowledge gained from sequencing human genomes and implications for medicine and biomedical research. Novel diagnoses and treatment of diseases, including stem cells, gene therapy and rational drug design. Personal genomics and how it is used to improve health and well being. Social and ethical implications of genetic information such as privacy, discrimination and insurability. Course Webpage: <http://biochem118.stanford.edu/>.

**BIOC 199. Undergraduate Research. 1-18 Unit.**

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

**BIOC 200. Applied Biochemistry. 2 Units.**

Enrollment limited to MD candidates. Fundamental concepts of biochemistry as applied to clinical medicine. Topics include vitamins and cofactors, metabolism of carbohydrates, lipids, amino acids and nucleotides, and the integration of metabolic pathways. Clinical case studies discussed in small-group, problem-based learning sessions.

**BIOC 202. Biochemistry Bootcamp. 1 Unit.**

Open to first year Biochemistry students and to other PhD students with consent of instructor. Hands-on, week-long immersion in biochemical methods and practice, high-throughput sequencing and data analysis, theory and application of light microscopy, and computational approaches to modern biological problems.

**BIOC 205. Molecular Foundations of Medicine. 3 Units.**

For medical students. Topics include DNA structure, replication, recombination, and repair; gene expression via transcription and translation; biotechnology; and genomics. Patient presentations, journal clubs, and class presentations discuss the impact of molecular biology on medicine.

**BIOC 209A. The Human Genome and Disease. 3 Units.**

The variability of the human genome and the role of genomic information in research, drug discovery, and human health. Concepts and interpretations of genomic markers in medical research and real life applications. Human genomes in diverse populations. Original contributions from thought leaders in academia and industry and interaction between students and guest lecturers. Students with a major, minor or cotermin in Biology: 109A/209A or 109B/209B may count toward degree program but not both. Same as: BIO 109A, BIOC 109A, HUMBIO 158

**BIOC 215. Frontiers in Biological Research. 1 Unit.**

Students analyze cutting edge science, develop a logical framework for evaluating evidence and models, and enhance their ability to design original research through exposure to experimental tools and strategies. The class runs in parallel with the Frontiers in Biological Research seminar series. Students and faculty meet on the Tuesday preceding each seminar to discuss a landmark paper in the speaker's field of research. Following the Wednesday seminar, students meet briefly with the speaker for a free-range discussion which can include insights into the speakers' paths into science and how they pick scientific problems. Same as: DBIO 215, GENE 215

**BIOC 220. Chemistry of Biological Processes. 3 Units.**

The principles of organic and physical chemistry as applied to biomolecules. The goal is a working knowledge of chemical principles that underlie biological processes, and chemical tools used to study and manipulate biological systems. Current topics may include chemical genetics, activity-based probes, DNA/RNA chemistry and molecular evolution, protein labeling, carbohydrate engineering, fluorescent proteins and sensors, optochemical/optogenetic methods, mass spectrometry, and genome-editing technologies. Prerequisites: organic chemistry and biochemistry, or consent of instructor. Same as: CSB 220

**BIOC 221. The Teaching of Biochemistry. 3 Units.**

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.

**BIOC 223. Open Problems in Biology. 1 Unit.**

Introduces open problems in biology to those outside the field with quantitative backgrounds (e.g. science, computer science, engineering, and mathematics). Ten different experts cover ten different topics.

**BIOC 224. Advanced Cell Biology. 4 Units.**

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, and differentiation. Weekly reading of current papers from the primary literature. Preparation of an original research proposal. Prerequisite for advanced undergraduates: BIO 129A,B, and consent of instructor. Same as: BIO 214, MCP 221

**BIOC 236. Biology by the Numbers. 3 Units.**

For PhD students and advanced undergraduates. Students will develop skills in quantitative reasoning over a wide range of biological problems. Topics: biological size scales ranging from proteins to ecosystems; biological times time scales ranging from enzymatic catalysis and DNA replication to evolution; biological energy, motion and force from molecular to organismic scales; mechanisms of environmental sensing ranging from bacterial chemotaxis to vision. Same as: APPPHYS 236

**BIOC 241. Biological Macromolecules. 3-5 Units.**

The physical and chemical basis of macromolecular function. Topics include: forces that stabilize macromolecular structure and their complexes; thermodynamics and statistical mechanics of macromolecular folding, binding, and allostery; diffusional processes; kinetics of enzymatic processes; the relationship of these principles to practical application in experimental design and interpretation. The class emphasizes interactive learning, and is divided equally among lectures, in-class group problem solving, and discussion of current and classical literature. Enrollment limited to 50. Prerequisites: Background in biochemistry and physical chemistry recommended but material available for those with deficiency in these areas; undergraduates with consent of instructor only. Same as: BIOPHYS 241, GENE 241, SBIO 241

**BIOC 257. Currents in Biochemistry. 1 Unit.**

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

**BIOC 299. Directed Reading in Biochemistry. 1-18 Unit.**

Prerequisite: consent of instructor.

**BIOC 350. Development of Thesis Research. 2 Units.**

Biochemistry 2nd year PhD students with permission of instructor only. Students place their thesis research into a broader scientific perspective, identify important questions to ask, and learn to communicate these clearly. The course includes a series of roundtable discussions with students and faculty about the students' proposed research topics. The initial focus is on developing the equivalent of a specific aims page for a research grant.

**BIOC 360. Developing an Original Research Proposal. 1 Unit.**

Biochemistry 3rd year PhD students with permission of instructor only. Students foster broad familiarity with the biomedical literature and learn to develop new research directions. Topics well outside of each student's research topic are chosen for regular informal journal club presentations. Students work with faculty to hone skills for identifying important open scientific questions, formulating hypotheses, and refining experimental logic. Students work collectively to create a "model" research proposal on a topic of general interest to the group, and then individually to develop an original proposal on a topic of each student's choice.

**BIOC 370. Medical Scholars Research. 4-18 Units.**

Provides an opportunity for student and faculty interaction, as well as academic credit and financial support, to medical students who undertake original research. Enrollment is limited to students with approved projects.

**BIOC 399. Graduate Research and Special Advanced Work. 1-18 Unit.**

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

**BIOC 459. Frontiers in Interdisciplinary Biosciences. 1 Unit.**

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.

Same as: BIO 459, BIOE 459, CHEM 459, CHEMENG 459, PSYCH 459

**BIOC 801. TGR Project. 0 Units.**

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**BIOC 802. TGR Dissertation. 0 Units.**

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