

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, the Shriram Center for Bioengineering and Chemical Engineering, and the Stanford Genome Technology 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. The Biochemistry Department has made scores from the general Graduate Record Examination (GRE) (verbal, quantitative, and analytical) optional on our application.

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.

The Department of Biochemistry focuses on the molecular basis of life, by studying the structures and functions of proteins and nucleic acids, the control of development, molecular motors and the cytoskeleton, trafficking of proteins between organelles, regulation of gene expression, protein homeostasis, structure and design, genetic and epigenetic control of chromosome function, and the application of genomics, all towards the understanding of health and disease.

COVID-19 Policies

On July 30, the Academic Senate adopted grading policies effective for all undergraduate and graduate programs, excepting the professional Graduate School of Business, School of Law, and the School of Medicine M.D. Program. For a complete list of those and other academic policies relating to the pandemic, see the "COVID-19 and Academic Continuity (<http://exploreddegrees.stanford.edu/covid-19-policy-changes/#tempdeptemplatetabtext>)" section of this bulletin.

The Senate decided that all undergraduate and graduate courses offered for a letter grade must also offer students the option of taking the course for a "credit" or "no credit" grade and recommended that deans, departments, and programs consider adopting local policies to count courses taken for a "credit" or "satisfactory" grade toward the fulfillment of degree-program requirements and/or alter program requirements as appropriate.

Graduate Degree Requirements

Grading

The Biochemistry Department counts all courses taken in academic year 2020-21 with a grade of 'CR' (credit) or 'S' (satisfactory) towards satisfaction of graduate degree requirements that otherwise require a letter grade provided that the instructor affirms that the work was done at a 'B-' or better level.

Graduate Advising Expectations

The Department of Biochemistry is committed to providing academic advising in support of graduate student scholarly and professional development. When most effective, this advising relationship entails collaborative and sustained engagement by both the adviser and the advisee. As a best practice, advising expectations should be periodically discussed and reviewed to ensure mutual understanding. Both the adviser and the advisee are expected to maintain professionalism and integrity.

Faculty advisers guide students in key areas such as selecting courses, designing and conducting research, developing of teaching pedagogy, navigating policies and degree requirements, and exploring academic opportunities and professional pathways.

Graduate students are active contributors to the advising relationship, proactively seeking academic and professional guidance and taking responsibility for informing themselves of policies and degree requirements for their graduate program.

For a statement of University policy on graduate advising, see the "Graduate Advising (<http://exploreddegrees.stanford.edu/graduatedegrees/#advisingandcredentialstext>)" section of this bulletin.

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

Chair: Aaron F. Straight

Director of Graduate Studies: Daniel Herschlag

Professors: Steven Artandi, Gilbert Chu, Ronald W. Davis, James E. Ferrell, Jr., Daniel Herschlag, Peter Kim, Mark A. Krasnow, Suzanne R. Pfeffer, James A. Spudich, Aaron F. Straight

Associate Professors: Onn Brandman, Rhiju Das, Pehr A. B. Harbury, Rajat Rohatgi

Assistant Professors: Silvana Konermann, Lingyin Li, Julia Salzman

Courtesy Professors: Chaitan S. Khosla, Sharon Long, Karlene Cimprich

Courses

BIOC 109A. Building Blocks for Chronic Disease. 3 Units.

Researchers have come a long way in developing therapies for chronic disease but a gap remains between current solutions and the ability to address the disease in full. This course provides an overview to the underlying biology of many of these diseases and how they may connect to each other. A "think outside of the box" approach to drug discovery is needed to bridge such a gap in solutions, and this course teaches the building blocks for that approach. Could Legoland provide the answer? This is a guest lecture series with original contributions from prominent thought leaders in academia and industry. Interaction between students and guest lecturers is expected. Students with a major, minor or coterm 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. Advances in Therapeutic Development: Neuronal Signaling and Immunology. 3 Units.

This is a seminar course focused on teaching students about novel research and applications in the fields of neuroscience and immunology. The course will cover topics that range from the neuronal pathways in opioid addiction and the mechanics of pain, to advances in immunotherapy. Students will engage with diverse material from leading neuroscience and cancer immunotherapy experts in the Bay Area. Guest lecturers will visit from both academia and neighboring pharmaceutical/biotechnology companies. Active participation is required. Prerequisite: Biology or Human Biology core. Students with a major, minor or coterm in Biology: 109A/209A or 109B/209B may count toward degree program, but not both.

Same as: BIO 109B

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 Mini-Course. 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. 4 Units.

For medical students. The course examines the impact of molecular biology on medicine. Topics include DNA replication, recombination, and repair; genomics; gene transcription; protein translation; and proteins in cell decision-making. Medical impact is examined in patient presentations and small group discussions of papers from the medical literature.

BIOC 209A. Building Blocks for Chronic Disease. 3 Units.

Researchers have come a long way in developing therapies for chronic disease but a gap remains between current solutions and the ability to address the disease in full. This course provides an overview to the underlying biology of many of these diseases and how they may connect to each other. A "think outside of the box" approach to drug discovery is needed to bridge such a gap in solutions, and this course teaches the building blocks for that approach. Could Legoland provide the answer? This is a guest lecture series with original contributions from prominent thought leaders in academia and industry. Interaction between students and guest lecturers is expected. Students with a major, minor or coterm 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 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 224. Advanced Cell Biology. 4 Units.

For Ph.D. students. Taught from the current literature on cell structure, function, and dynamics. Topics include complex cell phenomena such as cell division, apoptosis, signaling, compartmentalization, transport and trafficking, motility and adhesion, and differentiation. Weekly reading of current papers from the primary literature. Advanced undergraduates may participate with the permission of the Course Director. Same as: BIO 214, MCP 221

BIOC 227. Connections: Life, Science, and, Community. 1 Unit.

¿Connections¿ aims to welcome first-year students into the Biochemistry Department by fostering connections between you as a scientist and you as an individual with the broader communities of the department, Stanford, and local, national and international communities. The students, staff and faculty who have organized Connections believe that a sense of oneself and of belonging are foundations for doing transformative science and for doing so with purpose and wellness. We strive not just to be scientists but rather citizen-scientists, with broad and manifold aspirations for ourselves and those around us. The sessions planned, in addition to providing practical information, are aimed at continuing your exploration of your values and goals and placing that exploration in context of the multiple communities that you can embrace and that will embrace you. They will do so in ways that are inclusive to all individuals, thereby empowering individuals to be whoever they are, strengthening community, and promoting the ongoing causes of social and societal fairness and justice.

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 239. Introduction to Analysis of RNA Sequence Data. 1-2 Unit.

Introduction to analysis of RNA-sequencing data including theory and applications. Topics discussed will include computer scientific approaches to sequencing alignment such as dynamic programming, and statistical techniques that are that are used in analysis of next-generation sequencing data: Poisson models, the Expectation-Maximization algorithm, bootstrapping, multivariate linear models. Time permitting, we will cover single cell RNA sequencing, analysis and topics that arise in the analysis of multiple or large numbers of samples.

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 among lectures, in-class group problem solving, and discussion of current and classical literature. Enrollment limited to 30. 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: BIOE 241, BIOPHYS 241, SBIO 241

BIOC 257. Currents in Biochemistry. 1 Unit.

Discussions with Biochemistry faculty on their research careers. Getting to know the faculty, how they think, what drives them, how they chose their directions, and how they made tactical and strategic research decisions along the way.

BIOC 281. Introduction to Single Cell Expression. 2 Units.

Student lead: In the last decade single cell expression profiling has contributed to nearly every facet of biology, from uncovering new cell types to mapping stem cell lineages to molecularly dissecting disease. Single cell projects¿ scale and scope have grown as mRNA and cell capture have improved, and it is now possible to profile millions of cells across entire organisms. The data deluge has spurred development of hundreds of tools to analyze and extract as much information from these rich datasets, creating a dizzying landscape for biologists. This minicourse breaks down single cell expression analysis into phases, exploring important considerations and software for each and provides a hands-on environment to implement them.

BIOC 294. Chemistry for Biologists and Others. 3 Units.

Chemical transformations are central to biology and function, and chemical methods provide some of the most powerful tools for everyday experimental biology. Yet, most practitioners of biology have learned chemistry through memorization and do not use chemical principles or intuition in their research, even though chemistry underlies most processes and experiments carried out in biology and by biologists. Fortunately, a basic understanding and working knowledge can be gained in a short time, through a small set of simple concepts and limited number of memorized ¿facts¿. These concepts and facts will be introduced and then mastered through use in highly interactive, in-class problems and evaluation of selected literature. At the end of the three-week course students will have an ability to understand the chemistry underlying cellular processes and to better discuss and evaluate chemical tools and approaches. Prerequisites: High school or college introductory chemistry recommended but not required. Same as: BIOS 294

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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