BIOCHEMISTRY

Emeriti: (Professors) Robert L. Baldwin, Paul Berg, David S. Hogness, Arthur Kornberg
Chair: Suzanne R. Pfeffer
Professors: Douglas L. Brutlag, Ronald W. Davis, A. Dale Kaiser, I. Robert Lehman, Suzanne R. Pfeffer, James A. Spudich
Associate Professors: Patrick O. Brown, Gilbert Chu, Daniel Herschlag, Mark A. Krasnow
Assistant Professors: Pehr A. B. Harbury, Julie A. Theriot
Courtesy Professors: Chaitan S. Khosla, Sharon Long

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. A basic series in biochemistry (200, 203) is taught by the entire staff and requires a good background in organic chemistry and cell biology.

Advanced courses are offered in more specialized areas and they emphasize the most 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, ranging from bacteria to animal cells.

GRADUATE PROGRAM

DOCTOR OF PHILOSOPHY

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. Selection of these courses is tailored to fit the background and interests of each student. A second requirement involves the submission of three research proposals, which are presented by the student to a small advisory committee of departmental faculty members who are also responsible for monitoring the progress of student curricular and research programs. 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 a 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 15.

Beginning September 1, applications are available and can be requested by mail from Graduate Admissions, Registrar's Office, Old Union, Stanford University, Stanford CA 94304-3005, by phone (650) 723-4291, or email at ck.gaa@forsythe.stanford.edu . Applications may also be submitted electronically at http://www.stanford.edu/dept/registrar/admissions/index.html and http://www.med.stanford.edu/school/biosciences/ . Applicants are notified by April 1 of decisions on their applications. Stanford University requires scores from the Graduate Record Examination (GRE) (verbal, quantitative, and analytical), and applicants must 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 and a Howard Hughes Medical Institute Predoctoral Traineeship. Students are provided with financial support to cover normal living expenses; Stanford tuition costs are paid.

All 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.

COURSES

118Q. Stanford Introductory Seminar: Genomics, Bioinformatics, and Medicine—Preference to sophomores. The kind of knowledge gained from sequencing the human genome and the implications of such knowledge for medicine and biomedical research. Novel diagnostic methods and treatment of diseases, including gene therapy and drug design. The ethical implications of genetic information. The use of genome and disease databases to determine the function of genes involved in disease. Recommended: Biological Sciences 52 or Human Biology 2A.
3 units, Spr (Brutlag)

200. Biochemical Structure, Metabolism, and Energetics—The structure and function of biological molecules, enzyme kinetics and mechanisms, bioenergetics, pathways of intermediary metabolism and their control, and membrane structure and function. Lectures on special topics. Prerequisites: organic chemistry, cell biology.
5 units, Win (Harbury, Pfeffer, Spudich, Theriot)

201. Advanced Molecular Biology—Lectures on rapidly developing frontiers in DNA structure and metabolism, chromosome structure and function, gene expression and its control, regulation of transcription, protein structure and function, RNA processing, and translation. Prerequisite: course in basic molecular biology.
5 units, Win (Davis, Brutlag)

203. Molecular Biology—Enrollment limited to medical students or by consent of instructors. DNA structure and metabolism, chromosome structure and function, gene expression and its control, regulation of transcription, protein structure and function, RNA processing, and translation. Minicourses provide in-depth treatment of material in the

core lectures, topics with medical relevance, and reviews of original literature. Prerequisite: 200 or equivalent.

4 units, Spr (Brown, Chu, Krasnow)

210. Advanced Topics in Membrane Biochemistry—The structure, function, and biosynthesis of cellular membranes and organelles. Based on current literature, with extensive student participation. Prerequisites: 200, 203, or equivalents, or consent of instructor.

4 units (Pfeffer) not given 2000-01

211. Development in Microorganisms—Cell differentiation and multicellular development in microorganisms. Microbes are attractive subjects for molecular studies of the regulation of development because they can be manipulated easily by genetic and biochemical techniques, handled in large numbers, and because their genomes are relatively small. Topics: temporal and spatial regulation of cell division; sporulation; flagella and pili morphogenesis; positional information; cell-cell communication and multicellular development; signal transduction pathways. Lectures/readings in current literature.

2 units (Kaiser, Shapiro) not given 2000-01

213. Biological Signaling during Development—The biochemical and genetic analysis of the developmental response of cells, or cell clusters, to specific molecular signals. Signals vary from complex proteins to simple molecules (steroid hormones), and the responding cells vary from these in close proximity to signal-generating cells to all cells in the organism. Focus is on the signaling mechanisms and on the evolutionary conservation of these systems. Prerequisites: knowledge of basic biochemistry and genetics.

3 units (Hogness) not given 2000-01

214. Physical and Chemical Principles of Biochemistry—The physical chemistry of proteins, nucleic acids and their complexes, and the chemistry underlying biological reactions; the principles of enzymatic catalysis. The physical and chemical concepts that are fundamental to biological processes. Appraisal of experimental and conceptual approaches and analysis of classic and current papers in the literature. Areas: interactions involved in protein and nucleic acid structure and folding; the energetic, chemical, and structural principles of enzymatic catalysis and control. Prerequisites: 200, 203 or equivalent, a course in physical chemistry, and a course in organic chemistry.

4 units (Herschlag) not given 2000-01

215. Frontiers in Biological Research—(Same as Developmental Biology 215.) Faculty-student discussion, emphasizing how to critically evaluate primary research literature in different areas of biological research. Held in conjunction with a seminar series, hosted in alternate weeks by the departments of Biochemistry, Genetics, and Developmental Biology. Each Wednesday, distinguished investigators present their current work at the frontiers of biological research. Before the seminar, students and course faculty meet and discuss in depth one or more papers from the primary research literature on a related topic. After the seminar, students have the opportunity to meet informally with the seminar speaker to discuss their research and future directions. The techniques most commonly used to study problems in biology, and a comparison between the genetic and biochemical approaches in biological research.

1 unit, Aut, Win (D. Kingsley, P. Harbury, S. Kim)

217. Advanced Tutorial in Special Topics—Readings and tutorial in membrane biochemistry, enzyme mechanisms, chromosome structure, biochemical genetics, bacterial and animal viruses, and nucleic acid enzymology. Conducted under the guidance of advanced graduate students and postdoctoral fellows.

1-3 units, any quarter (Staff)

218. Computational Molecular Biology—(Same as Biomedical Informatics 231.) For molecular biologists and computer scientists desiring a practical, hands-on approach to computational molecular biology; recommended for molecular biologists and computer scientists desiring to understand the major issues concerning representation and analysis of biological sequences and structure. Existing methods are critically described with the strengths and limitations of each. Future directions for development of new methods. Practical assignments utilizing the tools described. Topics: accessing molecular databases, pattern search, classification of sequence and structure, alignment of sequences, rapid similarity searching, phylogenies, automated pattern learning, representing protein structure, modeling protein structure by homology, protein-protein docking and protein-ligand docking. Final project utilizes or analyzes the methods presented. Lecture/lab. Enrollment limited to 40. Prerequisite: introductory molecular biology at the level of Biological Sciences 52 or consent of instructor. Recommended: 210.

3 units, all quarters via Internet (Brutlag)

221. The Teaching of Biochemistry—To be taken by all teaching assistants in 200, 203, or 217. Emphasizes practical experience in teaching on a one-to-one basis, and problem set design and analysis. Familiarization with current lecture and text materials is expected, along with evaluations of class papers and examinations. Prerequisite: enrollment in the Biochemistry Ph.D. program or consent of instructor.

3 units, any quarter (Staff)

225. Molecular Motor Proteins and the Cytoskeleton—(Same as Developmental Biology 225.) The molecular basis of energy transduction leading to movements generated by microfilament-based and microtubule-based motors. Analysis of 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 in general. Topics: structure of the molecular motors and their accessory proteins; regulation of the function of motile assemblies 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, and high-resolution light microscopy. Focuses on how a complex cellular process is analyzed at the molecular level by a multifaceted approach using biochemical, biophysical, and genetic techniques. Prerequisites: knowledge of basic biochemistry and cell biology.

3 units (Fuller, Spudich) not given 2000-01

237. Introduction to Biotechnology—(Same as Chemical Engineering 450, Civil and Environmental Engineering 237, Developmental Biology 237, Structural Biology 237). Faculty from the departments of Biochemistry, Biological Sciences, Chemical Engineering, Civil and Environmental Engineering, Developmental Biology, Structural Biology, and invited industrial speakers review the interrelated elements of modern biotechnology. Topics: protein structure and dynamics, protein engineering, biocatalysis, gene expression, cellular metabolism and metabolic engineering, fermentation technology, and purification of biomolecules. Prerequisite: graduate student or upper-division undergraduate in the sciences or engineering.

3 units, Spr (Robertson, Swartz)

241. Biological Macromolecules—(Same as Structural Biology 241.) The molecular principles of protein and nucleic acid structures. The forces that stabilize biopolymers is presented with the goal of understanding three-dimensional structures and their functional implications. Topics: protein folding, domain structures, enzyme active sites, DNA and RNA structure, and protein-nucleic acid complexes.

3 units, Aut (Aldrich, Ferrell, Herschlag, Lewis, Puglisi, Weis)

242. Methods in Molecular Biophysics—(Same as Structual Biology 242.) Introduces students from diverse backgrounds to the potential utility of physical approaches to research and helps prepare them to evaluate literature that incorporates these methods. Experimental methods in molecular biophysics are from a theoretical and practical stand-

point. Emphasis is on x-ray diffraction and nuclear and nuclear magnetic resonance spectroscopy. Fluorescence spectroscopy, circular diochroism, calorimetry, separation methods.

3 units, Win (Harbury, McKay, Puglisi, Weis)

294. DNA Repair, Recombination, and Replication—Enzymes and molecular mechanisms, and how some physiological aspects of DNA transactions may be explained at the molecular level. Prerequisites: 200, 203.

2 units (Lehman) not given 2000-01

299. Directed Reading—Prerequisite: consent of instructor.

1-18 units, any quarter (Staff)

399. Research and Special Advanced Work—Register by section numbers by arrangement with faculty. Prerequisite: consent of instructor.

1-18 units, any quarter

459. Frontiers in Interdisciplinary Biosciences—(Cross-listed in multiple departments in the schools of Humanities and Sciences, Engineering, and Medicine; students should enroll directly through their affiliated department, if at all possible.) Introduction to cutting-edge research involving interdisciplinary approaches to bioscience and biotechnology; for specialists and non-specialists. Associated with Stanford's Clark Center for Interdisciplinary Bioscience, and held in conjunction with a seminar series meeting twice monthly during 2000-01. Leading investigators from Stanford and throughout the world speak on their research; students also meet separately to present and discuss the ever-changing subject matter, related literature, and future directions. Prerequisite: keen interest in all of science, with particular interest in life itself. Recommended: basic knowledge of biology, chemistry, and physics.

2 units, Aut, Win, Spr (S. Block)