SCHOOL OF MEDICINE

Dean: Philip Pizzo
Senior Associate Dean for Research and Training: John C. Boothroyd
Senior Associate Dean for Research and Training: Harry B. Greenberg
Senior Associate Dean for Medical Education: Julie Parsonnet

The School of Medicine offers courses of study leading to the M.S., Ph.D., and M.D. degrees.

UNDERGRADUATE PROGRAMS

At the undergraduate level, a number of the school's courses are open to any registered Stanford student who has fulfilled the prerequisites, subject to the usual limits of course enrollment and faculty approval. In the classroom, the school offers courses targeted to undergraduates as well as graduate-level courses where advanced undergraduates with a strong background in the life sciences are welcome. Among these offerings are many Stanford Introductory Seminars for freshmen and sophomores; interested students are encouraged to peruse the complete list of these offerings in the "Stanford Introductory Seminars" section of this bulletin or at http://www.stanford.edu/group/introsems/.

GRADUATE PROGRAMS

M.S. AND Ph.D. PROGRAMS

The School of Medicine is home to graduate programs covering a broad range of disciplines within biomedicine leading to Ph.D. or M.S. degrees. All of these programs focus on interdisciplinary training with in-depth investigation of an original problem of fundamental importance to bioscience. Each degree program sets its own curriculum, but many courses are taught by groups of faculty from multiple programs and departments. Flexibility is a priority to ensure that all students obtain the best possible training for pursuing careers in their areas of interest. Admission is through one of about 15 home programs. These home programs enable students to carry out dissertation research and training with School of Medicine faculty, as well as investigators in the departments of Biological Sciences and Biophysics in the School of Humanities and Sciences. Detailed information on School of Medicine M.S. and Ph.D. programs, curricula, and research can be found at http://med.stanford.edu/ms/ and http://med.stanford.edu/phd/. Application information may be obtained from Graduate Admissions, Office of the University Registrar, Old Union Building, 520 Lasuen Mall, Stanford University, Stanford, CA 94305-3005, or at http://gradadmissions.stanford.edu/.

M.D. PROGRAM

The School of Medicine seeks to attract creative medical students who are passionate about scholarship and wish to improve the health of the world's people through research, innovation, and leadership. The Stanford M.D. curriculum provides education in biomedical and clinical sciences along with study and independent research through scholarly concentrations. Emphasis is placed on interdisciplinary learning, with streamlined content and melding of basic science and clinical instruction across the curriculum. Blocks of unscheduled time allow for individual or group study, participation in elective courses, research, and reflection. Alternative pathways through the curriculum include an option of a fifth or sixth year of study as well as opportunities for pursuing a second degree, such as an M.P.H. or Ph.D.

Broad clinical science education occurs throughout the curriculum with exposure to patient care and the practice of medicine beginning on the first day of medical school. Students may begin clinical clerkships as early as May of the second year. All medical students complete formal clinical experiences in medicine, surgery, pediatrics, obstetrics-gynecology, family medicine, psychiatry, neurology, and critical care.

Scholarly concentrations offer opportunities for in-depth study in subject areas including bioengineering, biomedical ethics and medical humanities, biomedical informatics, clinical research, community health and public service, health services and policy research, immunology, molecular basis of medicine, neuroscience, women's health, and other areas that are independently designed. Students may pursue a scholarly concentration through the Original Research Track or the Scholars Track. Students in the Original Research Track pursue in-depth study in the area of concentration as well as a four quarter, independent research project, concluding with completion and write-up of the project. Original research is not required in the Scholars Track. Students also have the opportunity to conduct a Traveling Scholars project overseas. Following completion of 13 quarters of academic work, additional quarters may be taken at a decreased tuition rate. Completion of the M.D. degree must be achieved within six years, unless a petition is granted to extend this time frame.

Students with strong interests in medical research as a career are urged to investigate opportunities available under the auspices of the Medical Scientist Training Program (MSTP). This program provides a limited number of students the opportunity to pursue an individualized program of research and course work leading to both the M.D. and Ph.D. degrees. The estimated time for completion of the program is seven years. Students interested in participating in the MSTP are asked to provide supplemental information relevant to their research background and are considered for entry into the MSTP at the time of their application to the School of Medicine. Stanford also participates in a joint Master of Public Health program with the University of California, Berkeley, which requires an additional year to complete. Details about these programs may be found at http://med.stanford.edu/combined_degree/.

Stanford recognizes the diversity of the United States and California populations and is committed to representing this diversity in the medical student class. Provided an applicant to the school has completed the basic courses in physics, chemistry, and biology, the choice of an undergraduate major may reflect other interests, including the arts and humanities. Course work in biochemistry and the behavioral sciences is strongly recommended because of their importance in understanding medicine. Extracurricular activities and breadth of interests and experiences play an important role in the selection of students from among those applicants having superior records.

For further details on the M.D. degree, including admission requirements, see http://med.stanford.edu/md/admissions/.

BIOCHEMISTRY

Emeriti: (Professors) Robert L. Baldwin, Paul Berg, David S. Hogness, Arthur Kornberg, A. Dale Kaiser, I. Robert Lehman
Chair: Suzanne R. Pfeffer
Professors: Patrick O. Brown, Douglas L. Brutlag, Gilbert Chu, Ronald W. Davis, James E. Ferrell, Jr., Daniel Herschlag, Mark A. Krasnow, Suzanne R. Pfeffer, James A. Spudich
Associate Professors: Pehr A. B. Harbury, Julie A. Theriot
Assistant Professor: Aaron F. Straight
Courtesy Professors: Chaitan S. Khosla, Sharon Long
Department Offices: Beckman Center, B400
Mail Code: 94305-5307
Phone: (650) 723-6161
Web Site: http://biochem.stanford.edu/

Courses given in Biochemistry have the subject code BIOC. For a complete list of subject codes, see Appendix.

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 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, 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 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 13.

Applications should be submitted at http://gradadmissions. stanford. edu/ and http://www.med.stanford.edu/school/biosciences/. If necessary, a paper application can be requested by mail from Graduate Admissions, Registrar's Office, Old Union, 520 Lasuen Mall, Stanford University, Stanford CA 94304-3005, by phone (650) 723-4291, or email at gradadmissions@stanford.edu. 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 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

BIOC 118Q. Genomics, Bioinformatics, and Medicine—Stanford Introductory Seminar. 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. See http://biochem118.stanford.edu/. Recommended: BIOSCI 42 or HUMBIO 2A. GER:DB-EngrAppSci

3 units, Spr (Brutlag)

BIOC 199. Undergraduate Research—Prerequisite: consent of instructor.

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

BIOC 202. Metabolic Biochemistry: Structure, Metabolism, and Energetics—Structure and function of biological molecules, enzyme kinetics and mechanisms, bioenergetics, pathways of intermediary metabolism and their control, and membrane structure and function. Course offered via online lectures and problem sets, with weekly small-group review sessions.

1-3 units, Aut (Brutlag)

BIOC 205. Molecular Foundations of Medicine—Topics include: DNA structure, replication, repair, and recombination; chromosome structure and function; gene expression including mechanisms for regulating transcription and translation; and methods for manipulating DNA, RNA, and proteins. Patient presentations illustrate how molecular biology affects the practice of medicine.

3 units, Aut (Chu, Brown, Krasnow)

BIOC 210. Advanced Topics in Membrane Trafficking—The structure, function, and biosynthesis of cellular membranes and organelles. Current literature. Prerequisites: 200, 203, or equivalents, and consent of instructor.

3 units (Pfeffer) not given 2005-06

BIOC 214. Physical and Chemical Principles of Enzyme Function—Enzymatic mechanisms, with emphasis on the fundamental behavior of biochemical systems and the properties that emerge due to the complex nature of these systems. Student presentations on specific enzymes based on classic and current literature, developed in consultation with the instructor. Prerequisites: BIOC/SBIO 241 and a course in organic chemistry.

3-5 units (Herschlag) not given 2005-06

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, Win, Spr (Harbury, Kingsley, Baker)

BIOC 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 by advanced graduate students and postdoctoral fellows.

1-3 units, Aut, Win, Spr (Staff)

BIOC 218. Computational Molecular Biology—Online course; see http://biochem218.stanford.edu. For molecular biologists and computer scientists. Major issues, existing methods, and future directions concerning biological sequences and structure. Topics: accessing molecular databases, pattern search, classification of sequence and structure, alignment of sequences, rapid similarity searching, phylogenies, automated pattern learning, representing protein structure, gene expression profiling, clustering expressed genes, and discovering transcription factor binding sites. Lecture/lab. Final project. Enrollment limited to 40. Prerequisite: BIOSCI 52 or equivalent, or consent of instructor.

3 units (Brutlag) not given 2005-06

BIOC 220. Chemistry of Biological Processes—(Same as MPHA 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, Aut (Wandless, Herschlag, Chen, Bogyo)

BIOC 221. The Teaching of Biochemistry—Required for teaching assistants in 203, 204, 217, or 218. 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, Win, Spr, Sum (Staff)

BIOC 230. Molecular Interventions in Human Disease—For M.D. students who intend to declare a concentration in molecular basis of medicine, M.S.T.P. students, and Ph.D. students with a strong interest in medicine. Advanced medical biochemistry focusing on cases where molecular-level research has led to new medical treatments or changes in the understanding of important diseases. The underlying molecular basis of diseases and the reasons for success and failure in molecular approaches to treatment. Student-led discussions on primary medical and scientific literature.

2-3 units, Aut (Theriot, Harbury)

BIOC 241. Biological Macromolecules—(Enroll in SBIO 241.)

3-5 units, Aut (Puglisi, Weis, Block, Herschlag, Ferrell, McKay, Pande, Garcia)

BIOC 242. Methods in Molecular Biophysics—(Enroll in SBIO 242.)

3 units (Weis, Puglisi) not given 2005-06

BIOC 257. Currents in Biochemistry—Limited to graduate students and postdoctoral fellows in Biochemistry. Seminars by Biochemistry faculty on their ongoing research. Background, current advances and retreats, general significance, and tactical and strategic research directions. Written reviews required.

1-2 units (Kornberg, Lehman) not given 2005-06

BIOC 299. Directed Reading—May be repeated for credit. Prerequisite: consent of instructor.

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

BIOC 399. Research and Special Advanced Work—Prerequisite: consent of instructor.

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

BIOC 450. Introduction to Biotechnology—(Enroll in CHEMENG 450.)

3 units, Spr (Khosla)

BIOC 459. Frontiers in Interdisciplinary Biosciences—(Same as CHEMENG 459, BIOSCI 459, CHEM 459, PSYCH 459, BIOE 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://www.stanford.edu/group/biox/courses/459.html. Recommended: basic mathematics, biology, chemistry, and physics.

1 unit, Aut, Win, Spr (Robertson)

CENTER FOR BIOMEDICAL ETHICS

Director: David C. Magnus
Director Emeritus: Thomas A. Raffin
Associate Director: Mildred K. Cho
Assistant Director: Anne J. Footer
Participating Faculty and Staff: Clarence H. Braddock, Julie A. Collier, LaVera M. Crawley, Maren Grainger-Monsen, Henry Greely, Judy Illes, Agnieszka Jaworska, Sandra S. Lee, Jose R. Maldonado, Audrey Shafer, Sara L. Tobin, Lawrence I. Zaroff
Center Offices: 701 Welch Road, Building A, Suite 1105, Palo Alto, CA 94304
Mail Code: 94304-5748
Phone: (650) 723-5760
Web Site: http://scbe.stanford.edu/

The Stanford University Center for Biomedical Ethics (SCBE) is dedicated to interdisciplinary research and education in biomedical ethics, and provides clinical and research ethics consultation. SCBE serves as a scholarly resource on emerging ethical issues raised by medicine and biomedical research.

SCBE offers a scholarly concentration in Biomedical Ethics and Medical Humanities to medical students. This program allows medical students to study in depth the ethical and humanistic dimensions of research and practice. Additional information on requirements for the scholarly concentration, and a comprehensive list of other related courses is available at http://scbe.stanford.edu/education/bemh.html.

COURSES

For further information, see the Stanford University *School of Medicine Catalog*.

MEDICINE

INDE 136. Foundations of Bioethics—Classic articles, legal cases, and foundational concepts. Theoretical approaches derived from philosophy. The ethics of medicine and research on human subjects, assisted reproductive technologies, genetics, cloning, and stem cell research. Ethical issues at the end of life.

3 units, Win (Magnus)

INDE 212. The Human Condition: Medicine, Arts, and Humanities—The interdisciplinary field of medical humanities: the use of the arts and humanities to examine medicine in personal, social, and cultural contexts. Topics include the doctor/patient relationship, the patient perspective, the meaning of doctoring, and the meaning of illness. Sources include visual and performance arts, film, and literary genres such as poetry, fiction, and scholarly writing. Non-M.D. students may enroll with consent of instructor.

2 units, Spr (Zaroff)

INDE 226. History of Medicine Online

1 unit, Aut, Win, Spr Sum, (Meites, Shafer)

INDE 238. Current Concepts and Dilemmas in Genetic Testing—(Same as GENE 238) For M.D. students and biomedical graduate students. Issues arising from the translational process from research to

commercialization. Diagnostic inventions and applications, community implications, newborn screening, cancer genetics, and pharmacogenomics. Guest experts. Limited enrollment.
2 units, Spr (Tobin, Cowan, Schrijver)

MED 250A. Medical Ethics I—Required core course for Scholarly Concentration in Biomedical Ethics and Medical Humanities. The field of bioethics including theoretical approaches to bioethical problems. Contemporary controversies and clinical cases. Issues include: genetics and stem cell research; rationing; ethical issues in care at the end of life; organ transplantation issues. Values that arise in different situations and clinical encounters.
2 units, Win (Magnus)

MED 255. The Responsible Conduct of Research—Forum. How to identify and approach ethical dilemmas that commonly arise in biomedical research. Issues in the practice of research such as in publication and interpretation of data, and issues raised by academic/industry ties. Contemporary debates at the interface of biomedical science and society regarding research on stem cells, bioweapons, genetic testing, human subjects, and vertebrate animals. Completion fulfills NIH/ADAMHA requirement for instruction in the ethical conduct of research. Recommended: research experience.
1 unit, Aut, Win, Spr (Staff)

INTERDEPARTMENTAL OFFERINGS

GENETICS

GENE 104Q. Law and the Biosciences
3 units, Spr (Greely)

HEALTH RESEARCH AND POLICY

HRP 210. Health Law and Policy I—(Same as LAW 313)
3 units, Aut semester (Greely)

HRP 211. Law and the Biosciences—(Same as LAW 368)
3 units, Aut (Greely)

LAW

LAW 440. Biotechnology Law and Policy
3 units, Spr (Greely)

PHILOSOPHY

PHIL 78. Medical Ethics
4 units, Spr (Jaworska)

PHIL 170. Ethical Theories
4 units, Spr (Jaworska)

PHIL 378. Problems in Medical Ethics
4 units, Win (Jaworska)

BIOMEDICAL INFORMATICS PROGRAM

Committee: Russ B. Altman *(Chair and Program Director);* Mark A. Musen *(Co-Director)*; Betty Cheng, Amar K. Das, Lawrence M. Fagan *(Associate Directors);* Douglas L. Brutlag, Atul Butte, Teri E. Klein

Participating Faculty and Staff by Department:

Opportunities for research are not limited to the faculty and departments listed.

Anesthesia: David M. Gaba (Professor)
Biochemistry: Douglas L. Brutlag (Professor), Ron Davis (Professor), Julie Theriot (Assistant Professor)
Bioengineering: Scott L. Delp (Associate Professor)
Biostatistics: Richard A. Olshen (Professor)
Business: Alan M. Garber (Professor, by courtesy)
Chemistry: Vijay Pande (Assistant Professor)
Civil and Environmental Engineering: Raymond E. Levitt (Professor)
Computer Science: Serafim Batzoglou (Assistant Professor), Leo Guibas (Professor), Daphne Koller (Associate Professor), Jean-Claude Latombe (Professor), Gio Wiederhold (Professor, Research, emeritus), Terry Winograd (Professor)
Genetics: Russ B. Altman (Professor), Mike Cherry (Associate Professor, Research), Stanley N. Cohen (Professor), Stuart Kim (Professor), Teri E. Klein (Senior Research Scientist), Richard M. Myers (Professor), Gavin Sherlock (Assistant Professor)
Health Research and Policy: Mark A. Hlatky (Professor), Richard A. Olshen (Professor), Robert Tibshirani (Professor)
Management Science and Engineering: Margaret Brandeau (Professor), Ronald A. Howard (Professor), Ross D. Shachter (Associate Professor)
Mathematics: Samuel Karlin (Professor, emeritus)
Medicine: Jay Bhattacharya (Assistant Professor), Terrance Blaschke (Professor), Atul Butte (Assistant Professor), Robert W. Carlson (Professor), Amar K. Das (Assistant Professor), Parvati Dev (Senior Research Scientist), Lawrence M. Fagan (Senior Research Scientist), Alan M. Garber (Professor), Mary Goldstein (Professor), Michael Higgins (Consulting Associate Professor), Peter D. Karp (Consulting Assistant Professor), David Katzenstein (Professor, Research), John Koza (Consulting Professor), Henry Lowe (Associate Professor, Research; Senior Associate Dean for Information Resources and Technology), Mark A. Musen (Professor), Douglas K. Owens (Associate Professor), Robert W. Shafer (Assistant Professor, Research), P.J. Utz (Associate Professor)
Microbiology and Immunology: Karla Kirkegaard (Professor), Garry Nolan (Associate Professor)
Neurosurgery: John R. Adler (Professor), Ramin Shahidi (Assistant Professor, Research)
Obstetrics and Gynecology: W. LeRoy Heinrichs (Professor, emeritus)
Pathology: Arend Sidow (Assistant Professor)
Pediatrics: Atul Butte (Assistant Professor)
Psychiatry and Behavioral Sciences: Amar K. Das (Assistant Professor)
Radiation Oncology: Arthur L. Boyer (Professor), Lei Xing (Assistant Professor, Research)
Radiology: Sam Gambhir (Professor), Gary H. Glover (Professor), Sandy A. Napel (Professor), Norbert J. Pelc (Professor), Geoffrey Rubin (Associate Professor)
Statistics: Trevor J. Hastie (Professor), Susan Holmes (Professor), Art Owen (Professor)
Structural Biology: Michael Levitt (Professor)
Surgery: Thomas Krummel (Professor), Charles Taylor (Assistant Professor, Research)

Program Offices: MSOB 215
Mail Code: 94305-5479
Phone: (650) 723-6979
Web Site: http://www.bmi.stanford.edu

Courses given in Biomedical Informatics Program have the subject code BIOMEDIN. For a complete list of subject codes, see Appendix.

This interdisciplinary program was created in response to a recognized need for well-trained researchers and academic leaders in the expanding field of biomedical informatics. The Biomedical Informatics Program was formerly called Medical Informatics Sciences (1982-2000).

The program in Biomedical Informatics emphasizes research to develop novel computational methods that can advance biomedicine. Students receive training in the investigation of new approaches to conceptual modeling and to development of new algorithms that address challenging problems in the biological sciences and clinical medicine. Students with a primary interest in developing new informatics methods and knowledge are best suited for this program. Students with a primary interest in the biological or medical application of existing informatics techniques may be better suited for training in the application areas themselves.

GRADUATE PROGRAMS

The Biomedical Informatics Program is interdepartmental and offers instruction and research opportunities leading to M.S. and Ph.D. degrees in Biomedical Informatics. All students are required to complete the core curriculum requirements outlined below, and also to elect additional courses to complement both their technical interests and their goals in applying informatics methods to clinical settings, biology, or imaging. Students who fail to maintain a 3.0 grade point average (GPA) in all five categories of the core curriculum are expected to pass a comprehensive exam in that area before the graduate degree is granted. In addition, prior to being formally admitted to candidacy for the Ph.D. degree, the student must demonstrate knowledge of biomedical informatics fundamentals and a potential for research by passing a qualifying exam.

The core curriculum is common to all degrees offered by the program but is adapted or augmented depending on the interests and prior experience of the student. Deviations from the core curriculum outlined below must be justified in writing and approved by the student's Biomedical Informatics academic adviser and the chair of the Biomedical Informatics Committee. It should be noted, however, that the program is intended to provide flexibility and to complement other opportunities in applied medical research that exist at Stanford. Although most students are expected to comply with the basic program of study outlined here, special arrangements can be made for those with unusual needs or those simultaneously enrolled in other degree programs within the University. Similarly, students with prior relevant training will have the curriculum adjusted to eliminate requirements that were met as part of their prior training.

CORE CURRICULUM

All students are expected to participate regularly in the Biomedical Informatics Student Seminar (201) and Colloquia (200), regardless of whether they register for credit in those courses. In addition, all students are expected to fulfill requirements in the following five categories:

1. *Core Biomedical Informatics* (15 units): students are expected to understand current applications of computers in biology and medicine and to develop a broad appreciation for research in the management of biomedical information. Required courses are: BIOMEDIN 200, 201, 210, 211, 212, and 214, all of which should be taken during the first and second year in the program. BIOMEDIN 200 and 201 are required courses but are not counted toward the core Biomedical Informatics requirement. Students must also take an additional 3 units of Biomedical Informatics course work (which may include crosslisted courses from other departments, but not including BIOMEDIN 200, 201, 299, 302, 303, or 305), selected in consultation with the academic adviser.
2. *Computer Science* (9 units): the student is expected to acquire a knowledge of the use of computers, computer organization, programming, and symbolic systems. It is assumed that students will have had by matriculation prior computing experience at least equivalent to a course introducing the fundamentals of data structures and algorithms such as CS 103A,B, 103X, 106A,B, 106X, or other courses approved by academic adviser or executive committee. All students are required to take a minimum of 9 units of courses in the Department of Computer Science. If similar courses have not been taken previously, these units must include CS 121, 161, and a course that requires significant programming and knowledge of machine architectures (for example, CS 108, or the CS 193 series). For those who have taken such courses previously, replacement units may be taken from any other course in CS selected by the student and approved by the academic adviser. A course in databases is especially recommended. With the exception of CS 108, all other courses applied to the degree requirements must be numbered 137 or higher.
3. *Probability, Statistics, and Decision Science* (9 units): students are required to take at least three courses that span the following five topics: basic probability theory, Bayesian statistics, decision analysis, machine learning, and experimental-design techniques. Prior courses in statistics at least equivalent to STATS 60 and calculus equivalent to MATH 42 are prerequisites. A prior course in linear algebra equivalent to MATH 103 or 113 is recommended. For the probability requirements, students may, for example, take MS&E 120, STATS 116, or MS&E 221. For the statistics requirements, students should take STATS 141, if they have not had an equivalent class prior to entry to the program. Otherwise, sequences (taken after STATS 116) may include STATS 200 followed by a course in stochastic modeling, machine learning or data mining, such as STATS 202 or 315A,B, or CS 228 or 229. Options for decision analysis include MS&E 152 or 252, or cost effectiveness analysis (BIOMEDIN 432). Specific courses should be chosen in consultation with the student's academic adviser. Also recommended is a course in the psychology of human problem solving.
4. *Biomedical Domain Knowledge* (9 units): students are expected to acquire an understanding of pertinent life sciences and how to analyze a domain of application interest. Prior courses in biology at least equivalent to BIOSCI 41 and 42 are prerequisites. All students must have completed a course in basic biochemistry, molecular biology, or genetics. Other areas of basic biology may be an acceptable alternative. Exposure to laboratory methods in biology is encouraged. All students without formal health care training must take IMMUNOL 230 (formerly BIOMEDIN 207).
5. *Social and Ethical Issues* (3 units): candidates are expected to be familiar with key issues regarding ethics, public policy, financing, organizational behavior, management, and pertinent legal topics. Students may select at least 3 units from suitable courses that include, for example, BIOMEDIN 432; CS 201; MS&E 284, 197; HRP 391, 392; or any other advanced course in policy and social issues proposed by the student and approved by the Biomedical Informatics academic adviser.

The core curriculum generally entails a minimum of 45 units of course work, but can require substantially more or less depending upon the courses selected and the previous training of the student. The varying backgrounds of students are well recognized and no one is required to take courses in an area in which he or she has already been adequately trained; under such circumstances, students are permitted to skip courses or substitute more advanced work. Students design appropriate programs for their interests with the assistance and approval of their Biomedical Informatics academic adviser. At least 27 units of formal course work are expected.

PROGRAM REQUIREMENTS FOR THE ACADEMIC M.S., PROFESSIONAL M.S., AND COTERMINAL DEGREES

Students enrolled in any of the M.S degrees must complete the program requirements in order to graduate. Programs of at least 54 units that meet the following guidelines are normally approved:

1. Completion of the core curriculum.
2. A minimum of 6 additional units of courses in Computer Science numbered 135 or higher, courses in Management Science and Engineering or Statistics numbered 200 or higher, PSYCH 256 or 225, or relevant courses in other departments approved by the student's academic adviser.
3. Electives: additional courses to bring the total to 54 or more units.

The University requirements for the M.S. degree are described in the "Graduate Degrees" section of this bulletin.

MASTER OF SCIENCE (ACADEMIC)

This degree is designed for individuals who wish to undertake in-depth study of biomedical informatics. Normally, a student spends two years in the program and implements and documents a substantial project during the second year. The first year involves acquiring the fundamental concepts and tools through course work and research project involvement. All first- and second-year students are expected to devote 50 percent or more of their time participating in research projects. Research rotations are not required, but can be done with approval of the academic adviser or training program director. Graduates of this program are prepared to contribute creatively to basic or applied projects in biomedical informatics. This degree requires a written research paper to be approved by two faculty members.

MASTER OF SCIENCE (PROFESSIONAL)

This degree is primarily designed for the working professional who already has advanced training in one discipline and wishes to acquire interdisciplinary skills. This program is offered part-time and courses are available online. The professional M.S. is offered in conjunction with Stanford Center of Professional Development (SCPD), which establishes the rates of tuition and fees. SCPD is based on the honors cooperative model (HCP), which assumes that the student is working in a corporate setting and is enrolled in the M.S. on a part-time basis. The student has up to five years to complete the program. Research projects are optional and the student must make arrangements with program faculty. Graduates of this program are prepared to contribute creatively to basic or applied projects in biomedical informatics.

MASTER OF SCIENCE (COTERMINAL)

The coterminal degree program allows undergraduates to study for a master's degree while completing their bachelor's degree(s) in the same or a different department. Please refer to the "Coterminal Bachelor's and Master's Degrees" section under "Undergraduate Degrees and Programs" in this bulletin for additional information.

The coterminal Master of Science program follows the same program requirements as the Master of Science (Professional), except for the requirement to be employed in a corporate setting. The coterminal degree is only available to current Stanford undergraduates. Coterminal students are enrolled full-time and courses are taken on campus. Research projects are optional and the student must make arrangements with program faculty. Graduates of this program are prepared to contribute creatively to basic or applied projects in biomedical informatics

For University coterminal degree program rules and University application forms, see http://registrar.stanford.edu/publications/#Coterm.

DOCTOR OF PHILOSOPHY

The University's basic requirements for the doctorate (residence, dissertation, examination, and so on) are discussed in the "Graduate Degrees" section of this bulletin.

Individuals wishing to prepare themselves for careers as independent researchers in biomedical informatics, with applications experience in bioinformatics, clinical informatics, or imaging informatics, should apply for admission to the doctoral program. The following are additional requirements imposed by the Biomedical Informatics Interdisciplinary Committee:

1. A student should plan and successfully complete a coherent program of study including the core curriculum and additional requirements for the master's program. In addition, doctoral candidates are expected to take at least three more advanced courses (see categories under item '2' of the master's program requirements). In the first year, two or three research rotations are strongly encouraged. The master's requirements should be completed by the end of the second year in the program (six quarters of study, excluding summers). Doctoral students are generally advanced to Ph.D. candidacy after passing the qualifying exam, which takes place during the second year of training. A student's academic adviser has primary responsibility for the adequacy of the program, which is regularly reviewed by the Biomedical Informatics Executive Committee.
2. To remain in the Ph.D. program, each student must attain a grade point average (GPA) as outlined above, and must pass a comprehensive exam covering introductory level graduate material in any curriculum category in which he or she fails to attain a GPA of 3.0. The student must fulfill these requirements and apply for admission to candidacy for the Ph.D. by the end of six quarters of study (excluding summers). In addition, reasonable progress in the student's research activities is expected of all doctoral candidates.
3. During the third year of training, generally in the Winter Quarter, each doctoral student is required to give a preproposal seminar that describes evolving research plans and allows program faculty to assure that the student is making good progress toward the definition of a doctoral dissertation topic. By the end of nine quarters (excluding summers), each student must orally present a thesis proposal to a dissertation committee that generally includes at least one member of the Biomedical Informatics Executive Committee. The committee determines whether the student's general knowledge of the field, and the details of the planned thesis, are sufficient to justify proceeding with the dissertation.
4. As part of the training for the Ph.D., each student is required to be a teaching assistant for two courses approved by the Biomedical Informatics Executive Committee; one should be completed in the first two years of study.
5. The most important requirement for the Ph.D. degree is the dissertation. Prior to the oral dissertation proposal and defense, each student must secure the agreement of a member of the program faculty to act as dissertation adviser. The principal adviser need not be an active member of the Biomedical Informatics program faculty, but all committees should include at least one participating BMI faculty member.
6. No oral examination is required upon completion of the dissertation. The oral defense of the dissertation proposal satisfies the University oral examination requirement. At the completion of training, the student should give a final talk.
7. The student is expected to demonstrate an ability to present scholarly material orally and present his or her research in a lecture at a formal seminar.
8. The student is expected to demonstrate an ability to present scholarly material in concise written form. Each student is required to write a paper suitable for publication, usually discussing his or her doctoral research project. This paper must be approved by the student's academic adviser as suitable for submission to a refereed journal before the doctoral degree is conferred.
9. The dissertation must be accepted by a reading committee composed of the principal dissertation adviser, a member of the program faculty, and a third faculty member chosen from anywhere within the University.

COURSES

BIOMEDIN 156/256. Economics of Health and Medical Care—(Same as ECON 126/256.) Graduate students with research interests should take ECON 248. Institutional, theoretical, and empirical analysis of the problems of health and medical care. Topics: institutions in the health sector; measurement and valuation of health; nonmedical determinants of health; medical technology and technology assessment; demand for medical care and medical insurance; physicians, hospitals, and managed care; international comparisons. Prerequisite: ECON 50 and 102A or equivalent statistics, or consent of instructor. Recommended: ECON 51.

5 units, Aut (Bhattacharya)

BIOMEDIN 200. Biomedical Informatics Colloquium—Series of colloquia offered by program faculty, students, and occasional guest lecturers. Credit available only to students in a Biomedical Informatics degree program. May be taken no more than three times for credit.

1 unit, Aut, Win, Spr (Musen)

BIOMEDIN 201. Biomedical Informatics Student Seminar—Participants report on recent articles from the Biomedical Informatics literature or their research projects. Goal is to teach presentation skills. Credit available only to students in an Biomedical Informatics degree program. May be repeated three times for credit.

1 unit, Aut, Win, Spr (Musen)

BIOMEDIN 202. Introductory Biomedical Informatics—Overview of current research problems and computational approaches to them. Topics include medical security and privacy, electronic medical records, controlled terminologies and biomedical ontologies, electronic retrieval, technology-assisted learning environments, medical decision making and support, sequence analysis, phylogenetics, biological networks and pathways, microarray analysis, natural language processing, and protein structural analysis and prediction. For medical students; others by consent of instructor. Graduate students in the Biomedical Informatics training program may not take this class for credit.

1 unit, Aut, Win, Spr, Sum (Cheng, Fagan)

BIOMEDIN 210. Introduction to Biomedical Informatics: Fundamental Methods—(Same as CS 270.) Issues in the modeling, design, and implementation of computational systems for use in biomedicine. Topics: basic knowledge representation, controlled terminologies in medicine and biological science, fundamental algorithms, information dissemination and retrieval, knowledge acquisition, and ontologies. Emphasis is on the principles of modeling data and knowledge in biomedicine and on translation of resulting models into useful automated systems. Recommended: principles of object-oriented systems.

3 units, Aut (Musen)

BIOMEDIN 211. Introduction to Clinical Systems—(Same as CS 271.) Design and implementation of computational and information systems in complex biomedical environments. Topics: requirements analysis, workflow and organizational factors, functional specification, knowledge models, data heterogeneity and standards, component-based architectures, human-computer interaction, and system evaluation. Case studies illustrate challenges of system design for research and clinical settings. Prerequisite: 210, or consent of instructor.

3 units, Win (Das)

BIOMEDIN 212. Biomedical Informatics Project Course—(Same as CS 272.) Hands-on software building. Student teams conceive, design, specify, implement, evaluate, and report on a software project in the domain of biomedicine. Creating written proposals, peer review, providing status reports, and preparing final reports. Guest lectures from professional biomedical informatics systems builders on issues related to the process of project management. Software engineering basics. Prerequisites: 210 or 214, or consent of instructor.

3 units, Aut (Altman, Cheng, Klein)

BIOMEDIN 214. Representations and Algorithms for Computational Molecular Biology—(Same as CS 274.) Topics: algorithms for alignment of biological sequences and structures, computing with strings, phylogenetic tree construction, hidden Markov models, computing with networks of genes, basic structural computations on proteins, protein structure prediction, protein threading techniques, homology modeling, molecular dynamics and energy minimization, statistical analysis of 3D biological data, integration of data sources, knowledge representation and controlled terminologies for molecular biology, graphical display of biological data, and genetic algorithms and programming applied to biological problems. Prerequisites: programming skills and matrix algebra.

3-4 units, Spr (Altman)

BIOMEDIN 216. Lectures on Representations and Algorithms for Molecular Biology—Lecture series for BIOMEDIN 214. Recommended: familiarity with biology.

1 unit, Spr (Altman)

BIOMEDIN 216A. Biological Knowledge and Symbolic Biocomputing

3 units, Spr (Shrager)

BIOMEDIN 228. Influence Diagrams and Probabilistics Networks—(Enroll in MS&E 355.)

3 units, Win (Shachter) alternate years, not given 2006-07

BIOMEDIN 231. Computational Molecular Biology—(Enroll in BIOC 218.)

3 units (Brutlag) not given 2005-06

BIOMEDIN 233. Intermediate Biostatistics: Analysis of Discrete Data—(Same as STATS 261, HRP 261.) The 2x2 table. Chi-square test. Fisher's exact test. Odds ratios. Sampling plans; case control and cohort studies. Series of 2x2 tables. Mantel Hantzel. Other tests. *k x m* tables. Matched data logistic models. Conditional logistic analysis, application to case-control data. Log-linear models. Generalized estimating equations for longitudinal data. Cell phones and car crashes: the crossover design. Special topics: generalized additive models, classification trees, bootstrap inference.

3 units, Win (Hastie, Cobb)

BIOMEDIN 234. Biomedical Genomics—How genomics is influencing medical research and health-care delivery, illuminating the genomic discoveries being translated into diagnostic and therapeutic medical applications. Themes: the relevance of human genome project and functional genomics to inherited and acquired diseases, and the role of public databases and computational methods for solving problems in biology. Human genetic variation, SNPs, comparative genomics, computer models of biological processes, microbial genomics, pharmacogenomics, structure-based drug design, gene therapy. Case studies demonstrate the use of information technologies for converting molecular biological data into knowledge that can improve patient care and accelerate the discovery of new therapeutics.

3 units, Win (Shafer)

BIOMEDIN 239. Computer-Based Medical Education—Directed reading and research for graduate students in web-based hypermedia and simulation techniques in education. Possible topics: replacement of a lecture or a lab session, distance learning, student models, and clinical case simulations.

1-6 units, Aut, Win, Spr, Sum (Dev)

BIOMEDIN 240. Causal Models in Biomedical Informatics— Computational formalisms for encoding causal models in biological and biomedical domains from recent work on modeling genetic networks; also models that arise in medical applications. Readings include papers that describe causal models within a specific representational framework. Associated methods for reasoning over knowledge structures in that paradigm and for inducing such models from data. Goal is to understand how to represent, reason about, and discover biological knowledge in each framework, along with the strengths and weaknesses of that formalism.

3 units (Langley) not given 2005-06

BIOMEDIN 251. Outcomes Analysis—(Same as HRP 252.) Introduction to methods of conducting empirical studies which use large existing medical, survey, and other databases to ask both clinical and policy questions. Econometric and statistical models used to conduct medical outcomes research. How research is conducted on medical and health economics questions when a randomized trial is impossible. Problem sets emphasize hands-on data analysis and application of methods, including re-analyses of well-known studies. Prerequisites: one or more courses in probability, and statistics or biostatistics.

3 units, Spr (Bhattacharya)

BIOMEDIN 262. Computational Genomics—(Same as CS 262.) Applications of computer science to genomics, and concepts in genomics from a computer science point of view. Topics: dynamic programming, sequence alignments, hidden Markov models, Gibbs sampling, and probabilistic context-free grammars. Applications of these tools to sequence analysis: comparative genomics, DNA sequencing and assembly, genomic annotation of repeats, genes, and regulatory sequences, microarrays and gene expression, phylogeny and molecular evolution, and RNA structure. Prerequisites: 161 or familiarity with basic algorithmic concepts. Recommended: basic knowledge of genetics.

3 units, Win (Batzoglou)

BIOMEDIN 273. Algorithms for Structure and Motion in Biology—(Same as CS 273.) Algorithms motivated by challenges in predicting molecule properties in silico. Topics: geometric and kinematic models of biomolecules (proteins, ligands), conformation spaces, obtention of structure from experimental data, finding sequence and structural similarities, molecular surfaces and shape analysis, energy calculation, detection of steric clashes and proximity computation, conformation sampling, threading, and study folding and binding motions.

3 units, Spr (Batzoglou, Latombe)

BIOMEDIN 278. Probabilistic Models in Artificial Intelligence—(Enroll in CS 228.)

3 units, Win (Koller, Elidan)

BIOMEDIN 299. Directed Reading and Research
1-18 units, Aut, Win, Spr, Sum (Staff)

BIOMEDIN 301. Special Topics in Biomedical Informatics
1-6 units, Aut, Win, Spr, Sum (Staff)

BIOMEDIN 303. Statistics for Research—Statistical methods commonly used in research. Emphasis is on when and how to use the methods rather than on proofs. How to describe data and detect unusual values, compare treatment effects, interpret p-values, detect and quantify trends, detect and measure association and correlation, determine the sample size and power for an experiment, and choose statistical tests and software. Topics include descriptive statistics (mean, median, standard deviation, standard error), probability, paired and unpaired t-tests, analysis of variance, correlation, regression, chi-square, discriminant analysis, and power and sample size. Statistical analysis software including Excel and Statistica.
1 unit (M. Walker) alternate years, given 2006-07

BIOMEDIN 328. Computational Structural Biology—(Enroll in SBIO 228, BIOPHYS 228.)
3 units, Aut, Spr (Levitt)

BIOMEDIN 329. Topics in Artificial Intelligence—(Enroll in CS 329.)
3 units, Aut, Win, Spr (Staff)

BIOMEDIN 348. Computer Graphics: Image Synthesis Techniques—(Enroll in CS 348B.)
3-4 units, Spr (Hanrahan)

BIOMEDIN 366. Computational Biology—(Same as STATS 166/366.) Methods to understand sequence alignments and phylogenetic trees built from molecular data, and general genetic data. Phylogenetic trees, median networks, microarray analysis, Bayesian statistics. Binary labeled trees as combinatorial objects, graphs, and networks. Distances between trees. Multivariate methods (PCA, CA, multidimensional scaling). Combining data, nonparametric inference. Algorithms used: branch and bound, dynamic programming, Markov chain approach to combinatorial optimization (simulated annealing, Markov chain Monte Carlo, approximate counting, exact tests). Software such as Matlab, Phylip, Seq-gen, Arlequin, Puzzle, Splitstree, XGobi.
2-3 units, Aut (Holmes)

BIOMEDIN 374. Algorithms in Biology—(Same as CS 374.) Algorithms and computational models applied to molecular biology and genetics. Topics vary annually. Possible topics include biological sequence comparison, annotation of genes and other functional elements, molecular evolution, genome rearrangements, microarrays and gene regulation, protein folding and classification, molecular docking, RNA secondary structure, DNA computing, and self-assembly. May be repeated for credit. Prerequisites: 161, 262 or 274, or BIOCHEM 218, or equivalents.
2-3 units, Aut (Batzoglou)

BIOMEDIN 379. Interdisciplinary Topics: Computational Systems Biology—(Enroll in CS 379.)
3 units, Win (Staff)

BIOMEDIN 390A,B,C. Curricular Practical Training—Provides educational opportunities in biomedical informatics research. Qualified biomedical informatics students engage in internship work and integrate that work into their academic program. Students register during the quarter they are employed and must complete a research report outlining their work activity, problems investigated, key results, and any follow-up on projects they expect to perform. BIOMEDIN 390A, B, and C may each be taken only once.
1 unit, Aut, Win, Spr, Sum (Musen)

BIOMEDIN 432. Analysis of Costs, Risks, and Benefits of Health Care—(Same as MGTECON 332, HRP 392.) For graduate students. The principal evaluative techniques for health care, including utility assessment, cost-effectiveness analysis, cost-benefit analysis, and decision analysis. Emphasis is on the practical application of these techniques. Group project presented at end of quarter. Guest lectures by experts from the medical school, pharmaceutical industry, health care plans, and government.
4 units, Aut (Garber, Owens)

CANCER BIOLOGY PROGRAM

Program Director: Joseph Lipsick (Pathology and Genetics)
Committee on Cancer Biology: Steven Artandi (Medicine), Laura Attardi (Radiation Oncology, Genetics), Jeffrey Axelrod (Pathology), Dean Felsher (Medicine, Pathology), Joseph Lipsick (Pathology, Genetics), Anthony Oro (Dermatology), Timothy Stearns (Biological Sciences, Genetics)

Program Offices: Alway Building, 300 Pasteur Drive, Room M105
Mail Code: 94305-5121
Phone: (650) 723-6198
Email: Gina.Rocca@stanford.edu
Web Site: http://www.stanford.edu/group/cancerbio/

Courses given in Cancer Biology have the subject code CBIO. For a complete list of subject codes, see Appendix.

Established in 1978, the Cancer Biology Program at Stanford University includes an interdisciplinary program leading to the Ph.D. degree. During the past 25 years, understanding of cancer has increased dramatically with the discovery of oncogenes, tumor suppressor genes, pathways of DNA damage and repair, cell cycle regulation, angiogenesis and responses to hypoxia, and recent glimpses into the molecular basis of metastasis. In addition, methods of parallel analysis including gene expression arrays, protein arrays, and tissue arrays have begun to refine and redefine the taxonomy of cancer diagnosis. This explosion of basic and clinical science has, in turn, resulted in the first successful cancer chemotherapies and immunotherapies based on knowledge of specific molecular targets. Stanford presents a unique environment to pursue interdisciplinary cancer research because the School of Medicine, the School of Humanities and Sciences, and the School of Engineering are located on a single campus, all within walking distance of one another.

The goal of the Cancer Biology Ph.D. program is to provide students with education and training that enables them to make significant contributions to this remarkable field. Course work during the first year is designed to provide a broad understanding of the molecular, genetic, cell biological, and pathobiological aspects of cancer. Students also learn about the current state of the epidemiology, clinical diagnosis, treatment, and prevention of human cancers. Equally important during the first year is a series of three rotations in research laboratories chosen by each student. By the beginning of the second year, each student chooses a research adviser and begins work on the dissertation project. A qualifying examination must be completed by the end of the second year. An annual Cancer Biology conference at Asilomar on the Pacific Ocean provides students with an opportunity to present their research to one another and to faculty. The expected time to degree is four to five years.

Students are not limited to a single department in choosing their research adviser. The Cancer Biology Ph.D. program currently has approximately 50 graduate students located in various basic science and clinical departments throughout the School of Medicine and the School of Humanities and Sciences.

GRADUATE PROGRAM

DOCTOR OF PHILOSOPHY

University requirements for the Ph.D. are described under the "Graduate Degrees" section of this bulletin.

A small number of well-qualified applicants are admitted to the program each year. Applicants should have completed an undergraduate major in the biological sciences; applicants with undergraduate majors in physics, chemistry, or mathematics may be admitted if they complete background training in biology during the first two years of study. During the first year, each student is required to take a minimum of three, one quarter laboratory rotations. Students must choose a dissertation adviser prior to the end of Summer Quarter, first year, but not before the end of Spring Quarter, first year.

The requirements for the Ph.D. degree are as follows:

1. Training in biology equivalent to that of an undergraduate biology major at Stanford.

2. Completion of the following courses:
   a) CBIO 241. Molecular, Cellular, and Genetic Basis of Cancer
   b) GENE 203. Advanced Genetics
   c) MCP 221. Cell Biology of Physiological Processes
   d) MPHA 210. Signal Transduction Pathways and Networks
   e) CBIO 280. Cancer Biology Journal Club; required for first- andsecond-year graduate students in Autumn, Winter, and Spring quarters.
   f) MED 255. Responsible Conduct in Research; with permission, may be audited.
3. At least 6 units of additional cancer biology-related, graduate-level courses. Course work taken is determined in consultation with the student's adviser and/or the Program Director.
4. Presentation of research results at the annual Cancer Biology Conference on at least three occasions, at least one being an oral presentation.
5. Successful completion of a qualifying examination in Cancer Biology is required for admission to Ph.D. candidacy. The exam consists of an NIH-style written grant proposal not to exceed ten pages (excluding references), and an oral examination. The examining committee consists of three faculty members from the Cancer Biology Program and does not include the student's dissertation adviser. The composition of this committee is chosen by the student and dissertation adviser and must be submitted to and approved by the program director prior to the end of Autumn Quarter, second year. The qualifying examination must be taken prior to the end of Spring Quarter, second year. If necessary, one retake is permitted prior to the end of Summer Quarter, second year. After the qualifying examination has been successfully completed, the student is required to form a dissertation reading committee that includes the student's adviser and three other members of the Academic Council with appropriate expertise. Each student is required to arrange annual meetings (more frequently, if necessary) of the dissertation reading committee, at which time oral presentations of progress during the past year and a plan of study for the coming year are presented and discussed. Completion of each annual committee meeting must be communicated in writing to the Program Director by the adviser by the end of Spring Quarter each year.
6. The major accomplishment of each successful Ph.D. student is the presentation of a written dissertation resulting from independent investigation that contributes to knowledge in the area of cancer biology. An oral examination is also required for the Ph.D. degree. In the Cancer Biology Program, a public seminar (one hour) is presented by the Ph.D. candidate, followed by a closed-door oral examination. The oral examination committee consists of at least four examiners (the members of the doctoral dissertation reading committee) and a chair. The oral examination chair may not have a full or joint appointment in the adviser's or student's home department. However, a courtesy appointment does not affect eligibility. The oral examination chair may be from the same department as any other member(s) of the examination committee. All members of the oral examination committee are normally members of the Academic Council, as the oral examination chair must be. With the prior approval of the program director or school dean, one of the examiners may be a person who is not a member of the Academic Council if that individual contributes expertise not otherwise available. Official responsibility for selecting the oral examination chair rests with the program. Cancer Biology delegates this to the student and dissertation adviser.

COURSES

Course and lab instruction in the Cancer Biology Program conform to the "Policy on the Use of Vertebrate Animals in Teaching Activities," the text of which is available at http://www.stanford.edu/dept/DoR/rph/8-2.html.

CBIO 101. Cancer Biology—Experimental approaches to understanding the origins, diagnosis, and treatment of cancer. Focus on key experiments and discoveries with emphasis on genetics, molecular biology, and cell biology. Topics include carcinogens, tumor virology, oncogenes, tumor suppressor genes, cell cycle regulation, angiogenesis, invasion and metastasis, cancer genomics, cancer epidemiology, and cancer therapies. Discussion sections based on primary research articles that describe key experiments in the field. Prerequisites: BIOSCI 41/42

4 units, Spr (Lipsick)

CBIO 241. Molecular, Cellular, and Genetic Basis of Cancer—Core course required for all first-year Cancer Biology graduate students. Focus is on key experiments and classic primary research papers in cancer biology. Letter grade required. Undergraduates require consent of course director.

5 units, Aut (Lipsick)

CBIO 260. Teaching in Cancer Biology—Credit is given for assisting a professor in the teaching of a cancer biology course. Prerequisite: consent of supervising instructor.

1-10 units, Aut, Win, Spr (Staff)

CBIO 280. Cancer Biology Journal Club—Focus is on recent papers in the literature presented by graduate students. When possible, discussion of these papers relates to and precedes cancer-related seminars at Stanford. Attendance at the relevant seminar required. Required for and limited to first- and second-year graduate students in the Cancer Biology Program.

1 unit, Aut, Win, Spr (Lipsick)

CBIO 299. Research—Cancer Biology Ph.D. students must register as soon as they begin dissertation-related research work.

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

COMPARATIVE MEDICINE

Chair: Linda C. Cork
Professor: Linda C. Cork
Associate Professors: Donna Bouley, Paul Buckmaster, Sherril Green, Shaul Hestrin, Ravi Tolwani
Assistant Professors: Catherine Beckwith, Corinna Darian-Smith, Manuel Garcia

Department Offices: Edwards Building, Room R321
Mail Code: 94305-5342
Phone: (650) 498-5080
Web Site: http://med.stanford.edu/compmed/

Courses given in Comparative Medicine have the subject code COMPMED. For a complete list of subject codes, see Appendix.

The Department of Comparative Medicine is a clinical department and does not offer degrees, but its faculty offer courses and participate in teaching in other departments at the undergraduate and graduate level. Faculty members, most of whom are specialists in some veterinary medical specialty, also accept students to participate in ongoing research projects within the department and assist students with special research projects.

The discipline of Comparative Medicine utilizes the differences and similarities among species to understand basic biologic and disease mechanisms. Comparative Medicine incorporates the use of spontaneous or induced disease models as one of several approaches to research. The research interests of faculty members are in neuroscience, infectious diseases, neuropathology, and molecular genetics.

COURSES

Course and lab instruction in the Department of Comparative Medicine conforms to the "Policy on the Use of Vertebrate Animals in Teaching Activities," the text of which is available at http://www.stanford.edu/dept/DoR/rph/8-2.html.

COMPMED 81N. Comparative Anatomy and Physiology of Mammals—Stanford Introductory Seminar. Preference to freshmen. Comparative approach to common mammals, laboratory, and domestic species. The unique adaptations of each species in terms of its morphological, anatomical, and behavioral characteristics. How these species interact with humans and the historical relationships between humans and these animal species.

3 units, Win (Bouley)

COMPMED 83Q. Horse Medicine—Stanford Introductory Seminar. Preference to sophomores. The most common equine diseases, ranging from colic to lameness. Equine anatomy and physiology relevant to topics in equine medicine. Equine infectious diseases, respiratory disorders, care of the newborn foal, a what's-your-diagnosis problem series, and emergency first aid strategies.

1-2 units, Spr (Green)

COMPMED 85N. Animal Models in Biomedical Research—Stanford Introductory Seminar. Preference to freshmen. How and why animals are used in biomedical science and how animal models have advanced biomedical research. Documenting the humane care and treatment of laboratory animals in research and the science of animal modeling for the purpose of studying human disease. Animal models as an important tool to study mechanisms of disease and develop new therapies. Examples of animal models in medical disciplines. Genetic engineering and other techniques used to develop animal models, and innovative approaches to develop therapies for disease including gene therapy approach.

3 units, Aut (Green, Tolwani)

COMPMED 106. A Primate Perspective on Brain Evolution—How to distinguish primate subgroups; how to place primates among mammals, and humans among primates, with respect to body structure, brain organization, and function. The unique characteristics of primates; what factors contributed to the evolution of primate groups, hominids, and modern human beings. The role of the hand in primate evolution. What extant primates reveal about language acquisition. How these changes are reflected in the sensorimotor organization of the primate brain. Prerequisite: freshman biology.

3 units, Aut (Darian-Smith)

COMPMED 107/207. Comparative Neuroanatomy—(Graduate students register for 207.) Functional organization and evolution of the vertebrate nervous system. Topics include paleoneurology, cladistic analysis, allometry, mosaic versus concerted evolution, and evolution of brain region structure, connectivity, and neurons. Comparisons between structure and function of vertebrate forebrains including hippocampi. Evolution of the primate visual and sensorimotor central nervous system as related to vocalization, socialization, and intelligence.

4 units, Aut (Buckmaster, Darian-Smith)

COMPMED 108/208. Animals Advancing Biomedical Technology—(Graduate students register for 208.) Open to graduate students and undergraduates in all degree programs, especially computer science, engineering, or the BioX program. Lectures by faculty members in Comparative Medicine and invited speakers from the biomedical industry. The role of animals in biomedical research. Possible topics include: comparative anatomy and physiology of species used in biotechnology and medical device research; selecting an animal model for a research project; the genetically engineered mouse; and preclinical, animal testing of medical devices intended for use in humans. No background in animal biology required.

2 units (Cork) not given 2005-06

COMPMED 215. Synaptic Transmission—(Enroll in MCP 215.)

5 units, Aut (Smith, Madison)

UNDERGRADUATE INDIVIDUAL WORK

COMPMED 198. Directed Reading—May be taken as a prelude to research and may also involve participation in a lab or research group seminar and/or library research.

1-3 units, Aut, Win, Spr, Sum (Staff)

COMPMED 199. Undergraduate Research—By arrangement with department faculty. May be repeated for credit.

1-3 units Aut, Win, Spr, Sum (Staff)

FOR GRADUATE STUDENTS

COMPMED 299. Directed Reading—May be repeated for credit. Prerequisite: consent of instructor.

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

COMPMED 399. Research—Opportunities are available in comparative medicine and pathology, immuno-histochemistry, electron microscopy, molecular genetics, quantitative morphometry, neuroanatomy and neurophysiology of the hippocampus, pathogenesis of intestinal infections, immunopathology, biology of laboratory rodents, anesthesiology of laboratory animals, gene therapy of animal models of neurodegenerative diseases, and development and characterization of transgenic animal models. Enrollment limited to 6 . Prerequisite: consent of instructor.

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

DEVELOPMENTAL BIOLOGY

Emeriti: (Professors) David A. Clayton, David S. Hogness, A. Dale Kaiser
Chair: Margaret Fuller
Associate Chair: Lucy Shapiro
Professors: Ben Barres, Gerald Crabtree, Margaret Fuller, Stuart Kim, David Kingsley, Roeland Nusse, Matthew Scott, Lucy Shapiro, James Spudich, Irving Weissman
Associate Professors: William Talbot, Anne Villeneuve
Assistant Professor: Seung Kim
Associate Professor (Teaching): Ellen Porzig
Associate Professor (Research): Harley McAdams

Courses given in Development Biology have the subject code DBIO. For a complete list of subject codes, see Appendix.

A fundamental problem in biology is how the complex set of multicellular structures that characterize the adult animal is generated from the fertilized egg. Advances at the molecular level, particularly with respect to the genetic control of development, have been explosive. These advances represent the beginning of a major movement in the biological sciences toward the understanding of the molecular mechanisms underlying developmental decisions and the resulting morphogenetic processes. This new thrust in developmental biology derives from the extraordinary methodological advances of the past decade in molecular genetics, immunology, and biochemistry. However, it also derives from groundwork laid by the classical developmental studies, the rapid advances in cell biology and animal virology, and from models borrowed from prokaryotic systems. Increasingly, the work is directly related to human diseases, including oncogene function and inherited genetic disease.

The Department of Developmental Biology includes a critical mass of scientists who are leading the thrust in developmental biology and who can train new leaders in the attack on the fundamental problems of development. Department labs work on a wide variety of organisms from microbes to worms, flies, and mice. The dramatic evolutionary conservation of genes that regulate development makes the comparative approach of the research particularly effective. Scientists in the department labs have a very high level of interaction and collaboration. The discipline of developmental biology draws on biochemistry, cell biology, genetics, and molecular biology.

The department is located in the Beckman Center for Molecular and Genetic Medicine within the Stanford University Medical Center.

GRADUATE PROGRAM

MASTER OF SCIENCE

Students in the Ph.D. program in Developmental Biology may apply for an M.S. degree, assuming completion of their course requirements and preparation of a written proposal. The master's degree awarded by the Department of Developmental Biology does not include the possibility of minors for graduate students enrolled in other departments or programs.

Students are required to take, and satisfactorily complete, at least three lecture courses offered by the department, including 210, Developmental Biology. In addition, students are required to take three courses outside the department. Students are also expected to attend Developmental Biology seminars and journal clubs. In addition, the candidate must complete a re-

search paper proposing a specific experimental approach and background in an area of science relative to developmental biology.

DOCTOR OF PHILOSOPHY

University requirements for the Ph.D. are described in the "Graduate Degrees" section of this bulletin.

The graduate program in Developmental Biology leads to the Ph.D. degree. The department also participates in the Medical Scientists Training Program in which individuals are candidates for both the M.D. and Ph.D. degrees.

Students are required to take, and satisfactorily complete, at least six courses, including Developmental Biology (210); Advanced Genetics (203); Frontiers in Biological Sciences (215); and an advanced molecular biology, biochemistry, or biophysics course. Students are also expected to attend Developmental Biology seminars and journal clubs.

Successful completion of a qualifying examination is required for admission to Ph.D. candidacy. The examination consists of two parts. One proposal is on a subject different from the dissertation research and the other proposal is on the planned subject of the thesis. The final requirements of the program include the presentation of a Ph.D. dissertation as the result of independent investigation and constituting a contribution to knowledge in the area of developmental biology. The student must then successfully pass the University oral examination which is taken only after the student has substantially completed his or her research. The examination is preceded by a public seminar in which the research is presented by the candidate. The oral examination is conducted by a dissertation reading committee.

COURSES

Course and lab instruction in the Department of Developmental Biology conforms to the "Policy on the Use of Vertebrate Animals in Teaching Activities," the text of which is available at http://www.stanford.edu/dept/DoR/rph/8-2.html.

DBIO 156. Human Developmental Biology and Medicine—(Same as HUMBIO 156.) The biological, medical, and social aspects of normal and abnormal human development. Topics: in vitro fertilization and embryo transfer; gene and cell therapy; gametogenesis; pattern formation in the nervous system and limb development; gene and grand multiple pregnancies; prematurity, in utero effects of teratogens; sex determination and differentiation; growth control; gigantism and dwarfism; neural tube defects; cardiac morphogenesis; progress in the developmental biology of humans. Limited enrollment. Prerequisites: Human Biology or Biological Sciences core, or consent of instructor.

4 units, Spr (Porzig)

DBIO 198. Research

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

DBIO 199. Undergraduate Research

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

DBIO 201. Development and Disease Mechanisms—Mechanisms that direct human development from conception to birth. Conserved molecular and cellular pathways regulate tissue and organ development; errors in these pathways result in congenital anomalies and human diseases. Topics: molecules regulating development, cell induction, developmental gene regulation, cell migration, programmed cell death, pattern formation, stem cells, cell lineage, and development of major organ systems. Emphasis on links between development and clinically significant topics including infertility, assisted reproductive technologies, contraception, prenatal diagnosis, multiparity, teratogenesis, inherited birth defects, fetal therapy, adolescence, cancer, and aging.

4 units, Aut (Kingsley, Crabtree, Porzig, Seung, Kim, Nusse, Scott)

DBIO 202. Infertility: Mechanisms of Disease and Clinical Frontiers—(Same as OBGYN 202.) Primary literature in basic and clinical science, and demonstrations of assisted reproductive technologies (ART). Techniques include in vitro fertilization including micromanipulation procedures such as intracytoplasmic sperm injection and the culture of blastocysts, using mouse gametes, and pre-embryos. Students observe procedures in the ART clinic. Recommended: DBIO 201 or consent of instructors.

3-4 units, Win (Porzig, Behr)

DBIO 203. Advanced Genetics—(Same as BIOSCI 203, GENE 203.) For graduate students in Bioscience programs; may be appropriate for graduate students in other programs. The genetic toolbox. Examples of analytic methods, genetic manipulation, genome analysis, and human genetics. Emphasis is on use of genetic tools in dissecting complex biological pathways, developmental processes, and regulatory systems. Faculty-led discussions sections with evaluation of papers. Students with minimal experience in genetics should prepare by working out problems in college level textbooks.

4 units, Aut (Barsh, Kim, Sidow, Stearns)

DBIO 210. Developmental Biology—Current areas of research in developmental biology. How organismic complexity is generated during embryonic and post-embryonic development. The roles of genetic networks, induction events, cell lineage, maternal inheritance, cell-cell communication, and hormonal control in developmental processes in well-studied organisms such as vertebrates, insects, and nematodes. Team-taught. Students meet with faculty to discuss current papers from the literature. Prerequisite: graduate standing, consent of instructor. Recommended: familiarity with basic techniques and experimental rationales of molecular biology, biochemistry, and genetics.

5 units, Spr (Talbot, Nusse, Crabtree, Fuller, Kim, Kingsley, Scott)

DBIO 215. Frontiers in Biological Research—(Same as BIOC 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, Win, Spr (Harbury, Kingsley, Baker)

DBIO 232. Readings in the History of Molecular Biology—Prerequisite: graduate standing.

2 units (Kaiser) not given 2005-06

DBIO 299. Directed Reading—May be repeated for credit. Prerequisite: consent of instructor.

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

DBIO 399. Research—Investigations sponsored by faculty members. May be repeated for credit. Prerequisite: consent of instructor.

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

EPIDEMIOLOGY PROGRAM

Director: Victor W. Henderson (Professor, Health Research and Policy, and Neurology and Neurological Sciences)

Advisory Committee: Stephen P. Fortmann (Professor, Medicine), John R. Huguenard (Associate Professor, Neurology and Neurological Sciences), Charles C. Prober (Professor, Pediatrics, and Microbiology and Immunology), Robert Tibshirani (Professor, Health Research and Policy)

Core Faculty and Academic Teaching Staff: Raymond R. Balise (Lecturer), Gary D. Friedman* (Consulting Professor), Mark Hlatky (Professor), Victor W. Henderson* (Professor), Abby C. King* (Professor), Lorene M. Nelson* (Associate Professor), Julie Parsonnet* (Professor), Rita A. Popat (Instructor), Dee W. West* (Professor), Alice S. Whittemore* (Professor)

Instructor: Kristin Cobb

* Member of the program steering committee

Program Offices: HRP Redwood Building, Room T213D,
Mail Code: 94305-5405
Phone: (650) 723-5456
Email: epiprogram@med.stanford.edu
Web Site: http://www.stanford.edu/dept/HRP/epidemiology/

GRADUATE INTERDISCIPLINARY PROGRAM IN EPIDEMIOLOGY

The Graduate Interdisciplinary Program in Epidemiology offers instruction and interdisciplinary research opportunities leading to the M.S. degree in Epidemiology. Core faculty and academic teaching staff are administratively housed in the Department of Health Research and Policy. Affiliated faculty come from Stanford University departments and centers and Bay Area research facilities. The program provides researchers from diverse clinical backgrounds with the knowledge and skills to become clinical investigators; it also provides an introduction to Epidemiology for students without a clinical background or research experience and students with research experience in the behavioral and social sciences. Research strengths include cancer epidemiology, cardiovascular disease epidemiology, infectious disease epidemiology, musculoskeletal disease epidemiology, neuroepidemiology, epidemiologic methods, genetic epidemiology, reproductive epidemiology and women's health, and environmental and occupational epidemiology.

The program recognizes two academic tracks leading to the M.S. degree: the Traditional Epidemiology track for students without prior clinical training who are considering careers in epidemiology and for behavioral and social scientists who wish to bring an epidemiologic orientation to their research; and the Clinical Epidemiology track for physicians and others with specific interests in clinical research who receive training in epidemiologic methods, statistical analysis, and other areas essential to patient-oriented clinical research. Students in this track are typically clinical investigators with an M.D. or comparable clinical degree, often during the fellowship stage of their training.

To receive the degree, students in both instructional tracks are expected to obtain a grounding in epidemiologic methods and applied biostatistics and to demonstrate research skills through the completion of a master's thesis. Required courses are HRP 225, Design and Conduct of Clinical and Epidemiologic Studies; HRP 226, Advanced Epidemiologic and Clinical Research Methods; HRP 236, Epidemiology Research Seminar; HRP 259, Introduction to Probability and Statistics for Epidemiology; HRP 261, Intermediate Biostatistics; HRP 262, Regression, Prediction, Survival Analysis; and a master's thesis with 12 or more units of credit. Students in the Clinical Epidemiology track must also complete HRP 251, Design and Conduct of Clinical Trials; and MED 255, Responsible Conduct of Research. All students are required to select at least two other courses in Epidemiology. Students are assigned a methodology mentor, who is usually from the Department of Health Research and Policy, and a research mentor, who may be from another department. For the students in the Clinical Epidemiology track, the research mentor is often an affiliated faculty member from the department of the student's clinical specialty. Other programmatic requirements are described in *Graduate Interdisciplinary Program in Epidemiology, Information and Guidelines*, available from the educational coordinator in the Department of Health Research and Policy.

COURSES

The course listings of individual departments participating in the Graduate Interdisciplinary Program in Epidemiology should be consulted for complete descriptions.

GENETICS

Emeritus: (Professor) Luca Cavalli-Sforza, Leonard Herzenberg
Chair: Richard M. Myers
Professors: Russ Altman, Gregory S. Barsh, Stanley N. Cohen, Ronald W. Davis, Andrew Fire, Uta Francke, Margaret Fuller, Mark Kay, Stuart Kim, Joseph Lipsick, Richard M. Myers, Matthew Scott
Associate Professors: Michele Calos, Arend Sidow, Tim Stearns, Anne Villenueve, Douglas Vollrath
Assistant Professors: Laura Attardi, Julie Baker, Anne Brunet, James Ford, Julien Sage, Joanna Mountain, , Man-Wah Tan
Professor (Research): Leonore Herzenberg
Associate Professors (Research): J. Michael Cherry, Zijie Sun
Assistant Professor (Research): Gavin Sherlock
Courtesy Professor: Hank Greely
Consulting Professor: David Cox

Mail Code: 94305-5120
Phone: (650) 723-3335
Email: genetics-info@genome.stanford.edu
Web Site: http://genome-www.stanford.edu/genetics/

Courses given in Genetics have the subject code GENE. For a complete list of subject codes, see Appendix.

GRADUATE PROGRAMS

University requirements for the Ph.D. degree are described in the "Graduate Degrees" section of this bulletin.

The Ph.D. program in the Department of Genetics offers graduate students the opportunity to pursue a discipline that encompasses not just a set of tools but a coherent and fruitful way of thinking about biology and medicine. All major areas of genetics are represented in the department, including human genetics (molecular identification of Mendelian traits and the pathophysiology of genetic disease, gene therapy, genetic epidemiology, analysis of complex traits, genetic anthropology, and human evolution), and application of model organisms such as bacteria, yeast, flies, worms, zebrafish, or mice to basic questions in biomedical research. The department is especially strong in genomic and bioinformatic approaches to genome biology and evolution, and includes several genome-scale databases such as the *Saccharomyces* Genome Database (SGD), the Stanford Microarray Database (SMD), and the Pharmacogenetics and Pharmacogenomics Knowledge Base (PharmGKB), the Stanford Human Genome Center (SHGC), and, administered through the Department of Biochemistry, the Stanford Genome Technology Center (SGTC).

Exposure to the broad intellectual scope that characterizes and integrates the department is provided by laboratory rotations, dissertation research, a series of advanced courses in genetics and other areas of biomedical science, seminar series, journal clubs, and an annual three-day retreat that includes faculty members, students, postdoctoral fellows, and staff scientists. A strong emphasis is placed on interactions and collaborations among students, postdoctoral students, and faculty members within the department and throughout the campus.

Located in the School of Medicine, the department includes approximately 50 graduate students, 75 postdoctoral fellows, 50 staff members, and 30 faculty. In addition to interactions within the department, graduate students have contact with a much larger number of students, fellows, and faculty programs throughout the School of Medicine and the University.

During their first year, graduate students in the department take advanced graduate courses and sample several areas of research by doing rotations in three or four of the department's laboratories. At the end of the first three quarters, students may select a laboratory in which to do their dissertation research. While the dissertation research is generally performed in one laboratory, collaborative projects with more than one faculty member are encouraged. In addition to interacting with their faculty preceptor, graduate students receive input regularly from other faculty members who serve as advisers on their dissertation committee. Study for the Ph.D. generally requires between four and five years of graduate

work, most of which is focused on dissertation research.

Students are generally enrolled in the program to receive the Ph.D. degree, although a limited number of M.D. candidates can combine research training in genetics with their medical studies. Ph.D. candidates who have passed the qualifying exam in the second year can opt to receive the M.S. degree.

There are opportunities for graduate students to teach in graduate-level and professional-school courses. In addition, students are encouraged to participate in educational outreach activities coordinated by the department, which include opportunities to interact with secondary school students and teachers, lay groups, and local science museums.

Students who have recently received a bachelor's, master's, M.D., or Ph.D. degree in related fields may apply for graduate study in the Department of Genetics. Prospective students must have a background in general biology, mathematics, physics and chemistry. Decisions for admission are based on comparison of the relative merits of all the candidates' academic abilities and potential for research. Interviews take place in late February or early March and successful applicants are offered admission by early spring. Students who wish to pursue a combined M.D./Ph.D. degree are considered for admission into the graduate program in the Department of Genetics after they have been admitted to the M.D. program in the School of Medicine. All applicants are considered equally regardless of race, color, creed, religion, national origin, sexual preference, age, or gender.

Students begin graduate studies in the Autumn Quarter. Prospective students are encouraged to start the application process early to ensure that they are able to submit a complete application by the December deadline. All students accepted into the Ph.D. program in the Department of Genetics are provided with full tuition and a stipend to cover the cost of living. Two training grants from the National Institutes of Health provide major support for the graduate training program in the department. Other student support is provided by departmental funds and from research grants, both federal and private, of the faculty. In addition, a number of graduate students are funded by fellowships, including those from the National Science Foundation. Prospective students are encouraged to apply for a fellowship by requesting an application from the National Science Foundation, http://www.nsf.gov. The application is due on November 1 of each year.

COURSES

For further information on the availability of courses, consult the quarterly *Time Schedule*, or inquire at the departmental office. Additional courses in or related to genetics are included in the listings of the departments of Biological Sciences, Biochemistry, Developmental Biology, Microbiology and Immunology, Neuroscience, Biomedical Informatics, and Structural Biology.

GENE 104Q. Law and the Biosciences—Stanford Introductory Seminar. Preference to sophomores. Focus is on human genetics; also assisted reproduction and neuroscience. Topics include forensic use of DNA, genetic testing, genetic discrimination, eugenics, cloning, pre-implantation genetic diagnosis, neuroscientific methods of lie detection, and genetic or neuroscience enhancement. Student presentations on research paper conclusions.

3 units, Spr (Greely)

GENE 106Q. The Heart of the Matter—Stanford Introductory Seminar. Preference to sophomores. The molecular and biochemical basis of life. Emphasis is on the methods and scientific logic that lead to advances in knowledge. The human heart and circulatory system is the unifying theme for topics such as the constituents and activities of cells, tissues, and organs; the chemicals and proteins that carry on life processes; the biotechnology revolution; the role of genes in human disease and normal functions; and the Human Genome Project. How scientific knowledge is built up through research; how biology initiates advances in medicine; and how science, engineering, and economics interact in biotechnology. Student presentations, demonstrations, and field trips. GER:DB-NatSci

3 units, Win (Myers, Simoni)

GENE 109Q. Genomics: A Technical and Cultural Revolution—Stanford Introductory Seminar. Preference to sophomores. For nonscience majors. Concepts of genomics, high-throughput methods of data collection, and computational approaches to analysis of data. The social, ethical, and economic implications of genomic science. Students may focus on computational or social aspects of genomics.

3 units, Win (Altman)

GENE 199. Undergraduate Individual Research—Prerequisite: consent of instructor. May be repeated for credit.

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

GENE 202. Human Genetics—Theoretical and experimental basis for the genetics of human health and disease. Molecular, chromosomal, biochemical, developmental, cancer, and medical genetics, emphasizing the last. Clinical case discussions. Prerequisites: biochemistry; basic genetics.

4 units, Aut (Ford, Myers)

GENE 203. Advanced Genetics—(Same as BIOSCI 203, DBIO 203.) For graduate students in Bioscience programs; may be appropriate for graduate students in other programs. The genetic toolbox. Examples of analytic methods, genetic manipulation, genome analysis, and human genetics. Emphasis is on use of genetic tools in dissecting complex biological pathways, developmental processes, and regulatory systems. Faculty-led discussions sections with evaluation of papers. Students with minimal experience in genetics should prepare by working out problems in college level textbooks.

4 units, Aut (Barsh, Kim, Sidow, Stearns)

GENE 211. Genomics—Genome evolution, organization, and function; technical, computational, and experimental approaches; hands-on experience with representative computational tools used in genome science; and a beginning working knowledge of PERL.

3 units, Win (Cherry, Myers, Sidow, Sherlock)

GENE 215. Frontiers in Biological Research—(Same as BIOC 215, DBIO 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, Win, Spr (Harbury, Kingsley, Baker)

GENE 222. Method and Logic in Experimental Genetics—For graduate students only. How experimental strategies are applied to biological questions irrespective of discipline boundaries. Examples include purifying activities from complex mixtures, localizing molecules in space and time, discovering macromolecular interactions, inferences from sequence similarity, using structure to elucidate function, and applying genomics to biological problems. Weekly discussion of two representative papers selected by faculty and a student presentation of a third paper which illustrate principles of biochemistry and cell and molecular biology, and the historical context of important scientific advances.

3 units, Win (Baker)

GENE 233. The Biology of Small Modulatory RNAs—(Same as MI 233, PATH 233.) Open to graduate and medical students. How recent discoveries of miRNA, RNA interference, and short interfering RNAs reveal potentially widespread gene regulatory mechanisms mediated by small modulatory RNAs during animal and plant development. Requires paper proposing novel research.

2 units, Aut (Chen, Fire)

GENE 235. *C. Elegans* Genetics—Genetic approaches to *C. elegans,* practice in designing experiments and demonstrations of its growth and anatomy. Probable topics include: growth and genetics, genome map and sequence, mutant screens that start with a desired phenotype, reverse genetics and RNAi screens, genetic duplications, uses of

null phenotype non-null alleles, genetic interactions and pathway analysis, and embryogenesis and cell lineage. Focus of action, mosaic analysis, and interface with embryological and evolutionary approaches.
2 units, Spr (Fire)

GENE 238. Current Concepts and Dilemmas in Genetic Testing—(Same as INDE 238.) For M.D. students and biomedical graduate students. Issues arising from the translational process from research to commercialization. Diagnostic inventions and applications, community implications, newborn screening, cancer genetics, and pharmacogenomics. Guest experts. Limited enrollment.
2 units, Spr (Tobin, Cowan, Schrijver)

GENE 255. The Responsible Conduct of Research—A forum for scientists to familiarize themselves with institutional policies/practices and professional standards that define scientific integrity. Overview of ethics in research, authorship, patents, and human interest at the academic-commercial interface, and small group sessions for more extended discourse between students and faculty. Completion fulfills NIH/ADAMHA requirement for instruction in the ethical conduct of research. Required course for incoming students.
1 unit, Win (Staff)

GENE 260. Supervised Study—Genetics graduate student lab research from first quarter to filing of candidacy. May be repeated for credit. Prerequisite: consent of instructor.
1-18 units, Aut, Win, Spr, Sum (Staff)

GENE 262. Advanced Microbial Genetics and Genomics—(Same as BIOSCI 162/262.) Genetic tools for studying the cell biology and behavior of bacteria. Case studies on genetic approaches in combination with biochemistry, microscopy, and genomics to study mechanisms of gene expression, signal transduction, cell cycle regulation, development, and pathogenesis. GER:DB-NatSci
4 units, Spr (Tan, Burkholder)

GENE 299. Directed Reading—May be repeated for credit. Prerequisite: consent of instructor.
1-18 units, Aut, Win, Spr, Sum (Staff)

GENE 399. Research—May be repeated for credit. Prerequisite: consent of instructor.
1-18 units, Aut, Win, Spr, Sum (Staff)

HEALTH RESEARCH AND POLICY

Emeriti: (Professors) John Farquhar, Victor R. Fuchs, Lincoln E. Moses, Ralph S. Paffenbarger, Jr.
Chair: Alice Whittemore
Co-Chair: Robert Tibshirani
Professors: Bradley Efron, Trevor Hastie, Victor W. Henderson, Mark Hlatky, Iain M. Johnstone, Abby C. King, Philip W. Lavori, Richard A. Olshen, Julie Parsonnet, Robert Tibshirani, Alice S. Whittemore, Dee W. West, Wing Wong
Associate Professors: Laurence Baker, Lorene M. Nelson
Assistant Professor: M. Kate Bundorf
Professor (Research): Dan Bloch
Associate Professor (Research): Laura Lazzeroni
Courtesy Professors: Stephen P. Fortmann, Alan M. Garber, Mary Goldstein
Courtesy Associate Professors: Alex Macario, Yvonne Maldonado, Mark McClellan (on leave), Douglas Owens, David R. Rogosa, Marilyn Winkleby
Courtesy Assistant Professors: Michael K. Gould, Paul Heidenreich
Senior Lecturer: Irene Corso
Lecturers: Raymond Balise, Margaret Eaton, Laurel Habel, Lisa Herrington, Pamela Horn-Ross, Andy Karter, David Lilienfeld, Caroline Tanner, Timothy K. Stanton, Stephen Van Den Eeden
Consulting Professors: Gary Friedman, Elizabeth Holly, Joseph Selby
Consulting Associate Professors: Paul Barnett, Sally Glaser, Esther John
Consulting Assistant Professor: Todd Wagner
Visiting Associate Professor: Marion Lee
Instructor: Kristin Cobb, Rita Popat

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Web Site: http://www.stanford.edu/dept/HRP/

Courses given in Health Research and Policy have the subject code HRP. For a complete list of subject codes, see Appendix.

The Department of Health Research and Policy has three principal areas of scholarly interest:

1. Biostatistics deals with scientific methodology in the medical sciences, emphasizing the use of statistical techniques.
2. Epidemiology is concerned with problems of health and disease in human populations and with efforts toward improving levels of health. Epidemiology also provides training in the application of epidemiologic methods to the study of disease etiology and control.
3. Health Services Research is concerned with many aspects of health policy analysis in the public and private sectors.

GRADUATE PROGRAMS

The Program in Epidemiology and the Program in Health Services Research are housed in the Department of Health Research and Policy. These programs, which offer M.S. degrees in Epidemiology and in Health Services Research, are described separately in the relevant sections this bulletin. Students with an interest in pursuing advanced degrees with an emphasis on biostatistics can do so through programs offered by the Department of Statistics. Division of Biostatistics faculty participate in these programs.

For additional information, address inquiries to the Educational Coordinator, Department of Health Research and Policy, Stanford University School of Medicine, HRP Redwood Building, Room T213D, Stanford, California 94305-5405.

COURSES

Course and lab instruction in the Department of Health Research and Policy conforms to the "Policy on the Use of Vertebrate Animals in Teaching Activities," the text of which is available at http://www.stanford.edu/dept/DoR/rph/8-2.html.

HRP 89Q. Introduction to Crosscultural Issues in Medicine—Stanford Introductory Seminar. Preference to sophomores. Crosscultural issues that impact health care delivery such as ethnicity, immigration, language barriers, and service expectations. Fosters an understanding of culturally unique and non-English speaking populations, developing interpersonal and communication skills with diverse ethnic groups. GER:EC-AmerCul
3 units, Win (Corso)

HRP 199. Undergraduate Research—Student investigations sponsored by faculty members. Prerequisite: consent of the instructor.
1-18 units, Aut, Win, Spr, Sum (Staff)

HRP 206. Topics in Quantitative Methods: Meta-Analysis—(Enroll in STATS 211, EDUC 493B.)
1-3 units, Win (Olkin)

HRP 207. Issues and Methods of Health Services and Policy Research—Primarily for students in the Health Services and Policy Research scholarly track. Topics include health care systems and institutions, health insurance, regulation, cost effectiveness analysis, and medical decision making.
2 units, Aut (Baker, McDonald)

HRP 209. Medicine and the Law—Topics: medical malpractice, patient consent and confidentiality rights, human subject research, withdrawing life support and physician-assisted suicide, futile medical care, legal requirements in psychiatry, physician discipline, medical staff law, and HMO litigation.

2 units, Win (Eaton)

HRP 210. Health Law and Policy—(Same as Law 313.) Open to law or medical students and qualified undergraduates by consent of instructor. The American health care system and its legal and policy problems. Topics: characteristics of medical care compared to other goods and services; difficulties of assuring quality care; the complex patchwork of the financing system; and ethical problems the system raises. Course begins September 6.

3 term units, Aut semester (Greely)

HRP 211. Law and Biosciences—(Same as LAW 368.) For medical students; graduate students by consent of instructor. Legal, social, and ethical issues arising from advances in the biosciences. Focus is on human genetics; also advances in assisted reproduction and neuroscience. Topics include forensic use of DNA, genetic testing, genetic discrimination, eugenics, cloning, pre-implantation genetic diagnosis, neuroscientific methods of lie detection, and genetic or neuroscience enhancement. Course begins September 6.

3 term units, Aut semester (Greely)

HRP 212. Crosscultural Medicine—Interviewing and behavioral skills needed to facilitate culturally relevant health care across all population groups. Explicit and implicit cultural influences operating in formal and informal medical contexts.

3 units, Spr (Corso)

HRP 214. Scientific Writing—Step-by-step through the process of writing and publishing a scientific manuscript. How to write effectively, concisely, and clearly. Preparation of an actual scientific manuscript. Students are encouraged to bring a manuscript on which they are currently working to develop and polish throughout the course.

2-3 units, Win (Cobb)

HRP 223. Data Management and Statistical Programming—The skills required for management and analysis of biomedical data. Topics include importing and exporting data from multiple database systems, visualizing and cleaning data, data management for multicenter projects, and data security. Introduction to applied statistical programming relevant to epidemiologic and clinical research. No previous programming experience required.

2-3 units, Aut (Balise)

HRP 225. Design and Conduct of Clinical and Epidemiologic Studies—Intermediate-level. The skills to design, carry out, and interpret epidemiologic studies, particularly of chronic diseases. Topics: epidemiologic concepts, sources of data, cohort studies, case-control studies, cross-sectional studies, sampling, estimating sample size, questionnaire design, and the effects of measurement error. Prerequisite: 159/259 or equivalent, or consent of instructor.

3-4 units, Aut (Popat)

HRP 226. Advanced Epidemiologic and Clinical Research Methods—The principles of measurement, measures of effect, confounding, effect modification, and strategies for minimizing bias in epidemiologic studies. Prerequisite: 225 or consent of instructor.

3-4 units, Win (Nelson)

HRP 230. Cancer Epidemiology—Descriptive epidemiology and sources of incidence/mortality data; the biological basis of carcinogenesis and its implications for epidemiologic research; methodological issues relevant to cancer research; causal inference; major environmental risk factors; genetic susceptibility; cancer control; examples of current research; and critique of the literature. Prerequisite: 225, or consent of instructor.

3 units, Win (West) alternate years, not given 2006-07

HRP 231. Epidemiology of Infectious Diseases—The principles of the transmission of the infectious agents (viruses, bacteria, rickettsiae, mycoplasma, fungi, and protozoan and helminth parasites). The role of vectors, reservoirs, and environmental factors. Pathogen and host characteristics that determine the spectrum of infection and disease. Endemicity, outbreaks, and epidemics of selected infectious diseases. Principles of control and surveillance.

3 units (Parsonnet, Maldonado) not given 2005-06

HRP 234. Foundations of Pharmacoepidemiology—Historical development of pharmacoepidemiology, the drug development process and pharmacoepidemiology role in it, pharmacovigilance/drug safety systems, epidemiology in outcomes research, the role of pharmacoepidemiology in risk management, and classic examples of pharmacoepidemiologic investigations.

2-3 units, Spr (Lilienfeld) alternate years, not given 2006-07

HRP 236. Epidemiology Research Seminar—Weekly forum for ongoing epidemiologic research by faculty, staff, guests, and students, emphasizing research issues relevant to disease causation, prevention, and treatment. May be repeated for credit.

1 unit, Aut, Win, Spr (Friedman, Henderson)

HRP 248. Promoting Health over the Life Course: Multidisciplinary Perspectives—(Enroll in HUMBIO 148.)

3 units, Aut (Alles, Stefanick)

HRP 250C. Statistical Analysis in Educational Research: Multivariate Analysis—(Enroll in EDUC 250C.)

2-4 units, Win (Olkin)

HRP 251. Design and Conduct of Clinical Trials—The rationale for phases 1-3 clinical trials, the recruitment of subjects, techniques for randomization, data collection and endpoints, interim monitoring, and reporting of results. Emphasis is on the theoretical underpinnings of clinical research and the practical aspects of conducting clinical trials.

3 units, Spr (Hlatky)

HRP 252. Outcomes Analysis—(Same as BIOMEDIN 251.) Introduction to methods of conducting empirical studies which use large existing medical, survey, and other databases to ask both clinical and policy questions. Econometric and statistical models used to conduct medical outcomes research. How research is conducted on medical and health economics questions when a randomized trial is impossible. Problem sets emphasize hands-on data analysis and application of methods, including re-analyses of well-known studies. Prerequisites: one or more courses in probability, and statistics or biostatistics.

3 units, Spr (Bhattacharya)

HRP 256. Economics of Health and Medical Care—(Enroll in ECON 126/256, BIOMEDIN 156/256.)

5 units, Aut (Bhattacharya)

HRP 259. Introduction to Probability and Statistics for Epidemiology—Topics: random variables, expectation, variance, probability distributions, the central limit theorem, sampling theory, hypothesis testing, confidence intervals. Correlation, regression, analysis of variance, and nonparametric tests. Introduction to least squares and maximum likelihood estimation. Emphasis is on medical applications.

4-5 units, Aut (Cobb)

HRP 260A,B,C. Workshop in Biostatistics—(Same as STATS 260A.) Applications of statistical techniques to current problems in medical science. Enrollment for more than 2 units of credit involves extra reading or consulting and requires consent of instructor.

1-3 units, **A:** *Aut,* **B:** *Win,* **C:** *Spr (Lazzeroni, Olshen, Bloch, Efron, Hastie, Lavori, Tibshirani, Wong)*

HRP 261. Intermediate Biostatistics: Analysis of Discrete Data—(Same as STATS 261, BIOMEDIN 233.) The 2x2 table. Chi-square test. Fisher's exact test. Odds ratios. Sampling plans; case control and cohort studies. Series of 2x2 tables. Mantel Hantzel. Other tests. *k x m* tables. Matched data logistic models. Conditional logistic analysis, application to

case-control data. Log-linear models. Generalized estimating equations for longitudinal data. Cell phones and car crashes: crossover design. Topics: generalized additive models, classification trees, bootstrap inference.
3 units, Win (Hastie, Cobb)

HRP 262. Intermediate Biostatistics: Regression, Prediction, Survival Analysis—(Same as STATS 262.) Methods for analyzing longitudinal data. Topics include Kaplan-Meier methods, Cox regression, hazard ratios, time-dependent variables, longitudinal data structures, profile plots, missing data, modeling change, MANOVA, repeated-measures ANOVA, GEE, and mixed models. Emphasis is on practical applications. Prerequisites: basic ANOVA and linear regression.
3 units, Spr (Cobb)

HRP 280,281,282. Spanish for Medical Students—(Same as SPANLANG 121M,122M,123M.) Goal is a practical and rapid command of spoken Spanish. Topics: the human body, hospital procedures, diagnostics, food, and essential phrases for on-the-spot reference when dealing with Spanish-speaking patients. Series can be taken independently, depending on the level of prior knowledge.
3 units, **280:** *Aut,* **281:** *Win,* **282:** *Spr (Corso)*

HRP 283. Health Services Research Core Seminar—Presentation of research in progress and tutorials in the field of health services research.
1 unit, Aut, Win, Spr, Sum (Baker, Bundorf, Garber, Hlatky, Owens)

HRP 290. Advanced Spanish Conversation—Oral language skills covering pediatric, gynecological, and other specialty exams; patient health education and counseling; and diseases such as diabetes, asthma, and TB. Prerequisite: Spanish proficiency or consent of instructor.
3 units, Aut, Win, Spr (Corso)

HRP 299. Directed Readings in Health Research and Policy—Epidemiology, health services research, preventive medicine, medical genetics, public health, economics of medical care, occupational or environmental medicine, international health, or related fields. May be repeated for credit. Prerequisite: consent of instructor.
1-18 units, Aut, Win, Spr, Sum (Staff)

HRP 351. Innovation and Management in Health Care—(Same as GSBGEN 351.) The workings of the major institutions such as hospitals, health insurance companies, HMOs, Medicare and Medicaid, federal regulators, and the medical establishment. National health expenditures and alternative models for healthcare financing and delivery. Trends in treatment innovations provided by biopharmaceuticals, medical devices, and surgical procedures; delivery innovations facilitated by information systems and new processes. Policy and business challenges raised by these innovations and the health care ecosystems they promote.
4 units, Win (Zenios)

HRP 391. Political Economy of Health Care in the United States—(Same as PUBLPOL 231, MGTECON 331.) The economic tools and institutional and legal background to understand how markets for health care products and services work. Moral hazard and adverse selection. Institutional organization of the health care sector. Hospital and physician services markets, integrated delivery systems, managed care, pharmaceutical and medical device industries. Public policy issues in health care, medical ethics, regulation of managed care, patiets' bill of rights, regulation of pharmaceuticals, Medicare reform, universal health insurance, and coverage of the uninsured. International perspectives, how other countries' health care systems evolved, and what the U.S. can learn from their experiences.
4 units, Spr (Kessler)

HRP 392. Analysis of Costs, Risks, and Benefits of Health Care—(Same as MGTECON 332, BIOMEDIN 432.) For graduate students. The principal evaluative techniques for health care, including utility assessment, cost-effectiveness analysis, cost-benefit analysis, and decision analysis. Emphasis is on the practical application of these techniques. Group project presented at end of quarter. Guest lectures by experts from the medical school, pharmaceutical industry, health care plans, and government.
4 units, Aut (Garber, Owens)

HRP 399. Research—Graduate students investigations sponsored by individual faculty members. Prerequisite: consent of instructor.
1-18 units, Aut, Win, Spr, Sum (Staff)

HEALTH SERVICES RESEARCH PROGRAM

Director: Mark Hlatky (Professor, Health Research and Policy, and Medicine)
Executive Committee: Laurence Baker (Associate Professor, Health Research and Policy), M. Kate Bundorf (Assistant Professor, Health Research and Policy), Alan Garber (Professor, Medicine), Mary Goldstein (Associate Professor, Medicine), Mark Hlatky (Professor, Health Research and Policy, and Medicine), Douglas Owens (Associate Professor, Medicine)

Participating Faculty and Staff by Department:
Anesthesia: Alex Macario (Associate Professor)
Economics: Thomas MaCurdy (Professor), Mark McClellan (Associate Professor, on leave)
Business: Alain Enthoven (Professor, emeritus), Daniel Kessler (Professor)
Health Research and Policy: Laurence Baker (Associate Professor), Paul Barnett (Consulting Associate Professor), M. Kate Bundorf (Assistant Professor), Victor Fuchs (Professor, emeritus), Trevor Hastie (Professor), Mark Hlatky (Professor), Philip Lavori (Professor), Richard Olshen (Professor), Ciaran Phibbs (Consulting Associate Professor), Joseph Selby (Consulting Professor), Anita Stewart (Visiting Scholar), Robert Tibshirani (Professor)
Law: Henry Greely (Professor)
Management Science and Engineering: Margaret Brandeau (Professor)
Medicine: Jay Bhattacharya (Assistant Professor), Alan Garber (Professor), Mary Goldstein (Professor), Michael Gould (Assistant Professor), Paul Heidenreich (Assistant Professor), Mark Hlatky (Professor), Mark McClellan (Associate Professor, on leave), Douglas Owens (Associate Professor)
Pediatrics: Paul Wise (Professor)
Psychiatry: Rudolph Moos (Professor)
Sociology: Richard Scott (Professor, emeritus)

Program Offices: HRP Redwood Building, Room T213D
Mail Code: 94305-5405
Phone: (650) 723-5456
Email: HSRprogram@med.stanford.edu
Web Site: http://www.stanford.edu/dept/HRP

GRADUATE PROGRAM

MASTER OF SCIENCE

The Master's Degree Program in Health Services Research seeks to train students in the quantitative analysis of issues in health and medical care. The program emphasizes an individually designed program of course work and completion of a master's project under the mentorship of a faculty member. The typical student in the program is either a physician who has completed residency training and is preparing for a research career, or a student with a strong background in policy analysis who wishes to focus on problems in health or medical care. Faculty interests include outcomes research, health economics, health care organization, health care access, quality of care, decision analysis, clinical guidelines, and assessment of patient preferences and quality of life.

To receive the degree, students are expected to demonstrate knowledge of issues in health services research and the quantitative skills necessary for research in this area. Students must take at least 45 units of course work (9 of the units may be double-counted to meet other degree requirements) and write a University thesis. The course work requirements are:

1. At least 8 units from the following group of Health Research and Policy (HRP) core courses: 256, Economics of Health and Medical Care; 391,

Political Economy of Health Care in the United States; 392, Analysis of Costs, Risks, and Benefits in Health Care.
2. At least 6 units of graduate-level statistics courses. The sequence of HRP 261 and 262 is strongly recommended.
3. At least 3 units of HRP 283, Health Services Research Core Seminar.
4. At least 15 units of HRP research credit from 299, Directed Reading, or 399, Research.
5. An additional set of approved elective courses to complete the program total of at least 45 units.

For additional information, address inquiries to the Educational Coordinator, Department of Health Research and Policy, Stanford University School of Medicine, HRP Redwood Building, Room T213D, Stanford, California 94305-5405.

COURSES

The course listings of individual departments participating in the Health Services Research Program should be consulted for complete descriptions.

IMMUNOLOGY PROGRAM

Chair, Executive Committee for the Immunology Program: Lawrence Steinman (Professor, Neurology and Neurological Sciences)
Director for Immunology Program: K. Christopher Garcia (Associate Professor, Microbiology and Immunology)
Director for Clinical Immunology Program: C. Garrison Fathman (Medicine/Immunology and Rheumatology)

Participating Departments and Faculty:
Biological Sciences: Patricia P. Jones (Professor)
Cardiothoracic Surgery: Carol Clayberger (Associate Professor, Research, Pediatrics)
Chemistry: Harden M. McConnell (Professor, emeritus)*
Genetics: Leonard A. Herzenberg (Professor, emeritus), Lenore A. Herzenberg (Professor, Research), Man-wah Tan (Assistant Professor)
Medicine/Bone Marrow Transplantation Program: Robert Negrin (Professor), David Miklos (Assistant Professor), Judith Shizuru (Associate Professor)
Medicine/Endocrinology: Ajay Chawla (Assistant Professor)
Medicine/Hematology: Peter Lee (Assistant Professor)
Medicine/Immunology and Rheumatology: C. Garrison Fathman (Professor), Jane R. Parnes (Professor), William Robinson (Assistant Professor), Samuel Strober (Professor), Paul J. Utz (Assistant Professor)
Medicine/Oncology: Gilbert Chu (Associate Professor, and Biochemistry), Dean Felsher (Assistant Professor), Ronald Levy (Professor), Shoshana Levy (Professor, Research)
Microbiology and Immunology: Yueh-Hsiu Chien (Professor), Mark M. Davis (Professor), K. Christopher Garcia (Assistant Professor, and Structural Biology), Hugh McDevitt (Professor), Garry P. Nolan (Professor, Microbiology and Immunology), David Schneider (Assistant Professor)
Molecular and Cellular Physiology: Richard S. Lewis (Professor)
Molecular Pharmacology: Phyllis Gardner (Professor, and Medical/Clinical Pharmacology, and Cardiovascular Medicine)
Neurology and Neurological Sciences: Lawrence Steinman (Professor, and Pediatrics)
Pathology: Eugene C. Butcher (Professor), Michael Cleary (Professor), Gerald R. Crabtree (Professor, and Developmental Biology), Edgar G. Engleman (Professor, and Medicine/Immunology and Rheumatology), Magali Fontaine (Assistant Professor), Joseph S. Lipsick (Professor), Sara Michie (Associate Professor), Raymond A. Sobel (Associate Professor), Irving L. Weissman (Professor, and Developmental Biology)
Pediatrics: Ann Arvin (Professor, and Microbiology and Immunology), Christopher Contag (Assistant Professor, Research), Alan M. Krensky (Professor), Carol Clayberger (Professor, Research), David B. Lewis (Associate Professor), Elizabeth Mellins (Associate Professor)
Structural Biology: Peter Parham (Professor, and Microbiology and Immunology)
Surgery: Sheri Krams (Associate Professor, Research), Olivia Martinez (Associate Professor, Research)

* Recalled to active duty

Mail Code: 94305-5121
Phone: (650) 725-5076
Email: mopan@stanford.edu
Web Site: http://immunol.stanford.edu/

Courses given in Immunology have the subject code IMMUNOL. For a complete list of subject codes, see Appendix.

GRADUATE PROGRAMS

MASTER OF SCIENCE

Students in the Ph.D. program in Immunology may apply for an M.S. degree in Immunology, assuming completion of appropriate requirements. Students must complete:

1. Three full-tuition quarters of residency as a graduate student at Stanford
2. At least 45 units of academic work, all of which must be in courses at or above the 100 level, 36 units of which must be at or above the 200 level
3. 2-3 quarters of graduate research (IMMUNOL 300), consisting of rotations in the labs of 2-3 faculty members
4. Course work in Immunology as follows: coursework in basic immunology (BIOSCI 230, IMMUNOL 205 or equivalent, advanced Immunology such as IMMUNOL 201, 200, and 203). In addition, the student may take one of three possible courses: MPHA 210, Signal Transduction Pathways and Networks, SBIO 241, Biological Macromolecules, or DBIO 210, Developmental Biology. Other required core courses are: Gene 203, Advanced Genetics, IMMUNOL 215, Principles of Biological Technologies, MCP 221, Cell Biology of Physiological Processes.
5. Graduate-level biochemistry and molecular biology (BIOC 200, 201, or equivalents)
6. Course work in IMMUNOL 311, Seminar in Immunology, and IMMUNOL 311A, Seminar Discussion in Immunology
7. Participation in the Immunology journal club (IMMUNOL 305), and attendance at the weekly Immunology seminar and at the annual Stanford Immunology Scientific Conference
8. The qualifying examination in Immunology, the written exam (Part I) and the thesis proposal (Part II), and an oral presentation on the research of one rotation, before candidacy, both offered in July of the academic year.

DOCTOR OF PHILOSOPHY

University requirements for the Ph.D. are described in the "Graduate Degrees" section of this bulletin.

The interdepartmental Immunology Program offers instruction and research opportunities leading to a Ph.D. in Immunology. The goal of the program is to develop young investigators who have a solid foundation in immunology as well as related sciences and who can carry out innovative research. The program features a flexible selection of courses and seminars to enrich the students' backgrounds, combined with extensive research training in the laboratories of the participating immunology faculty.

Students applying to the program typically have an undergraduate major in biological sciences, but majors in other areas are acceptable if the applicants have had sufficient course work in biology and chemistry. Formal application should be made by December 12. Applications are evaluated by the Immunology Predoctoral Committee based on scores on the GRE exams (including the subject test in either biology, biochemistry, or chemistry), which should be taken by the October test date; grades; evidence of prior research experience; letters of recommendation, including letters from research sponsor(s); and commitment to a career in biomedical research. Interested Stanford medical students are welcome to apply to the

program and should submit a formal application by December 12th.

Students admitted to the program are offered financial support covering tuition, a living stipend, insurance coverage, and an allowance for books/travel. Applicants are urged to apply for independent fellowships such as from the National Science Foundation. Fellowship applications are due in November of the year prior to matriculation in the graduate program, but Immunology graduate students may continue to apply for outside fellowships after matriculation. Because of the small number of department-funded slots, students who have been awarded an outside fellowship will have an improved chance of acceptance into the program. On matriculation, each student is assisted in selecting courses and lab rotations in the first year and in choosing a lab for the dissertation research. Once a dissertation adviser has been selected, a dissertation committee including at least two Immunology faculty, and including the dissertation adviser, is constituted to guide the student during the dissertation research. The student must meet with the dissertation committee at least once a year.

Candidates for Ph.D. degrees at Stanford must satisfactorily complete a three-year program of study that includes 72 units of graduate course work and research. At least 3 units must be taken with each of four different Stanford faculty members.

The requirements for the Ph.D. degree in Immunology include the following:

1. Training in biology and cognate disciplines equivalent to that provided by the undergraduate Biology major at Stanford.
2. Completion of the following courses (or their equivalents from undergraduate work):
   a) Basic Immunology (BIOSCI 230 or MI 200)
   b) Advanced Immunology (IMMUNOL 201, 202, 203)
   c) Biochemistry and Molecular Biology (BIOC 200)
   c) Advanced Genetics (GENE 203)
   d) Cell Biology of Physiological Processes (MCP 221)
   e) Statistics (BIOSCI 141)
   f) Principles of biological technologies (IMMUNOL 215)
   g) one of three possible courses: MPHA 210, Signal Transduction Pathways and Networks; SBIO 241, Biological Macromolecules; or DBIO 210, Developmental Biology.
   h) Responsible Conduct in Science (MED 255)
   i) Immunology Journal Club (IMMUNOL 305)
3. First-year students are required to take both the IMMUNOL 311, Seminar in Immunology and the companion course, IMMUNOL 311A, Seminar Discussion in Immunology, and participate in IMMUNOL 305, Immunology Journal Club. Students in their second year and above must participate in the IMMUNOL 311, Seminar in Immunology and may opt to take the companion course, IMMUNOL 311A. Students who have not yet achieved TGR status must register for 1 unit for IMMUNOL 311. Students attend the weekly Immunology Seminar Series (4-5 p.m., Tuesdays). Students read the papers of and have dinner with visiting seminar speakers two or three times each quarter, and meet with a faculty member to discuss the material.
4. Elective courses as agreed upon by the student, adviser, and advisory committee. Electives may be chosen from graduate courses and seminars in any of the biomedical science departments and programs.
5. Completion in the first year of two or three one quarter rotations. Two weeks after taking the written portion of the qualifying examination process in mid-July, students shall present their lab rotation research projects to the Predoctoral Committee. Medical students who have declared Immunology as their scholarly concentration major, and who are accepted into the Ph.D. program, are exempt from doing lab rotations.
6. Teaching assistantship in two immunology courses. A teaching assistantship requirement may be fulfilled by proposing a graduate student-initiated course IMMUNOL 315, Topics in Immunology. Before fulfilling their teaching assistantships, Immunology graduate students are required to undertake a teaching assistantship workshop offered at the beginning of every quarter by the Center for Teaching and Learning.
7. For admission to candidacy, completion of two requirements by the end of the Autumn Quarter of the second year: a rotation presentation on one of three lab rotations, and a comprehensive written examination in immunology and related biomedical sciences must be completed satisfactorily by the middle of Summer Quarter of the first year. Finally, students must prepare and defend a research proposal on their dissertation research by December 17, the end of Autumn Quarter of their second year. Administration and evaluation of these requirements is the responsibility of the student's dissertation committee.
8. Participation (through regular attendance and oral presentation) in the student-run immunology journal clubs for at least the first 2 years (IMMUNOL 305). First- through fourth-year students are also expected to attend the graduate students' journal club, the Tuesday evening immunology seminars, and the annual Stanford Immunology Scientific Conference.
9. Passing of the University oral examination on the dissertation research, which is to be taken only after the student has substantially completed the research. The examination is preceded by a public seminar in which the candidate presents his/her research.
10. Completion of a Ph.D. dissertation, resulting from independent investigation and constituting a contribution to knowledge in the area of immunology.

COURSES

Course and lab instruction in the Immunology Program conforms to the "Policy on the Use of Vertebrate Animals in Teaching Activities," the text of which is available at http://www.stanford.edu/dept/DoR/rph/8-2.html.

IMMUNOL 201. Advanced Immunology I—(Same as MI 211.) For graduate and medical students and advanced undergraduates. Molecules and cells of the innate and adaptive immune systems; genetics, structure, and function of immune molecules; lymphocyte differentiation and activation; regulation of immune responses; autoimmunity and other problems in clinical immunology. Prerequisites: undergraduate course in Immunology; and familiarity with experimental approaches in biochemistry, molecular biology, and cell biology.

3 units, Win (Chien, Staff)

IMMUNOL 202. Advanced Immunology II—(Same as MI 212.) Readings of immunological literature and specific areas of immunology. Classic problems and emerging areas are covered based on primary literature. Student and faculty presentations. Prerequisite: 211.

3 units, Spr (Garcia, Staff)

IMMUNOL 203. Advanced Immunology III—(Same as MI 213.) Key experiments and papers in immunology. Student presentations and faculty participation; faculty describe their experimental process and scientific papers. Prerequisite: IMMUNOL 201/MI 211 or IMMUNOL 202/MI 212.

3 units, Sum (Staff)

IMMUNOL 215. Principles of Biological Technologies—(Same as MI 215.) Required of first-year graduate students in Microbiology and Immunology, and the Immunology program. The principles underlying commonly utilized technical procedures in biological research. Lectures and primary literature critiques on gel electrophoresis, protein purification and stabilization, immunofluorescence microscopy, FACS. Prerequisites: biochemistry, organic chemistry, and physics.

2 units, Spr (Kirkegaard)

IMMUNOL 230. Introduction to Medicine—For graduate students in biological sciences, bioengineering, and biomedical informatics. Information and approaches used by physicians to understand human disease. Focus is on diabetes. Lectures by medical school and outside faculty. Field trips, including a biotechnology company, clinics, and the clinical laboratory. Quarter-long, team projects addressing current medical issues.

2-4 units, Spr (Mellins, Parnes)

IMMUNOL 290. Teaching in Immunology—Practical experience in teaching by serving as a teaching assistant in an immunology course.

1-10 units, Aut, Win, Spr, Sum (Staff)

IMMUNOL 299. Directed Reading in Immunology
1-15 units, Aut, Win, Spr, Sum (Staff)

IMMUNOL 300. Research—For Ph.D., M.D./Ph.D. students, and medical students whose scholarly concentrations are in immunology.
1-15 units, Aut, Win, Spr, Sum (Staff)

IMMUNOL 305. Immunology Journal Club—Required of first- to fourth-year graduate students. Graduate students present and discuss recent papers in the literature. May be repeated for credit.
1 unit, Aut, Win, Spr (Staff)

IMMUNOL 311. Seminar in Immunology—Enrollment limited to Ph.D., M.D./Ph.D., and medical students whose scholarly concentrations are in immunology. Current research topics.
1 unit, Aut, Win, Spr (Fathman, Steinman)

IMMUNOL 311A. Immunology Seminar Discussion—Required of first-year students. Students discuss papers of speakers in 311, and meet with the speakers. Corequisite: 311.
1 unit, Aut, Win, Spr (Fathman, Steinman)

IMMUNOL 315. Special Topics in Immunology—Graduate student-initiated seminar in journal club style. Previous topics include evolutionary immunology and the principles of vaccine development, cytokines, tumor immunology, and neuroimmunology. May be repeated for credit.
1-4 units, Aut, Win, Spr, Sum (Staff)

IMMUNOL 317. Frontiers in Immunology—Seminar class in journal club style. Focus is on one topic in immunology per quarter. Readings range from historical development to current research and questions. May be repeated for credit.
1-3 units, Aut, Win, Spr, Sum (Staff)

MICROBIOLOGY AND IMMUNOLOGY

Emeriti: (Professors) Sidney Raffel, Leon T. Rosenberg, Esther M. Lederberg
Chair: Mark M. Davis
Professors: Ann Arvin, Helen Blau, John C. Boothroyd, Yueh-hsiu Chien, Mark M. Davis, Stanley Falkow, Stephen J. Galli, Harry B. Greenberg, Karla Kirkegaard, A. C. Matin, Hugh O. McDevitt, Edward S. Mocarski, Peter Parham, Phillip Pizzo, Charles Prober, Peter Sarnow, Gary K. Schoolnik, Lucy S. Tompkins
Associate Professors: Kenan Christopher Garcia, Peter Jackson, Garry Nolan, David Relman
Assistant Professors: Matthew Bogyo, Chang-Zheng Chen, David Schneider, Upinder Singh, Julie Theriot
Associate Professor (Teaching): Robert D. Siegel
Courtesy Assistant Professor: Christopher Contag (Pediatrics)

Department Offices: D300 Fairchild Building, 299 Campus Drive
Mail Code: 94305-5124
Phone: (650) 725-8541
Email: micro_immuno@lists.stanford.edu
Web Site: http://cmgm.stanford.edu/micro/

Courses given in Microbiology and Immunology have the subject code MI. For a complete list of subject codes, see Appendix.

The Department of Microbiology and Immunology offers a complete program of training leading to the Ph.D. degree, as well as research training, courses, and seminars for medical students and postdoctoral fellows. Research interests focus on two broad areas, host/parasite interactions, and the function of the immune system. Individual laboratories investigate mechanisms of pathogenesis and the physiology of viruses, bacteria, and protozoan parasites, as well as the lymphocyte function in antigen recognition, immune response, and autoimmunity.

GRADUATE PROGRAMS

MASTER OF SCIENCE

A regular M.S. program is not offered, although this degree is awarded under special circumstances. Candidates for master's degrees are expected to have completed the preliminary requirements for the B.S. degree, or the equivalent. In addition, the candidate is expected to complete 45 quarter units of work related to microbiology; at least 25 of these units should concern research devoted to a thesis. The thesis must be approved by at least two members of the department faculty.

DOCTOR OF PHILOSOPHY

University requirements for the Ph.D. are described in the "Graduate Degrees" section of this bulletin.

Application, Admission, and Financial Aid—Prospective Ph.D. candidates should have completed a bachelor's degree in a discipline of biology or chemistry, including course work in biochemistry, chemistry, genetics, immunology, microbiology, and molecular biology. The deadline for receipt of applications with all supporting materials is December 15.

Applicants must file a report of scores on the general subject tests and on an advanced test (normally in cellular and molecular biology, chemistry, or biochemistry) of the Graduate Record Examination (GRE). It is strongly recommended that the GRE be taken before October so that scores are available when applications are evaluated.

In the absence of independent fellowship support, entering predoctoral students are fully supported with a stipend and tuition award. Highly qualified applicants may be honored by a nomination for a Stanford fellowship. Successful applicants have been competitive for predoctoral fellowships such as those from the National Science Foundation.

Program for Graduate Study—The Ph.D. degree requires course work and independent research demonstrating an individual's creative, scholastic, and intellectual abilities. On entering the department, students meet an advisory faculty member and together they design a timetable for completion of the degree requirements. Typically, this consists of first identifying gaps in the student's undergraduate education and determining courses that should be taken. Then, a tentative plan is made for two to four lab rotations (one rotation per quarter). During the first year of graduate study in the department, each student also takes six or seven upper-level (200-series) courses. Three of these courses, Principles of Biological Techniques, Medical Microbiology, and Advanced Pathogenesis of Bacteria, Viruses, and Eukaryotic Parasites, are specific requirements of this department. Three courses, Advanced Genetics, Molecular Biology, and Cell Biology, are part of the core curriculum that is required of many graduate students in Stanford Biosciences.

In Spring Quarter of the second year, each student defends orally a formal research proposal on a topic outside the intended thesis project. The outline of this proposal is due to the Graduate Program Steering Committee by March 1st. Based on successful performance on this proposal, the student is admitted to candidacy. In the Autumn Quarter of the second year, a research proposal based on the student's own thesis topic is defended to his or her thesis committee. Teaching experience and training are also part of the graduate curriculum. All graduate students are required to act as teaching assistants for two quarters. In addition, first- and second-year graduate students are required to participate in a bi-weekly journal club.

COURSES

MI 25N. Modern Plagues—Stanford Introductory Seminar. Preference to freshmen. The molecular and medical aspects of new and old microorganisms that infect humans. Goal is to place modern human plagues in scientific and historical perspective focusing on the factors that lead to emergence and control. WRITE-2
3 units, Spr (Boothroyd)

MI 103. Parasites and Pestilence: Infectious Public Health Challenges—(Same as HUMBIO 103.) Parasitic and other diseases with public health impact. Pathogenesis, clinical syndromes, complex life cycles, and the interplay among environment, vectors, hosts, and reser-

voirs in historical context to understand public health policy approaches to halting disease transmission. Focus is on World Health Organization tropical disease research-targeted disease entities including: river blindness, sleeping sickness, leishmaniasis, schistosomiasis, mycobacterial disease (tuberculosis and leprosy), malaria, toxoplasmosis, dracunculiais, and intestinal helminthes. Guest lecturers in disease control. Original proposal to solve a current disease.

4 units, Spr (Smith)

MI 104. Innate Immunology—(Undergraduate section; see 204.)

3 units, Spr (Schneider)

MI 115A. Humans and Viruses—(Same as HUMBIO 115A.) Concepts in biology and the social sciences, focusing on emerging infections, viral classification, transmission and prevention, vaccination and treatment, eradication of disease, viral pathogenesis, mechanisms of virally-induced cancer, and viral evolution. Topics: molecular biology of genetic shift and drift in influenza virus, cellular tropism of HIV, developmental biology of virally-induced birth defects, clinical aspects of infantile diarrhea, social aspects of the common cold, policy issues of blood antibody tests, factors in pathogenesis and transmission of prions. Prerequisites: Human Biology core or consent of instructor.

6 units, Aut (Siegel)

MI 115B. The Vaccine Revolution—(Same as HUMBIO 115B.) Advanced seminar. Human aspects of viral disease, focusing on recent discoveries in the area of vaccine development and emerging infections. Journal club format: students select articles from primary scientific literature, write formal summaries, and synthesize it into a literature review on a specific topic. Emphasis is on the development of critical reading, analysis, experimental design, and interpretation of data. Students give oral presentations and lead discussions based on their scientific journal reading. Enrollment limited to 10. Prerequisite: 115A.

6 units (Siegel) alternate years, given 2006-07

MI 185. Topics in Microbiology—Topics include diversity, molecular regulation, growth, bioenergetics, and unique metabolic processes. Student papers for presentation on current topics such as antibiotic resistance and molecular approaches to bioremediation. Prerequisites: CHEM 31, 33, 35. Recommended: BIOSCI 31.

3 units, Spr (Matin, Staff)

MI 198A,B,C,D,E,F. Directed Reading—Fields of research open to students are decided in consultation with sponsoring faculty member.

1-15 units, Aut, Win, Spr, Sum (Staff)

MI 198A. Microbiology
MI 198B. Immunology
MI 198C. Virology
MI 198D. Microbial Genetics
MI 198E. Parasitology
MI 198F. Bacterial Physiology

MI 199. Undergraduate Research—Individual study or research by arrangement with a faculty member. Possible fields: microbial molecular biology and physiology, microbial pathogenicity, immunology, virology, and molecular parasitology. Prerequisites: consent of instructor.

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

MI 203. Biological Stress Response—Current literature. Possible topics: the nature and molecular regulation of the stress response; biochemistry and structural biology molecular chaperones; the role of stress proteins in the pathogenic process; psychoneuroendocrinology; multidrug resistance. Limited enrollment. Prerequisites: Biological Sciences core; upper-division course in molecular biology/genetics or biochemistry.

3 units, Win (Matin, Staff) alternate years, not given 2006-07

MI 204. Innate Immunology—(Undergraduate register for 104.) Innate immune mechanisms as the only defenses used by the majority of multicellular organisms. Topics include Toll signaling, NK cells, complement, antimicrobial peptides, phagocytes, neuroimmunity, community responses to infection, and the role of native flora immunity. How microbes induce and defeat innate immune reactions with examples from vertebrates, invertebrates, and plants.

3 units, Spr (Schneider)

MI 206. Animal Viruses—Current literature. Possible topics: the nature and molecular regulation of the stress response; biochemistry and structural biology molecular chaperones; the role of stress proteins in the pathogenic process; psychoneuroendocrinology; multidrug resistance. Limited enrollment. Prerequisites: Biological Sciences core; upper-division course in molecular biology/genetics or biochemistry.

3 units (Mocarski, Staff) alternate years, given 2006-07

MI 209. Medical Microbiology—For graduate and advanced undergraduate students. Required of first-year graduate students in Microbiology and Immunology. Introduction to the concepts of microbial pathogenesis with emphasis on the mechanisms employed by pathogenic microorganisms in establishing infection in the host, and the responses of the host to infection. Prerequisite: understanding of biochemistry and molecular biology.

1-3 units, Spr (Falkow)

MI 210. Advanced Pathogenesis of Bacteria, Viruses, and Eukaryotic Parasites—For graduate, medical, and advanced undergraduate students. Required for first-year graduate students in Microbiology and Immunology. The molecular mechanisms by which microorganisms invade animal and human hosts, express their genomes, interact with macromolecular pathways in the infected host, and induce disease. Problem sets and recent literature pertaining to microbial pathogenesis.

5 units, Win (Sarnow, Staff)

MI 211. Advanced Immunology I—(Same as IMMUNOL 201.) For graduate and medical students and advanced undergraduates. Molecules and cells of the innate and adaptive immune systems; genetics, structure, and function of immune molecules; lymphocyte differentiation and activation; regulation of immune responses; autoimmunity and other problems in clinical immunology. Prerequisites: undergraduate course in Immunology; and familiarity with experimental approaches in biochemistry, molecular biology, and cell biology.

3 units, Win (Chien, Staff)

MI 212. Advanced Immunology II—(Same as IMMUNOL 202.) Readings of immunological literature and specific areas of immunology. Classic problems and emerging areas are covered based on primary literature. Student and faculty presentations. Prerequisite: 211.

3 units, Spr (Garcia, Staff)

MI 213. Advanced Immunology III—(Same as IMMUNOL 203.) Key experiments and papers in immunology. Student presentations and faculty participation; faculty describe their experimental process and scientific papers. Prerequisite: IMMUNOL 201/MI 211 or IMMUNOL 202/MI 212.

3 units, Sum (Staff)

MI 215. Principles of Biological Technologies—(Same as IMMUNOL 215.) Required of first-year graduate students in Microbiology and Immunology, and the Immunology program. The principles underlying commonly utilized technical procedures in biological research. Lectures and primary literature critiques on gel electrophoresis, protein purification and stabilization, immunofluorescence microscopy, FACS. Prerequisites: biochemistry, organic chemistry, and physics.

2 units, Spr (Kirkegaard)

MI 233. The Biology of Small Modulatory RNAs—(Same as GENE 233, PATH 233.) Open to graduate and medical students. How recent discoveries of miRNA, RNA interference, and short interfering RNAs reveal potentially widespread gene regulatory mechanisms mediated by small modulatory RNAs during animal and plant development. Requires paper proposing novel research.

2 units, Aut (Chen, Fire)

MI 250. Frontiers in Microbiology and Immunology—Required of first- and second-year students in Microbiology and Immunology. How to evaluate biological research. Held in conjunction with the Microbiology and Immunology Friday noon seminar series. Before the seminar, students and faculty discuss one or more papers from the speaker's primary research literature on a related topic. After the seminar, students meet informally with the speaker to discuss their research.

1 unit, Aut, Win, Spr (Sarnow)

MI 299. Directed Reading—Prerequisite: consent of instructor. See faculty list for section numbers.

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

MI 399. Graduate Research—Students who have completed required foundation courses may elect research work in general bacteriology, bacterial physiology and ecology, bacterial genetics, microbial pathogenicity, immunology, parasitology, and virology. Prerequisite: consent of instructor.

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

MOLECULAR AND CELLULAR PHYSIOLOGY

Chair: Richard S. Lewis
Professors: Richard W. Aldrich, Axel T. Brunger, Brian K. Kobilka, W. James Nelson, Stephen J. Smith, Richard W. Tsien, William Weis
Associate Professor: V. Daniel Madison
Assistant Professors: Miriam Goodman, Merritt Maduke
Courtesy Associate Professor: Anson W. Lowe
Courtesy Assistant Professors: John Huguenard, Richard J. Reimer
Department Offices: Beckman Center, B100
Mail Code: 94305-5345
Phone: (650) 725-7554
Email: schantae@stanford.edu
Web Site: http://mcp.stanford.edu

Courses given in Molecular and Cellular Physiology have the subject code MCP. For a complete list of subject codes, see Appendix.

The Department of Molecular and Cellular Physiology is located in the Beckman Center for Molecular and Genetic Medicine.

A central goal of physiology in the post-genomic era is to understand how thousands of encoded proteins serve to bring about the highly coordinated behavior of cells and tissues. Research in the department approaches this goal at many levels of organization, ranging from single molecules and individual cells to multicellular systems and the whole organism. The faculty share common interests in the molecular mechanisms of cell signaling and behavior, with a special focus on structure/function analysis of ion channels and G-protein coupled receptors, and their roles at the cellular, organ, and whole-organism levels; the molecular basis of sensory transduction, synaptic transmission, plasticity and memory; the role of ion channels and calcium in controlling gene expression in neural and immune cells; and the regulation of vesicle trafficking and targeting, cell polarity, and cell-cell interactions in the nervous system and in epithelia. Research programs employ a wide range of approaches, including molecular and cell biology, biochemistry, genetics, biophysics, x-ray crystallography and solution NMR, electrophysiology, and *in vitro* and *in vivo* imaging with confocal and multi-photon microscopy.

GRADUATE PROGRAMS

The department offers required and elective courses for students in the School of Medicine and is also open to other qualified students with the consent of the instructor. Training of medical, graduate, and postdoctoral students is available. The program offers a course of study leading to the Ph.D. degree. No B.S. is offered, and an M.S. is offered only in the unusual circumstance where a student completes the course work, rotation, and the written section of the qualifying exam, but is unable to complete the requirements for the Ph.D.

DOCTOR OF PHILOSOPHY

Students with undergraduate or master's degrees who have completed a year each of college chemistry (including lectures in organic and physical chemistry), physics, calculus, and biology are considered for admission to graduate study. Applicants submit a report of scores from the Graduate Record Examination (verbal, quantitative, analytical, and an advanced subject test in one of the sciences) as part of the application.

Students who do not speak English as their native language must submit scores from TOEFL unless waived by Graduate Admissions, the Registrar's Office.

Study toward the Ph.D. is expected to occupy five years, including summers. A minimum of six quarter-long courses are required. These include four graduate-level courses (200-300 series) and a choice of two out of these three courses: MCP 221, MCP 255, and MCP 256. Students are also required to take the Molecular and Cellular Physiology seminar/Research In Progress series. Each student presents a talk on research in progress to the department at least every other year, starting their second year. Acceptable grades for all course work must be a minimum of 'B-', and at least two grades equal to 'A-' or above are necessary (but not sufficient) for continuation in the program.

Qualifying Examination—At the end of the second year in residence as a graduate student, each Ph.D. candidate presents a written thesis proposal to be defended at an oral comprehensive examination. The examinations may be taken only after all course work has been completed by the required standard. Students undertake individual research studies as early as possible after consultation with their preceptor. Upon passing this exam, the student is advanced to candidacy for the Ph.D.

Dissertation and University Oral Examination—The results of independent, original work by the students are presented in a dissertation. The oral examination is largely a defense of the dissertation.

Advisers and Advisory Committees—A graduate advisory committee, currently Professors Lewis and Aldrich, advises students during the period before the formation of their qualifying committees.

Financial Aid—Students may be funded by their advisers' research grants, by training grants, by department funds, or by extramural funds. Students are encouraged to obtain funding from outside sources (e.g., NIH and NSF).

COURSES

Course and lab instruction in the Department of Molecular and Cellular Physiology conforms to the "Policy on the Use of Vertebrate Animals in Teaching Activities," the text of which is available at http://www.stanford.edu/dept/DoR/rph/8-2.html.

MCP 100Q. The Hippocampus as a Window to the Mind—Stanford Introductory Seminar. Preference to sophomores.

3 units, Spr (Madison)

MCP 199. Undergraduate Research—Fields of research open to students decided in consultation with sponsoring faculty member.

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

MCP 200-204. Physiology— Offered jointly with the Department of Medicine. Lectures, small group instruction, clinical presentations, and lab demonstrations of normal and disordered human cardiovascular physiology, normal and disordered function in the endocrine, respiratory, renal, fluid and electrolyte, and acid-base systems. Prerequisite: understanding of general biochemistry.

MCP 200. Cardiovascular Physiology
5 units, Spr (Kobilka)

MCP 202. Gastrointestinal Physiology
1-3 units, Aut (Lowe)

MCP 203. Renal Physiology
1-3 units, Aut (Meyer)

MCP 204. Respiratory Physiology
1-2 units, Aut (Raffin)

MCP 213. Special Topics in Molecular and Cellular Physiology—Seminar. Introductory and advanced physiological topics agreed on by an instructor and students. Prerequisite: consent of instructor.

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

MCP 215. Synaptic Transmission—Primarily for graduate students with an interest in synaptic function; interested medical students and advanced undergraduates may enroll. The anatomical, physiological, and biochemical basis of synaptic function in the peripheral and central nervous system. Research papers.

5 units, Aut (Smith, Madison)

MCP 216. Genetic Analysis of Behavior—(Same as NBIO 216.) Advanced seminar. Findings and implications of behavioral genetics as applied to invertebrate and vertebrate model systems. Topics include biological clocks, and sensation and central pattern generators. Relevant genetic techniques and historical perspective. Student presentation.

4 units (Clandinin, Goodman) not given 2005-06

MCP 218. Transmembrane Signal Transduction—The molecular mechanisms of signal transduction for a variety of structurally and functionally different plasma membrane receptors. Topics: the structure of receptors and the interaction of the receptor protein with the lipid bilayer; ligand binding and ligand mediated changes in receptor structure; and cytosolic, cytoskeletal, and membrane proteins that interact with receptors. Recent research developments and the value of experimental approaches for the study of receptors.

2 units, Win (Kobilka)

MCP 221. Cell Biology of Physiological Processes—Open to graduate and medical students. Mechanisms of membrane and cellular biogenesis in relation to physiological processes. Emphasis is on regulatory and signaling mechanisms involved in coordinating cellular phenomena such as cellular organization, function, and differentiation. Topics: cellular compartmentalization, transport and trafficking of macromolecules, organelle biogenesis, cell division, motility and adhesion, and multicellularity. Prerequisites: Biological Sciences core, BIOSCI 187/287.

2-5 units, Win (Kopito, Frydman, Nelson)

MCP 221A,B,C,D,E,F,G,H. Cell Biology of Physiological Processes Discussion—Required course taken with 221, taught by medical school faculty, to expand on the topics covered in 221. Students register for only one section. Prerequisites: Biological Sciences core, BIOCHEM 201.

2 units, Win (Staff)

MCP 222. Imaging: Biological Light Microscopy—(Same as BIOSCI 152.) Survey of instruments which use light and other radiation for analysis of cells in biological and medical research. Topics: basic light microscopy through confocal fluorescence and video/digital image processing. Lectures on physical principles; involves partial assembly and extensive use of lab instruments. Lab. Prerequisites: some college physics, Biological Sciences core. GER:DB-NatSci

3 units, Spr (S. Smith)

MCP 232. Advanced Imaging Lab in Biophysics—(Same as BIOSCI 132/232, BIOPHYS 232.) Laboratory and lectures. Microscopy, emphasizing hands-on experience with a range of apparatus and techniques. Topics include microscope optics, Koehler illumination, contrast-generating mechanisms (bright/dark field, fluorescence, phase contrast, differential interference contrast), and resolution limits. Advanced topics vary by year, but include single-molecule fluorescence, fluorescence resonance energy transfer, confocal microscopy, two-photon microscopy, optical trapping, and fiber optic methods. Limited enrollment. Recommended: basic physics, Biological Sciences core or equivalent, and consent of instructor. GER:DB-NatSci

4 units, Spr (S. Block, Schnitzer, S. Smith, Stearns)

MCP 255. Molecular Physiology of Membranes—Recommended for MCP graduate students; open to graduate and medical students; advanced undergraduates with consent of instructor. Structure and mechanisms of the molecules underlying transmembrane processes. Topics include structure of membrane proteins, energetics of membranes, transmembrane signaling (receptors and channels), transport (transporters and pumps), single molecule methods and theory, and membrane complexes. Lectures introduce concepts; student activities and small group discussion emphasize application of concepts to research the literature. Recommended: BIOC/SBIO 214 or equivalent.

4 units, Win (Maduke, Aldrich)

MCP 256. Molecular Physiology of Cells—Recommended for MCP graduate students; open to graduate and medical students; advanced undergraduates with consent of instructor. Dynamic aspects of cell function, including cellular energetics, gas exchange, solute transport, absorption and secretion in epithelia, ionic and electrical signaling in nerve and muscle, and sensory physiology. Emphasis is on the cellular function of ion channels and transporters, joining experimental and analytical approaches. Lectures, in-class readings, discussions, student presentations, and the use of mathematical models of cell function. Recommended: 255; basic cell and molecular biology.

4 units, Spr (Lewis, Goodman)

MCP 258. Information and Signaling Mechanisms in Neurons and Circuits—How do synapses, cells and neural circuits process information relevant to a behaving organism? How phenomena of information processing emerge at several levels of complexity in the nervous system, including sensory transduction in molecular cascades, information transmission through axons and synapses, plasticity and feedback in recurrent circuits, and encoding of sensory stimuli in neural circuits.

5 units, Aut (Aldrich, Baccus, Tsien)

MCP 299. Directed Reading—Prerequisite: consent of instructor. See faculty list for section numbers.

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

MCP 399. Advanced Research—Investigation sponsored by individual faculty members undertaken by interested, qualified medical or graduate students. Research fields include endocrinology, neuroendocrinology, and topics in molecular and cellular physiology.

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

MOLECULAR PHARMACOLOGY

Emeriti: (Professors) Robert H. Dreisbach, Avram Goldstein, Dora B. Goldstein, Tag E. Mansour, James P. Whitlock

Chair: Daria Mochly-Rosen

Professors: James E. Ferrell, Jr., Oleg Jardetzky, Tobias Meyer, Daria Mochly-Rosen, Richard A. Roth

Assistant Professors: James K. Chen, Karlene A. Cimprich, Thomas J. Wandless

Consulting Professors: Gordon Ringold, Alejandro Zaffaroni

Web Site: http://molepharm.stanford.edu

Courses given in Molecular Pharmacology have the subject code MPHA. For a complete list of subject codes, see Appendix.

GRADUATE PROGRAMS

MASTER OF SCIENCE

Students in the Ph.D. program may apply for an M.S. degree, after having satisfactorily completed the course and laboratory requirements of the first two years. The degree also requires a written thesis based on literature or laboratory research. Postdoctoral research training is available to graduates having the Ph.D. or M.D. degree.

DOCTOR OF PHILOSOPHY

University requirements for the Ph.D. are described in the "Graduate Degrees" section of this bulletin.

The Department of Molecular Pharmacology offers interdisciplinary training to prepare students for independent careers in biomedical science. Research and training in the department focuses on the mechanisms by which hormones and drugs regulate cell function, and on the development

of new therapeutic technologies. At the heart of these issues lies the analysis of cell signaling at the level of pathways and networks.

The program leading to the Ph.D. degree includes formal and informal study in pharmacology, genetics, biochemistry, and molecular cell biology. First-year students spend one quarter in each of three different laboratories, working closely with other graduate students, a professor, and postdoctoral fellows on various research projects. During the fourth quarter, the student chooses a faculty mentor with whom to undertake thesis research, based on available positions and the student's interest. During or before the eighth quarter of study, students must pass a qualifying exam which consists of an oral exam on general knowledge and a defense of a research proposal. Course requirements are fulfilled during the first two years of study; the later years of the four- to six-year program are devoted to full-time dissertation research. Close tutorial contact between students and faculty is stressed throughout the program.

Research opportunities also exist for medical students and undergraduates. The limited size of the labs in the department allows for close tutorial contact between students, postdoctoral fellows, and faculty.

The department participates in the four quarter Health and Human Disease sequence which provides medical students with a comprehensive, systems-based education in physiology, pathology, microbiology, and pharmacology.

COURSES

Course and lab instruction in the Department of Molecular Pharmacology conforms to the "Policy on the Use of Vertebrate Animals in Teaching Activities," the text of which is available at http://www. stanford.edu/dept/DoR/rph/8-2.html.

MPHA 199. Undergraduate Research
1-18 units, Aut, Win, Spr, Sum (Staff)

ADVANCED

Open to all University students; instructor's consent required prior to registration. Students should consult with the instructor about the adequacy of their preparation.

MPHA 210. Signal Transduction Pathways and Networks—The molecular mechanisms through which cells receive and respond to external signals. Emphasis is on principles of cell signaling, the systems-level properties of signal transduction modules, and experimental strategies through which cell signaling pathways are being studied. Prerequisite: working knowledge of biochemistry and genetics.
4 units, Win (Ferrell, Meyer)

MPHA 220. Chemistry of Biological Processes—(Same as BIOC 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, Aut (Wandless, Herschlag, Chen, Bogyo)

MPHA 240. Drug Discovery—The scientific principles and technologies involved in making the transition from a basic biological observation to the creation of a new drug emphasizing molecular and genetic issues. Prerequisite: biochemistry, chemistry, or bioengineering.
4 units (Mochly-Rosen, Cimprich) alternate years, given 2006-07

MPHA 260. Quantitative Chemical Biology—Current topics including protein and small molecule engineering, cell signaling sensors and modulators, molecular imaging, chemical genetics, combinatorial chemistry, in vitro evolution, and signaling network modeling. Prerequisites: undergraduate organic chemistry, and biochemistry or cell biology.
4 units (Chen, Bogyo, Wandless, Jackson) alternate years, not given 2006-07

MPHA 270. Research Seminar—Current research in pharmacology. Seminars are reviewed and discussed in a separate conference with a member of the faculty.
1-2 units, Aut, Win, Spr (Staff)

MPHA 280. Tutorial Program—Guided readings in the literature of any area of pharmacology. Review paper may be required. Primarily for students in pharmacology. May be repeated for credit.
1-18 units, Aut, Win, Spr, Sum (Staff)

MPHA 299. Directed Reading—May be repeated for credit.
1-18 units, Aut, Win, Spr, Sum (Staff)

MPHA 399. Research—Investigations sponsored by individual faculty members. May be repeated for credit.
1-18 units, Aut, Win, Spr, Sum (Staff)

NEUROBIOLOGY

Emeritus: Denis Baylor, Eric Shooter, Lubert Stryer
Chair: Eric I. Knudsen
Professors: Ben Barres, Eric I. Knudsen, Uel J. McMahan, William T. Newsome
Assistant Professors: Stephen Baccus, Thomas Clandinin, Tirin Moore, Jennifer Raymond
Department Offices: Fairchild Building, Second Floor
Mail Code: 94305-5125
Web Site: http://www.stanford.edu/dept/nbio/

Courses given in Neurobiology have the subject code NBIO. For a complete list of subject codes, see Appendix.

GRADUATE PROGRAM

Graduate students in the Department of Neurobiology obtain the Ph.D. degree through the interdepartmental Neurosciences Ph.D. program. Accepted students receive funding for tuition and a living stipend. Applicants should familiarize themselves with the research interests of the faculty and, if possible, indicate their preference on the application form which is submitted directly to the Neurosciences Program.

Medical students also are encouraged to enroll in the Ph.D. program. The requirements of the Ph.D. program are fitted to the interests and time schedules of the student. Postdoctoral training is available to graduates holding Ph.D. or M.D. degrees, and further information is obtained directly from the faculty member concerned.

Research interests of the department include: mechanisms of visual transduction and information transmission in vertebrate retina; structure, function, and development of auditory and visual systems; integrative mechanisms and regeneration in the central and peripheral nervous system; mechanisms of ion channel function; and neuronal growth and differentiation.

COURSES

Course and lab instruction in the Department of Neurobiology conforms to the "Policy on the Use of Vertebrate Animals in Teaching Activities," the text of which is available at http://www.stanford.edu/dept/DoR/rph/8-2.html.

The department offers a one quarter course (NBIO 200) on the structure and function of the nervous system, which is open to medical and graduate students and advanced undergraduates. Advanced courses are open to students who have completed the basic course.

NBIO 199. Undergraduate Directed Reading
1-18 units, Aut, Win, Spr, Sum (Baccus, Barres, Clandinin, Knudsen, McMahan, Moore, Newsome, Raymond)

NBIO 204. Computational Neuroimaging—(Same as PSYCH 204A.) Advanced seminar. For students working with functional magnetic resonance imaging (fMRI). The physiological basis of the signal measured using fMRI. Possibilities for experiment design and interpretation of the signal with respect to other physiological and behavioral measurements. Emphasis is on experimental design, software tools, and pulse sequences for fMRI experiments.
1-3 units (Wandell, Grill-Spector) alternate years, given 2006-07

NBIO 206. The Nervous System—Introduction to the structure and function of the nervous system, including neuroanatomy, neurophysiology, and systems neurobiology. Topics include the properties of neurons and the mechanisms and organization underlying higher functions. Framework for general work in neurology, neuropathology, clinical medicine, and for more advanced work in neurobiology. Lecture and lab components must be taken together.
8 units, Win (Baccus, Barres, Knudsen, Newsome, Raymond, Clandinin, Moore)

NBIO 215. Synaptic Transmission—(Enroll in MCP 215.)
5 units, Aut (Smith, Madison)

NBIO 216. Genetic Analysis of Behavior—(Same as MCP 216.) Advanced seminar. Findings and implications of behavioral genetics as applied to invertebrate and vertebrate model systems. Topics include biological clocks, and sensation and central pattern generators. Relevant genetic techniques and historical perspective. Student presentation.
4 units (Clandinin, Goodman) not given 2005-06

NBIO 218. Neural Basis of Behavior—Advanced seminar. The principles of information processing in the vertebrate central nervous system, and the relationship of functional properties of neural systems with perception and behavior. Emphasis is on the visual and auditory systems. Original papers, directed discussions, and student presentations. Prerequisite: 200 or consent of instructor.
4 units, Spr (Knudsen, Raymond) alternate years, not given 2006-07

NBIO 220. Central Mechanisms in Visual Perception—Contemporary visual neuroscience, emphasizing the neural mechanisms underlying primate vision and visually guided behavior. Seven foundational topics in visual neuroscience; current papers concerning each topic. Student presentations. Computer-based demonstration exercises.
2-4 units (Newsome) not given 2005-06

NBIO 221. Frontiers in Translational Medicine—For first-year MSTP and M.D./Ph.D. students only. Pathways for combining science and medicine during graduate and postdoctoral training and in one's career. Practical aspects of translational medicine. Guest lecturers are physician-scientists who have advanced the frontiers of translational medicine, including Drs. Gilbert Chu, Jamie Topper, Irv Weissman, Ching Wang, Linda Giudice, Geoff Duyk, William Mobley, Judy Shizuru, and David Cox. Prerequisite: consent of instructor.
1 unit, Spr (Barres)

NBIO 228. Mathematical Tools for Neuroscience—Student-instructed. For students with no math background beyond basic calculus, or as a review for more advanced students. Techniques useful for analysis of neural data including linear algebra, Fourier transforms, probability and statistics, signal detection, Bayesian inference, and information theory.
1-3 units (Cohen, Corrado) not given 2005-06

NBIO 254. Molecular and Cellular Neurobiology—(Same as BIOSCI 154/254.) For advanced undergraduates and graduate students. Cellular and molecular mechanisms in the organization and functions of the nervous system. Topics: wiring of the neuronal network, synapse structure and synaptic transmission, signal transduction in the nervous system, sensory systems, molecular basis of behavior including learning and memory, molecular pathogenesis of neurological diseases. Prerequisite for undergraduates: Biological Sciences core or equivalent, or consent of instructors. GER:DB-NatSci
4 units (Luo, Shen, Clandinin) alternate years, given 2006-07

NBIO 258. Information and Signaling Mechanisms in Neurons and Circuits—(Same as MCP 258.) How synapses, cells, and neural circuits process information relevant to a behaving organism. How phenomena of information processing emerge at several levels of complexity in the nervous system, including sensory transduction in molecular cascades, information transmission through axons and synapses, plasticity and feedback in recurrent circuits, and encoding of sensory stimuli in neural circuits.
5 units, Aut (Aldrich, Baccus, Tsien)

NBIO 299. Directed Reading—Prerequisite: consent of instructor.
1-18 units, Aut, Win, Spr, Sum (Baccus, Barres, Clandinin, Knudsen, Moore, McMahan, Newsome, Raymond)

NBIO 300. Professional Development and Integrity in Neuroscience—Required of Neurosciences Ph.D. students every quarter. Develops professional skills in critical assessment and oral presentation of findings from current neuroscience literature in the visual presentation of quantitative data and writing research grants. The role of animals in lab research, fraud in science, the responsibility of authors and reviewers, science in a multicultural environment, and the relationship between student and mentor. Student and faculty presentations and discussions.
1-2 units, Aut, Win, Spr (Raymond)

NBIO 399. Individual Research—Prerequisite: consent of instructor.
1-18 units, Aut, Win, Spr, Sum (Baccus Barres, Clandinin, Knudsen, Moore, McMahan, Newsome, Raymond)

NEUROSCIENCES PROGRAM

Director: William T. Newsome (Professor, Neurobiology)
Committee: Richard Aldrich, Corinna Darian-Smith, Craig Garner, Kalanit Grill-Spector, Shaul Hestrin, John R. Huguenard, Liqun Luo, M. Bruce MacIver, William Mobley, William T. Newsome, Jennifer Raymond, Krishna Shenoy

Participating Faculty:
Anesthesia: Rona Giffard (Associate Professor), M. Bruce MacIver (Assistant Professor, Research), Sean Mackey (Assistant Professor), David Yeomans (Associate Professor)
Applied Physics: Mark Schnitzer (Assistant Professor)
Biological Sciences: Bruce Baker (Professor), Russell D. Fernald (Professor), William F. Gilly (Professor), H. Craig Heller (Professor), Ron Kopito (Professor), Liqun Luo (Assistant Professor), Susan McConnell (Professor), Robert M. Sapolsky (Professor), Mark Schnitzer (Assistant Professor), Kang Shen (Assistant Professor), Stuart Thompson (Professor)
Comparative Medicine: Paul S. Buckmaster (Assistant Professor), Linda C. Cork (Professor), Corinna Darian-Smith (Assistant Professor), Shaul Hestrin (Associate Professor)
Developmental Biology: Matthew P. Scott (Professor)
Electrical Engineering: Krishna Shenoy (Assistant Professor)
Genetics: Anne Brunet (Assistant Professor), David R. Cox (Professor)
Molecular and Cellular Physiology: Richard Aldrich (Professor), Miriam B. Goodman (Assistant Professor), Brian Kobilka (Professor), Richard S. Lewis (Professor), V. Daniel Madison (Associate Professor), Merritt C. Maduke (Assistant Professor), Stephen Smith (Professor), Richard Tsien (Professor)
Molecular Pharmacology: Helen Blau (Professor), Tobias Meyer (Professor), Daria Mochly-Rosen (Professor)
Neurobiology: Stephen Baccus (Assistant Professor), Ben Barres (Associate Professor), Tom Clandinin (Assistant Professor), Ricardo Dolmetsch (Assistant Professor), Eric I. Knudsen (Professor), U. J. McMahan (Professor), Tirin Moore (Assistant Professor), William T. Newsome (Professor), Jennifer Raymond (Assistant Professor)
Neurology and Neurological Sciences: Robert S. Fisher (Professor), Ting-Ting Huang (Assistant Professor), John A. Huguenard (Associate Professor), William C. Mobley (Professor), David A. Prince (Professor), Thomas A. Rando (Assistant Professor), Richard Reimer (Assistant Professor), Terence Sanger (Assistant Professor), Lawrence Steinman (Professor), Tony Wyss-Coray (Assistant Professor), Yanmin Yang (Assistant Professor)
Neurosurgery: Pak H. Chan (Professor), Theo Palmer (Assistant Professor), Gary K. Steinberg (Professor)
Pathology: Bingwei Lu (Assistant Professor), Raymond Sobel (Associate Professor)
Psychiatry and Behavioral Sciences: Karl Deisseroth (Assistant Professor), Craig Garner (Professor), Terrence A. Ketter (Associate Professor), Robert C. Malenka (Professor), Vinod Menon (Assistant

Professor, Research), Emmanuel Mignot (Professor), Allan L. Reiss (Professor), Edith Sullivan (Professor, Research)

Psychology: Ian Gotlib (Professor), Kalanit Grill-Spector (Assistant Professor), James J. Gross (Associate Professor), Brian Knutson (Assistant Professor), Anthony Wagner (Assistant Professor), Brian Wandell (Professor), Jeffrey J. Wine (Professor)

Radiology: Gary H. Glover (Professor)

Program Offices: Alway Bldg., M-105A
Mail Code: 94305-5121
Phone: (650) 723-9855
Web Site: http://neuroscience.stanford.edu/

Courses given in the Neurosciences Program have the subject code NEPR. For a complete list of subject codes, see Appendix.

GRADUATE PROGRAM

DOCTOR OF PHILOSOPHY

University requirements for the Ph.D. are described in the "Graduate Degrees" section of this bulletin.

The interdepartmental Neurosciences Program offers instruction and research opportunities leading to a Ph.D. in Neurosciences. The requirements for a Ph.D. degree follow those of the University and in addition are tailored to fit the background and interests of the student. Accepted students receive an award covering tuition, a basic health plan, and a living stipend. Qualified applicants should, where possible, apply for the predoctoral fellowships in open competition, especially those from the National Science Foundation. December 16 is the deadline for receipt in the Neurosciences Program office of applications with all supporting material.

Applicants should familiarize themselves with the research interests of the faculty and indicate their preferences clearly on the application form.

Since students enter with differing backgrounds, and the labs in which they may elect to work cover several different disciplines, the specific program for each student is developed individually with an advisory committee. All students are required to complete the basic introduction to neurobiology (NBIO 206 or equivalent). Students must also take five advanced courses, four of which must be distributed among four of the following core areas: systems and behavioral neuroscience, molecular and cellular neuroscience, developmental neuroscience, clinical neuroscience, and computational neuroscience. The fifth advanced course is chosen by the student in an area related to the student's research interest, and may be selected from outside the Neurosciences core with prior approval from the Program Director and the student's adviser.

Students usually rotate through several labs during their first year, although they may choose to begin thesis research on entry. After the first rotation, students may rotate both within and outside the Neurosciences Program. Required course work should be completed by the end of the second year. Passing of a comprehensive oral preliminary examination given by the student's advisory committee is required for admission to Ph.D. candidacy. This examination is usually taken by the end of the second year. The student is required to present a Ph.D. dissertation, which is the result of independent investigation contributing to knowledge in an area of neuroscience, and to defend his or her dissertation in a University oral examination, which includes a public seminar.

Medical students may participate in this program provided they meet the prerequisites and satisfy all the requirements of the graduate program as listed above. The timing of the program may be adjusted to fit their special circumstances.

COURSES

Course and lab instruction in the Neurosciences Program conforms to the "Policy on the Use of Vertebrate Animals in Teaching Activities," the text of which is available at http://www.stanford.edu/dept/DoR/rph/8-2.html.

NEPR 299. Directed Reading
1-18 units, Aut, Win, Spr, Sum (Staff)

NEPR 300. Professional Development and Integrity in Neuroscience—(Enroll in NBIO 300.)
1-2 units, Aut, Win, Spr (Raymond)

NEPR 399. Research—Prerequisite: consent of instructor.
1-18 units, Aut, Win, Spr, Sum (Staff)

OBSTETRICS AND GYNECOLOGY

Chair: Mary Lake Polan

Courses given in Gynecology have the subject code OBGYN. For a complete list of subject codes, see Appendix.

The Department of Obstetrics and Gynecology does not offer degrees; however, qualified medical, graduate, or undergraduate students with an interest in basic research in reproductive biology may apply to arrange individual projects under the supervision of the faculty. The focus for the Division of Reproductive Biology is the study of the molecular and cellular biology of male and female reproductive organs.

COURSES

OBGYN 199. Undergraduate Research
1-18 units, Aut, Win, Spr, Sum (Staff)

OBGYN 202. Infertility: Mechanisms of Disease and Clinical Frontiers—(Same as DBIO 202.) Primary literature in basic and clinical science, and demonstrations of assisted reproductive technologies (ART). Techniques include in vitro fertilization including micromanipulation procedures such as intracytoplasmic sperm injection and the culture of blastocysts, using mouse gametes, and pre-embryos. Students observe procedures in the ART clinic. Recommended: DBIO 201 or consent of instructors.
3-4 units, Win (Porzig, Behr)

PATHOLOGY

Emeriti: (Professor) Richard L. Kempson; *(Professor, Clinical)* P. Joanne Cornbleet, Lawrence F. Eng, Luis Fajardo, Heinz Furthmayr, F. Carl Grumet

Chair: Stephen J. Galli

Professors: Daniel Arber, Ellen Jo Baron, Gerald J. Berry, Eugene C. Butcher, Michael L. Cleary, Gerald R. Crabtree, Edgar G. Engleman, Andrew Fire, Steven Foung, Stephen J. Galli, Lawrence Tim Goodnough, Michael R. Hendrickson, Jon C. Kosek, Joseph S. Lipsick, Robert V. Rouse, Richard K. Sibley, Howard H. Sussman, Teresa S. F. Wang, Roger A. Warnke, Irving L. Weissman

Associate Professors: Jeffrey D. Axelrod, Athena M. Cherry, Tina Cowan, James D. Faix, Susan A. Galel, Sharon M. Geaghan, Peter K. Jackson, Sabine Kohler, Teri A. Longacre, Sara A. Michie, Kent W. Nowels, Bruce Patterson, Donald P. Regula, Arend Sidow, Raymond A. Sobel, Jan Matthijs van de Rijn, Hannes Vogel, James L. Zehnder

Assistant Professors: Matthew Bogyo, David Cassarino. Andrew Connolly, Dean Felsher, Magali Fontaine, Tracey George, John P. Higgins, Neeraja Kambham, Christina Kong, Bingwei Lu, Yasodha Natkunam, Jonathan R. Pollack, Iris Schrijver, Uma Sundram

Acting Assistant Professors: Soheil Dadras, Erich Schwartz, Robert West

Courtesy Professor: Lucy Tompkins

Courtesy Assistant Professor: Donna Bouley, Robert Shafer

Clinician Educators: Susan Atwater, Carey D. Austin, David B. Bingham, Christopher A. Callahan, Barbara Egbert, Tracey George, Terri Haddix, Norman Lehman, Melanie Manning, Dorothy Nguyen, Christopher Park, Michael Petzar, Brent Tan Maurene Viele

Adjunct Clinical Faculty: Robert Archibald, Jerome S. Burke, Stephen Shi-Hua Chen, Seth Haber, Maie K. Herrick, Paul W. Herrmann, Charles Lombard, John E. McNeal, Judy Melinek, Lawrence Naiman, Mahendra Ranchod, Thomas W. Rogers, William Ruehl, Joshua Sickel, Sharon Van Meter

Department Offices: Medical Center, Lane Building, L-235
Mail Code: 94305-5324
Phone: (650) 723-5252
Web Site: http://pathology.stanford.edu

Courses given in Pathology have the subject code PATH. For a complete list of subject codes, see Appendix.

PROGRAMS OF STUDY

The Department of Pathology offers advanced courses in aspects of pathology. The department does not offer advanced degrees in pathology, but qualified graduate students who are admitted to the Biophysics Program, the Cancer Biology Program, or other interdepartmental programs may elect to pursue their thesis requirements in the department's research laboratories. The discipline of pathology has served as a bridge between the preclinical and clinical sciences and is concerned with the application of advances in the basic biological sciences, both to the diagnosis of human disease and the elucidation of the mechanisms of normal molecular, cellular, and organ structure and function that manifest themselves in clinical disease. Accordingly, the department's research interests extend from fundamental molecular biology to clinical-pathological correlations, with an emphasis on experimental oncology.

At present, investigation in the department includes basic studies in different areas utilizing molecular biological, biochemical, and genetic cell biological techniques: DNA replication in yeast and cultured eukaryotic cells, cell cycle control in animal cells and yeast, identification and pathogenetic role of chromosomal aberrations in human malignancies and mechanisms of activation of oncogenes in human and animal cells, lymphocyte and neutrophil-interactions with endothelial cells, cell type specification and signal transduction pathways leading to specific gene expression or modulation of cytoskeletal behavior; cytoskeletal architecture, cell-matrix interaction, developmental biology of hematopoietic stem cells and thymus, regulation of the immune system, and mechanisms of immune and other responses in the central nervous system. In addition, a variety of studies focus on the development of novel diagnostic and immunotherapeutic treatment modalities and techniques for solid tumors, lymphomas, HIV, and genetic diseases. Research training in all of these areas is available for qualified medical and graduate students by individual arrangement with the appropriate faculty member. A summary of the research interests of the department faculty is available at http://pathology.stanford.edu.

COURSES

Course and lab instruction in the Department of Pathology conforms to the "Policy on the Use of Vertebrate Animals in Teaching Activities," the text of which is available at http://www.stanford.edu/dept/DoR/rph/8-2.html.

PATH 103Q. Leukocyte Migration—Stanford Introductory Seminar. Preference to sophomores.
1 unit, Aut (Michie)

PATH 105Q. Final Analysis: The Autopsy as a Tool of Medical Inquiry—Stanford Introductory Seminar. Preference to sophomores.
3 units, Spr (Regula)

PATH 199. Undergraduate Research
1-18 units, Aut, Win, Spr (Staff)

PATH 211. Advanced Immunology I—(Enroll in MI 211, IMMUNOL 201.)
3 units, Win (Chien, Staff)

PATH 218. Computational Analysis of Biological Images
2 units, Aut (Staff)

PATH 299. Directed Reading—Prerequisite: consent of instructor.
1-18 units, Aut, Win, Spr, Sum (Staff)

PATH 233. The Biology of Small Modulatory RNAs—(Same as GENE 233, MI 233.) Open to graduate and medical students. How recent discoveries of miRNA, RNA interference, and short interfering RNAs reveal potentially widespread gene regulatory mechanisms mediated by small modulatory RNAs during animal and plant development. Requires paper proposing novel research.
2 units, Aut (Chen, Fire)

PATH 399. Research—Department faculty are involved in active research programs at the Stanford Medical Center. Students interested in research at the molecular, cellular, and clinical-pathologic levels are encouraged to seek out faculty advisers. The department is equipped for modern research and maintains an active postdoctoral research training program. Prerequisite: consent of instructor.
1-18 units, Aut, Win, Spr, Sum (Staff)

RADIATION ONCOLOGY

Emeriti: Malcolm A. Bagshaw, Peter Fessenden, Don R. Goffinet, George M. Hahn, Kendric Smith
Chair: Richard T. Hoppe
Professors: Arthur Boyer, J. Martin Brown, Sarah S. Donaldson, Amato J. Giaccia, Steven L. Hancock, Richard T. Hoppe, Daniel S. Kapp, Steven A. Liebel
Associate Professors: Susan J. Knox, Quynh-Thu Le, Gary Luxton, Melanie C. Smitt, Lei Xing
Assistant Professors: Laura Attardi, Nicholas Denko, Iris C. Gibbs, Edward Graves, Christopher R. King, Albert C. Koong, Todd Pawlicki
Consulting Professor: Robert M. Sutherland

Courses given in Radiation Oncology have the subject code RADO. For a complete list of subject codes, see Appendix.

Radiation Oncology is a discipline focused around the use of radiation for both cancer therapy and research. The fundamental and applied research within the department reflects this spectrum in radiation therapy and clinical oncology, and in radiation and tumor biology.

The department does not offer degrees; however, its faculty teach a variety of courses open to medical students, graduate students, and undergraduates. The department also accepts students in other curricula as advisees for study and research. Graduate students in the Biophysics Program and in the Cancer Biology Program may perform their thesis research in the department. Undergraduate students may also arrange individual research projects under the supervision of the faculty.

At the present time, the major areas of basic research investigation in the department include: DNA repair in mammalian cells after ionizing irradiation; studies of the mechanism of tumor hypoxia in animal tumors; development of new anti-cancer drugs to exploit tumor hypoxia; cytogenetic and molecular methods of predicting the sensitivity of individual tumors to cancer therapy; radiolabeled monoclonal antibodies for cancer detection and treatment; studies of oxygen levels in human tumors using polarographic electrodes; clinical trials of a new hypoxic cytotoxic agent (tirapazamine); studies of the late effects of cancer therapy; and techniques of conformal and intensity modulated radiation therapy.

COURSES

Course and lab instruction in the Department of Radiation Oncology conforms to the "Policy on the Use of Vertebrate Animals in Teaching Activities," the text of which is available at http://www.stanford.edu/dept/DoR/rph/8-2.html.

The following are open to undergraduates and graduate students.

RADO 101. Readings in Radiation Biology
1-18 units, Aut, Win, Spr (Staff)

RADO 199. Undergraduate Research
1-18 units, Aut, Win, Spr, Sum (Staff)

RADO 299. Directed Reading—Prerequisite: consent of instructor.
1-18 units, Aut, Win, Spr, Sum (Staff)

RADO 399. Research—Investigations sponsored by individual faculty members. Prerequisite: consent of instructor.
1-18 units, Aut, Win, Spr, Sum (Staff)

RADIOLOGY

Emeriti: (Professors) Herbert L. Abrams, David A. Goodwin, Henry H. Jones, Albert Macovski, William H. Northway, Lewis Wexler, Leslie M. Zatz
Chair: Gary M. Glazer
Professors: Scott W. Atlas, Richard A. Barth, Sanjiv Sam Gambhir, Gary M. Glazer, Gary H. Glover, Michael L. Goris, Robert J. Herfkens, R. Brooke Jeffrey, Barton Lane, Ann Leung, Michael Marks, I. Ross McDougall, Robert E. Mindelzun, Michael Moseley, Sandy Napel, Matilde Nino-Murcia, Norbert J. Pelc, F. Graham Sommer
Associate Professors: Patrick D. Barnes, Christopher F. Beaulieu, Francis Blankenberg, Michael D. Dake, Bruce Daniel, Terry Desser, Huy M. Do, Debra M. Ikeda, Stephen Kee, Eric W. Olcott, Geoffrey D. Rubin, George M. Segall, Daniel M. Spielman, Daniel Y. Sze
Associate Professors (Research): Kim Butts, Craig Levin
Assistant Professors: Sandip Biswal, Frandics P. Chan, Dominik Fleischmann, Joan K. Frisoli, Garry E. Gold, Kathryn J. Stevens
Assistant Professors (Research): Mark Bednarski, Rebecca Fahrig, Sylvia Plevritis, Xiaoyuan Chen
Consulting Assistant Professor: Jarrett Rosenberg
Web Site: http://www-radiology.stanford.edu/

Courses given in Radiology have the subject code RAD. For a complete list of subject codes, see Appendix.

The Department of Radiology does not offer degrees; however, its faculty teach courses open to medical students, graduate students, and undergraduates. The department also accepts students in other curricula as advisees for study and research. Undergraduates may also arrange individual research projects under the supervision of the department's faculty. This discipline focuses on the use of radiation, ultrasound, and magnetic resonance as diagnostic, therapeutic, and research tools. The fundamental and applied research within the department reflects this broad spectrum as it relates to anatomy, pathology, physiology, and interventional procedures. Original research and development of new clinical applications in medical imaging is supported within the Radiological Sciences Laboratory.

COURSES

The following courses are open to undergraduates and graduate students.

RAD 101. Readings in Radiology Research
1-18 units, Aut, Win, Spr (Staff)

RAD 199. Undergraduate Research
1-18 units Aut, Win, Spr (Staff)

RAD 208. Experimental Nuclear Medicine—Computer applications in medicine, particularly in the use of radioisotopes as tracers. Recommended: some knowledge of physiology and calculus.
2 units, Win, Spr (Goris)

RAD 220. Introduction to Imaging and Image-Based Human Anatomy—(Same as BIOE 220.) The physics of medical imaging and human anatomy through medical images. Emphasis is on contrast mechanisms and the relative strengths of each imaging modality. Lab shows imaging and anatomy in real time. Recommended: basic biology, physics, and math.
3 units, Aut (Gold, K. Pauly)

RAD 221. Introduction to Radiologic Anatomy—Basic human anatomy through imaging examinations including radiography, computed tomography, ultrasound, and magnetic resonance imaging. How to recognize normal anatomy on imaging studies, spatial relationships, and three-dimensional thinking. Case studies of pathology.
2 units, Aut (Gold, Staff)

RAD 222. Multi-modality Molecular Imaging in Living Subjects—(Same as BIOE 222.) The molecular and cellular bases of life from an engineering perspective considering metabolism, information flow and feedback, signal transduction, and means for engineering these processes. Clinical motivations and practical applications.
4 units, Aut (Gambhir)

RAD 226. In Vivo Magnetic Resonance Spectroscopy and Imaging—Collections of identical independent nuclear spins are described by the classical vector model of magnetic resonance imaging (MRI); however, interactions among spins, as occur in many in vivo processes, require a more complete description. Physics and engineering principles of these in vivo magnetic resonance phenomena with emphasis on current research questions and clinical applications. Topics: quantum mechanical description of magnetic resonance, density matrix theory, product operator formalism, relaxation theory and contrast mechanisms, spectroscopic imaging, spectral editing, and multinuclear studies. Prerequisites: EE 369B or familiarity with magnetic resonance, working knowledge of linear algebra.
3 units, Win (Spielman)

RAD 227. Functional MRI Methods—(Same as BIOPHYS 227.) Functional magnetic resonance neuroimaging, including data acquisition, analysis, and experimental design. Journal club sections. Cognitive neuroscience and clinical applications. Prerequisites: basic physics, mathematics. Recommended: neuroscience.
3 units, Aut (Glover)

RAD 299. Directed Reading—Prerequisite: consent of instructor.
1-18 units, Aut, Win, Spr, Sum (Staff)

STRUCTURAL BIOLOGY

Chair: Joseph D. Puglisi
Associate Chair: Michael Levitt
Professors: Roger D. Kornberg, Michael Levitt, David B. McKay, Uel J. McMahan, Peter Parham, Joseph D. Puglisi, William I. Weis
Associate Professor: Kenen C. Garcia
Professor (Teaching): Patricia Cross
Associate Professor (Research): Yahli Lorch
Department Offices: Fairchild Building, D100
Mail Code: 94305- 5126
Phone: (650) 723-7576
Email: structuralbio@med.stanford.edu
Web Site: http://www.med.stanford.edu/school/structuralbio

Courses given in Structural Biology have the subject code SBIO. For a complete list of subject codes, see Appendix.

The department offers course work and opportunities for research in structural biology. Courses fall into two categories: (1) a series of one quarter courses that treat topics of current interest in structural biology and biophysics at an advanced level; and (2) INDE 216, Cells to Tissues, a course for medical students that includes lectures on structure-function relationships of mammalian cells and tissues and a lab on medical histology.

The emphasis of research in the department is on understanding fundamental cellular processes in terms of the structure and function of biological macromolecules and their assemblies. Techniques used include standard methods of biochemistry, cell culture, single-molecule fluorescence spectroscopy, genetic engineering, and three dimensional structure determination by x-ray diffraction, nuclear magnetic resonance spectroscopy and electron microscopy, coupled with the development of computational methods.

GRADUATE PROGRAMS

DOCTOR OF PHILOSOPHY

University requirements for the Ph.D. are described in the "Graduate Degrees" section of this bulletin.

The graduate program in Structural Biology leads to the Ph.D. degree. The department also participates in the Medical Scientists Training Program

in which individuals are candidates for both Ph.D. and M.D. degrees.

The graduate program is intended to prepare students for careers as independent investigators in cell and molecular biology. The principal requirement of a Ph.D. degree is the completion of research constituting an original and significant contribution to the advancement of knowledge. The requirements and recommendations for the Ph.D. degree include:

1. Training in physics or chemistry equivalent to that of an undergraduate physics or chemistry major at Stanford.
2. Completion of the following background courses or their equivalents at other institutions:
   a) CHEM 131, 171, 173, and 175
   b) BIOC 200, 201
3. Completion of the following courses or their equivalents:
   a) SBIO 241 and 242
   b) At least four additional graduate level courses in physical or biological science
   c) MED 255
4. Opportunities for teaching are available during the first nine quarters at the discretion of the advising committee.
5. The student must prepare a dissertation proposal defining the research to be undertaken including methods of procedure. This proposal should be submitted by Winter Quarter of the third year, and it must be approved by a committee of at least three members including the principal research adviser and at least one member from the Department of Structural Biology. The candidate must defend the dissertation proposal in an oral examination. The dissertation reading committee normally evolves from the dissertation proposal review committee.
6. The student must present a Ph.D. dissertation as the result of independent investigation and expressing a contribution to knowledge in the field of structural biology.
7. The student must pass the University oral examination, taken only after the student has substantially completed the research. The examination is preceded by a public seminar in which the research is presented by the candidate.

Applicants to the program should have a bachelor's degree and should have completed at least a year of course work in biology, mathematics, organic chemistry, physical chemistry, and physics. Application forms must be received by the department before December 15 for notification by April 15. Application to the National Science Foundation for fellowship support is also encouraged. Remission of fees and a personal stipend are available to graduate students in the department. Prospective applicants should contact the Department of Structural Biology for further information.

Current topics of research in the department lie in the areas of gene expression; theoretical, crystallographic, and genetic analysis of protein structure; and cell-cell interaction. See http://www.med.stanford.edu/school/structuralbio/ for further information.

COURSES

Course and lab instruction in the Department of Structural Biology conforms to the "Policy on the Use of Vertebrate Animals in Teaching Activities," the text of which is available at http://www.stanford.edu/dept/DoR/rph/8-2.html.

SBIO 199. Undergraduate Research
1-18 units, Aut, Win, Spr, Sum (Staff)

SBIO 201. Advanced Immunology I—(Enroll in MI 211, IMMUNOL 201.)
3 units, Win (Chien, Staff)

SBIO 228. Computational Structural Biology—(Same as BIOPHYS 228.) Online class. Interatomic forces and interactions such as electrostatics and hydrophobicity, and protein structure in terms of amino acid properties, local chain conformation, secondary structure, domains, and families of folds. How protein motion can be simulated. Bioinformatics introduced in terms of methods that compare proteins via their amino acid sequences and their three-dimensional structures. Structure prediction via simple comparative modeling. How to detect and model remote homologues. Predicting the structure of a protein from knowledge of its amino acid sequence.
3 units, Aut, Spr (Levitt)

SBIO 229. The Eukaryote Chromosome—The principles of chromosome structure and function including the structure, dynamics, and topological forms of DNA; units and hierarchies of DNA coiling in chromosomes; centromeres, telomeres, and basis of chromosome maintenance and sorting in mitosis; mechanism of gene activation with particular regard to enhancer, promoter, and terminator sequences; basis of sequence-specific protein-DNA interaction; and organization and assembly of the cell nucleus. Prerequisite: knowledge of basic biochemistry and cell biology.
3 units, Spr (Kornberg)

SBIO 241. Biological Macromolecules—The physical and chemical basis of macromolecular function. The 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 the level of individual molecular interactions and at the level of complex processes. Case studies. Prerequisite: BIOC 200 or equivalent.
3-5 units, Aut (Puglisi, Weis, Block, Herschlag, Ferrell, McKay, Pande, Garcia)

SBIO 242. Methods in Molecular Biophysics—The potential utility of physical approaches to research, and how to evaluate literature that incorporates these methods. Experimental methods in molecular biophysics from theoretical and practical standpoints. Emphasis is on x-ray diffraction and nuclear magnetic resonance spectroscopy. Additional topics include fluorescence spectroscopy, circular dichroism, calorimetry, and separation methods.
3 units (Weis, Puglisi) not given 2005-06

SBIO 274. Topics in Nucleic Acid Structure and Function—Principles of nucleic acid structure and function. Methods for investigating nucleic acid structure. Limited to graduate students and postdoctoral fellows in structural biology. Prerequisite: consent of instructor.
2 units, Aut (Staff).

SBIO 299. Directed Reading—Prerequisite: consent of instructor.
1-18 units, Aut, Win, Spr, Sum (Staff)

SBIO 399. Individual Research—Investigations sponsored by individual faculty members. Prerequisite: consent of instructor.
1-18 units, Aut, Win, Spr, Sum (Staff)

SURGERY

The following courses are open to undergraduates. For graduate and Medical School course offerings, see http://med.stanford.edu/.

Courses given in Surgery have the subject code SURG. For a complete list of subject codes, see Appendix.

COURSES

SURG 67Q. Medical Experience in Foreign Lands—Stanford Introductory Seminar. Preference to sophomores.
3 units, Win (Chase, Wang)

SURG 68Q. Current Concepts in Transplantation—Stanford Introductory Seminar. Preference to sophomores. Can tissues and organs be grown in a laboratory for transplantation to humans? Biological aspects of cell and organ transplantation, including issues that arise in the media. Diseases for which transplantation is a treatment, the state of the art in human transplantation, transplantation of animal tissue into humans (xenotransplantation), development of new tissue and organs in the

laboratory (tissue engineering and cloning), and development of drugs and biological strategies to promote long-term survival of the tissue or organ (tolerance). Team-taught; sources include popular and scientific literature and presentations. WRITE-2

3 units, Spr (Krams, Martinez)

SURG 69Q. It's All in the Head: Understanding Diversity, Development, and Deformities of the Face—(S,Sem)

3-4 units, Win (Helms)

SURG 101. Regional Study of Human Structure—Lectures in regional anatomy, dissection of the human body. The anatomy of the area through the dissection process. Enrollment limited to 32.

5 units, Win (Dolph, Gosling)

SURG 199. Undergraduate Research

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

SURG 223. Basic Emergency Care/Travel and Wilderness Medicine—Wilderness-related illnesses and injuries; framework for dealing with emergencies in the backcountry. Hands-on workshops. Topics include high altitude medicine, diving medicine, hypothermia, snake and spider envenomations, search and rescue, and travel medicine. Open to all students.

4 units, Spr (Weiss, Staff)

SURG 267. International Health—Fundamental issues in public health with an international perspective. Topics include: Colonialism and Development, Reproductive Health, Women's Health Issues, Environmental Health, Maternal Child Health, Primary Health Care and its Evolution, Health Policy, Infectious Disease, Human Rights and Social Justice. Speakers from UCSF and Berkeley School of public health.

1 unit, Spr (Staff)