School of Medicine

Dean: Philip Pizzo
Senior Associate Dean for Research and Training: Harry B.Greenberg
Senior Associate Dean for Research and Training: John C. Boothroyd
Senior Associate Dean for Education and Student Affairs: 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. Details on admission into undergraduate programs are described in the "Undergraduate Degrees" section of this bulletin.

GRADUATE PROGRAMS

M.S. AND Ph.D. PROGRAMS

Departments offer programs leading to the Ph.D. degree. Applications and information for all graduate programs may be obtained from Graduate Admissions, Registrar's Office, Stanford University, Stanford, CA 94305-3005, or at http://gradadmissions.stanford.edu.

M.D. PROGRAMS

The School of Medicine provides an educational environment that encourages intellectual diversity and offers stimulation and opportunity for self-motivated students who are interested in developing a scholarly, investigative approach to problems in medicine. Accordingly, Stanford has designed its medical curriculum with a two-fold purpose: to develop in all students the capacity for leadership in the clinical practice of scientific medicine and to provide them opportunities to prepare themselves for careers in research and teaching in the various branches of basic, clinical, and social medicine. The flexible curriculum allows for individual needs in scheduling course work. Students develop study plans that take into consideration their academic background, particular strengths, and career objectives.

All medical students must complete a formal curriculum in the basic medical sciences and have formal clinical experience in medicine, surgery, pediatrics, gynecology-obstetrics, family medicine, and psychiatry. Following completion of 13 quarters of academic work, additional quarters may be taken at a special student rate. Involvement in research and outside course work may extend the time spent in medical school. Completion of the M.D. degree must be achieved within six years, unless a petition is granted to extend this time frame.

There are a variety of opportunities for in-depth study of subject areas in the basic sciences. 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.

The admissions process recognizes that some minorities and women are underrepresented in the medical profession, and especially in academic medicine; the school has a strong commitment to identify, recruit, and educate such students.

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 mathematics and the behavioral sciences is highly recommend-

ed because of its 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.

Further details on the M.D. degree, including admission requirements, are in the Stanford University *School of Medicine Catalog*, available on the web at http://www-med.stanford.edu/school/catalog. For application materials write: Committee on Admissions, Stanford University, School of Medicine, 251 Campus Drive, Suite 341, Stanford, CA 94305-5404.

BIOCHEMISTRY

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

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. On-going 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 three research proposals, which are presented by the student to a small sy committee of departmental faculty members who are also responsible for monitoring the progress of student curricular and research programs. All Ph.D. students are expected to participate actively in the department's seminar program, and students are encouraged to attend and to present papers at regional and national meetings in cellular biochemistry and molecular biology. Teaching experience is an integral part of the Ph.D. curriculum and is required for the degree.

The Department of Biochemistry offers 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 15.

Beginning September 1, applications are available and 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. Applications may also be submitted electronically at http://gradadmissions.stanford.edu/ and http://www.med.stanford.edu/school/biosciences/. Applicants are notified by April 1 of decisions on their applications. Stanford University requires scores from the Graduate Record Examination (GRE) (verbal, quantitative, and analytical), and applicants must submit scores from the GRE Subject Test in either biochemistry, biology, or chemistry. Applicants should take the October GRE exam.

All applicants are urged to compete for non-Stanford fellowships or scholarships, and U.S. citizens should complete an application for a National Science Foundation 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: Biological Sciences 42 or Human Biology 2A. GER:2b
3 units, Spr (Brutlag)

BIOC 199. Undergraduate Research—Prerequisite: consent of instructor.
1-18 units (Staff)

BIOC 202. Metabolic Biochemistry: Structure, Metabolism, and Energetics
4 units (Staff)

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.

4 units, Aut (Chu, Brown, Krasnow)

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

4 units, Spr (Pfeffer)

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. Course format is 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 2003-04

BIOC 215. Frontiers in Biological Research—(Same as DBIO 215, GENE 215.) Literature discussion on how to critically evaluate biological research. Held in conjunction with a seminar series, hosted in alternate weeks by Biochemistry, Developmental Biology, and Genetics. Each Wednesday, distinguished investigators present their current work at the Frontiers in Biological Research seminar. Beforehand, students and faculty meet to discuss one or more papers from the speaker's primary research literature on a related topic. After the seminar, students meet with the speaker to discuss their research and future direction, the techniques most commonly used to study problems in biology, and a comparison between the genetic and biochemical approaches in biological research.

1 unit, Aut, Win, 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 under the guidance of advanced graduate students and postdoctoral fellows.

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

BIOC 218. Computational Molecular Biology—Course online only; see http://biochem218.stanford.edu. For molecular biologists and computer scientists. Hands-on approach to the major issues concerning representation and analysis of biological sequences and structure. Existing methods and future directions. 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, Aut, Win, Spr (Brutlag)

BIOC 221. The Teaching of Biochemistry—To be taken by all teaching assistants in 203, 204, 217, or 218. Emphasizes practical experience in teaching on a one-to-one basis, and problem set design and analysis. Familiarization with current lecture and text materials is expected, along with evaluations of class papers and examinations. Prerequisite: enrollment in the Biochemistry Ph.D. program or consent of instructor.

3 units, Aut, Win, Spr, Sum (Staff) by arrangement

BIOC 225. Molecular Motor Proteins and the Cytoskeleton—(Same as DBIO 225.) The molecular basis of energy transduction leading to movements generated by microfilament-based and microtubule-based motors. Forms of myosin, dynein, and kinesin and their roles in the cell as a model for understanding the structural, biochemical, and functional properties of biological machines. Topics: structure of the molecular motors and their accessory proteins; regulation of the function of motile assemblies; functions of molecular motors in cells; spatial and temporal controls on the formation of motile assemblies in cells. Experimental approaches: genetic analysis, DNA cloning and expression, reconstitution of functional assemblies from purified proteins, x-ray diffraction, three-dimensional reconstruction of electron microscope images, spectroscopic methods, and high-resolution light microscopy. Prerequisites: basic biochemistry and cell biology.

3 units, Spr (Spudich) not given 2004-05

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 specific diseases and the reasons for success and failure in molecular approaches to treatment. Students lead discussions examining papers from the primary medical and scientific literature. Prerequisite: understanding of molecular biology, cell biology, and biochemistry.

2-3 units, Aut (Theriot, Harbury)

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

3-5 units, Aut (Puglisi, Block, Herschlag, Kirkegaard, McKay)

BIOC 242. Methods in Molecular Biophysics—(Same as SBIO 242.) 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 (McKay, Puglis) alternate years, given 2004-05

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

1-2 units, Aut (Kornberg, Lehman)

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

1-18 units, Aut, Win, Spr, Sum, by arrangement

BIOC 399. Research and Special Advanced Work—Prerequisite: consent of instructor. See faculty list for section numbers.

1-18 units, Aut, Win, Spr, Sum, by arrangement

BIOC 450. Introduction to Biotechnology—(Same as CHEMENG 450). Stanford faculty from the schools of Medicine, Humanities and Sciences, and Engineering, and invited industrial speakers review the interrelated elements of modern biotechnology. Topics: development of recombinant protein pharmaceuticals, bacterial fermentation and scale-up, mammalian cell culture and scale-up, transgenic animals, transgenic protein production in plants, isolation and purification of protein pharmaceuticals, formulation and delivery of pharmaceutical proteins, environmental biotechnology, metabolic engineering, industrial enzymes, diagnostic devices, transciptomics and proteomics, drug delivery systems. Prerequisite: graduate student or upper-division undergraduate in the sciences or engineering.

3 units, Spr (Kao)

BIOC 459. Frontiers in Interdisciplinary Biosciences—(Crosslisted in multiple departments in the schools of Humanities and Sciences, Engineering, and Medicine. Students should enroll through their affiliated department; otherwise enroll in CHEMENG 459.) See CHEMENG 459 or http://biox.stanford.edu/chemeng_index.html for description.

1 unit, Aut, Win, Spr (Robertson)

CENTER FOR BIOMEDICAL ETHICS

Co-Directors: David C. Magnus, Thomas A. Raffin
Associate Director: Mildred K. Cho
Assistant Director: Anne J. Footer
Participating Faculty and Staff: LaVera M. Crawley, Margaret Eaton, Maren Grainger-Monsen, Henry Greely, Linda F. Hogle, Judy Illes, Agnieszka Jaworska, Barbara A. Koenig, Sandra S. Lee, Sara L. Tobin
Center Offices: 701 Welch Road, Building A, Suite 1105, Palo Alto, CA 94304
Mail Code: 94305-5748
Phone: (650) 723-5760
Web Site: http://www-med.stanford.edu/school/scbe/

The Stanford University Center for Biomedical Ethics is an interdisciplinary center devoted to teaching and research in scientific and biomedical ethics. Its mission is to: apply ethical reasoning to actual moral problems in the practice of medicine and science; contribute to the national and international discussion of biomedical and scientific issues through research, public symposia, and published papers and monographs; convene scholars, professionals, and policy makers to debate and propose policy solutions regarding biomedical and scientific ethical issues; serve as a scholarly resource for the University, the Medical Center, and the community at large on emerging ethical issues in medicine and science; and build a community of individuals dedicated to formulating fresh responses to contemporary ethical issues.

In conjunction with the Arts and Humanities Medical Scholars program, the Center is offering 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, and focus on issues they will confront whether at the bench side or the bedside. Additional information regarding requirements and courses will be available in Autumn 2003.

COURSES

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

MEDICINE

MED 214. Literature and Medicine—Reading and discussion. The uses of literature as a guide to the humanistic aspects of patient care. Essays, stories, and poems by physicians, patients, and family members on topics such as medical training, the patient's perspective, ethics, and AIDS. No paper, no final exam.
1 unit, Aut (Shafer, Zaroff)

MED 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)

INTERDEPARTMENTAL OFFERINGS

BUSINESS

GSBGEN 522. Ethical Issues in the Biotech Industry
2 units, Win (Eaton)

CULTURAL AND SOCIAL ANTHROPOLOGY

CASA 82A. Race and Medicine
5 units, Spr (Lee)

CASA 130A. Bioethics and Anthropology
5 units, Win (Koenig)

ETHICS IN SOCIETY

ETHICSOC 77. Methodology in Ethics: Translating Theory into Practice
5 units, Spr (Koenig)

HEALTH RESEARCH AND POLICY

HRP 209. Medicine and the Law
2 units, Win (Eaton)

LAW

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

PHILOSOPHY

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

BIOMEDICAL INFORMATICS PROGRAM

Committee: Russ B. Altman *(Chair and Program Director);* Mark A. Musen *(Co-Director)*; Betty Cheng, Lawrence M. Fagan *(Associate Directors);* Douglas L. Brutlag, Parvati Dev, Alan M. Garber, Teri E. Klein, Henry Lowe

Participating Faculty and Staff by Department:
Opportunities for research are not limited to the specific faculty and departments listed.

Anesthesia: David M. Gaba (Professor)
Biochemistry: Douglas L. Brutlag (Professor)
Bioengineering: Scott L. Delp (Associate Professor)
Biostatistics: Richard A. Olshen (Professor)
Business: Alain C. Enthoven (Professor, emeritus), 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), Richard E. Fikes (Professor, Research), Leo Guibas (Professor), Daphne Koller (Associate Professor), Jean-Claude Latombe (Professor), Gio Wiederhold (Professor, Research, emeritus), Terry Winograd (Professor)
Electrical Engineering: Albert Macovski (Professor, emeritus)
Genetics: Russ B. Altman (Associate Professor), Mike Cherry (Associate Professor, Research), Stanley N. Cohen (Professor), Stuart Kim (Associate Professor), Teri E. Klein (Senior Research Scientist), Richard M. Myers (Professor)
Health Research and Policy: Byron W. Brown, Jr. (Professor, emeritus), Mark A. Hlatky (Professor), Richard A. Olshen (Professor), Robert Tibshirani (Professor)
Management Science and Engineering: Samuel Holtzman (Consulting Associate Professor), Ronald A. Howard (Professor), Ross D. Shachter (Associate Professor)
Mathematics: Samuel Karlin (Professor, emeritus)
Medicine: Russ B. Altman (Associate Professor), Terrance Blaschke (Professor), Robert W. Carlson (Professor), Parvati Dev (Senior Research Scientist), Lawrence M. Fagan (Senior Research Scientist), Alan M. Garber (Professor), Mary Goldstein (Associate Professor), Michael Higgins (Consulting Associate Professor), Peter D. Karp (Consulting Assistant Professor), Teri E. Klein (Senior Research Scientist), 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), Glenn Rennels (Consulting Assistant

Professor), Gillian Sanders (Assistant Professor, Research), Peter Small (Associate Professor), Michael Walker (Consulting Assistant Professor), Liping Wei (Consulting Assistant Professor)

Neurosurgery: John R. Adler (Professor), Ramin Shahidi (Assistant Professor, Research)

Obstetrics and Gynecology: W. LeRoy Heinrichs (Professor, emeritus)

Pathology: Arend Sidow (Assistant Professor)

Radiation Oncology: Arthur L. Boyer (Professor), Lei Xing (Assistant Professor, Research)

Radiology: Gary H. Glover (Professor), Sandy A. Napel (Associate Professor), Norbert J. Pelc (Professor), Geoffry 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.smi.stanford.edu/academics/

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

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, all degree candidates must pass an oral examination that tests the student's ability to integrate the various components of the curriculum and to relate them to the overall field of biomedical informatics.

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 the three quarter sequence Introduction to BIOMEDIN 210, 211, and 214, all of which should be taken during the first year in the program. 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, or 303), selected in consultation with the academic adviser. BIOMEDIN 212 is strongly encouraged.
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, EE 182, CS 110, 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 110, 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, 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, 215, or 315A,B, or CS 228 or 229. Options for decision analysis include MSE 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 BIOMEDIN 207.
5. *Social and Ethical Issues* (6 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 6 units from suitable courses that include, for example, BIOMEDIN 250, 256, and 432; CS 201; HRP 390, 391, and 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 46 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 267, 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.
4. Teaching: all students are expected to act as Teaching Assistants (TAs) for at least one course during their first two years of training. This will generally be in one of the informatics short courses, although another course approved by the program faculty may occasionally be substituted.

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 new 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

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, oral examination, and additional requirements for the master's program. In addition, doctoral candidates are expected to take at least two 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, including the oral examination, 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 completing the oral examination. A student's academic adviser has primary responsibility for the adequacy of the program, which is regularly reviewed by the Graduate Study Committee of the Biomedical Informatics program.
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 Graduate Study Committee of the Biomedical Informatics program. 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 BMI exec; 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.
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 member chosen from anywhere within the University.

COURSES

BIOMEDIN 156/256. Economics of Health and Medical Care—(Same as ECON 156/256.) 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 ECON 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—For all students and faculty. Participants report on recent relevant articles from the Biomedical Informatics literature or their research projects. The ongoing experience, with feedback from faculty, is intended to teach presentation skills to Biomedical Informatics trainees. Credit available only to students in an Biomedical Informatics degree program. May be taken no more than three times for credit.

1 unit, Aut, Win, Spr (Musen)

BIOMEDIN 202. Introductory Biomedical Informatics—Offered online only. Current topics, research problems, and computational approaches. Topics include medical security and privacy, electronic medical records, controlled terminologies and biomedical ontologies, electronic retrieval, technology-assisted learning environments, medical decision making and decision support, sequence analysis, phylogenetics, biological networks and pathways, microarray analysis, natural language processing, and protein structural analysis and prediction. Graduate students in the biomedical informatics training program may not take this class for credit. Prerequisite: medical student or consent of instructor.

1 unit, Aut (Cheng, Fagan, Altman)

BIOMEDIN 207. Introduction to Medicine—(Same as IMMUNOL 230.) For graduate students in biological sciences, bioengineering, and biomedical informatics. Information and approaches used by physicians to understand human disease by focusing on two multisystem disorders: type I and type II diabetes mellitus. Lectures by medical school and outside faculty, and field trips to clinics, the clinical laboratory, clinical research center, and a relevant biotech company. Students carry out quarter-long, team projects.

3-4 units, Spr (Mellins, Parnes)

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: understanding of the basic principles of object-oriented systems at the level of CS 107.

3 units, Aut (Musen)

BIOMEDIN 211. Introduction to Clinical Systems—(Same as CS 271.) Survey of the major applications in clinical informatics, including imaging systems, information systems, and decision-support technology. Emphasis is on the system requirements, relevant data, standards, algorithms, and implementation issues in each area. Prerequisite: 210.

3 units, Win (Staff)

BIOMEDIN 212. Biomedical Informatics Project Course—(Same as CS 272.) A hands-on, software-building course following up on introductory courses in biomedical informatics. Designed to allow students to create novel software. Students conceive, design, specify, implement, evaluate, and report on a software project in the domain of biomedicine. Focus is on pragmatics of creating written proposals, providing status reports, and preparing final reports. Also aspects of software engineering at an introductory level such as version control, UML, and testing. Prerequisites: BIOMEDIN 210 or 214, or consent of instructor; CS 106.

3 units, Aut (Altman, Cheng, Klein)

BIOMEDIN 214. Representations and Algorithms for Computational Molecular Biology—(Same as CS 274.) Basic computational issues and methods used in bioinformatics, including access and use of biological data sources on the Internet. 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, genetic algorithms and genetic programming applied to biological problems. See instructor for unit options. Prerequisites: programming skills and understanding of matrix algebra.

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 226. Genetic Algorithms and Genetic Programming—(Enroll in CS 426.)

3 units, Aut (Koza)

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

3 units, Win (Shachter)

BIOMEDIN 230. Knowledge Acquisition for Expert Systems—(Same as CS 525.) For graduate students. Experimental approaches to the construction of expert-system knowledge bases. Topics: interviewing techniques, formal and informal approaches to modeling expert knowledge, and automated tools that facilitate knowledge acquisition. Enrollment limited to 20. Prerequisite: one course in artificial intelligence.

1-2 units, Spr (Musen)

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

3 units, Aut, Win, Spr (Brutlag)

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 (Tibshirani, 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 demon-

strate 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, Win (Langley)

BIOMEDIN 250. U.S. Health Care Systems and Health Policy—(Enroll in HRP 205.)

2 units, Win (Baker)

BIOMEDIN 251. Outcomes Analysis—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.) For graduate students. Introduction to the applications of computer science to genomics research and to basic concepts in genomics from a computer science point of view. Topics: algorithms for sequence analysis and their applications to the most current genomics research, sequence alignments, hidden Markov models, multiple alignment algorithms and heuristics such as Gibbs sampling, and the probabilistic interpretation of alignments. Applications of these tools to sequence analysis: DNA sequencing and assembly, genomic annotation of repeats, genes, and regulatory sequences, microarrays and gene expression, and comparative genomics. Prerequisites: CS 161 or familiarity with basic algorithmic concepts. Basic knowledge of genetics helpful, but not required.

3 units, Win (Batzoglou)

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

3 units, Win (Koller)

BIOMEDIN 299. Directed Reading and Research—For students wishing to receive credit for directed reading or research time.

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

BIOMEDIN 328. Computational Structural Biology—(Enroll in BIOPHYS 228, SBIO 228.)

3 units, Win (Levitt) alternate years, not given 2004-05

BIOMEDIN 301. Special Topics in Biomedical Informatics

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

BIOMEDIN 345. Genome Database Seminar—(Same as CS 545G.) Survey of molecular-biology databases. Goal is to extract principles and methodologies for constructing databases that encode molecular biology information, including DNA sequences, protein sequence and structure, gene expression, and metabolic and other functional genomics data. Emphasis is on representation and integration of data sources, and their presentation for biomedical and pharmaceutical researchers. Issues: data structures and ontologies, cross-referencing, quality control and error detection, search processes, suitability of different DBMSs, data provenance, and privacy protection for patient-derived information. Presentations by experts from commercial and research organizations. May be combined with a 395 project. (AU)

1 unit, Spr (Karp, Wiederhold)

BIOMEDIN 348. Computer Graphics: Image Synthesis Techniques—(Enroll in CS 348B.)

3-4 units, Spr (Hanrahan)

BIOMEDIN 366. Computational Biology—(Same as STATS 366.) For biologists, applied mathematicians, statisticians, or computer scientists. Methods necessary to understand the construction and evaluation of 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: most methods exist, in high level programming environments, e.g., Matlab. Specialized software: Phylip, Seq-gen, Arlequin, Puzzle, Splitstree, XGobi.

2-3 units, Aut (Holmes)

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 (Garber) not given 2003-04

BIOMEDIN 459. Frontiers in Interdisciplinary Biosciences—(Cross-listed in multiple departments in the schools of Humanities and Sciences, Engineering, and Medicine. Students should enroll through their affiliated department; otherwise enroll in CHEMENG 459.) See CHEMENG 459 or http://biox.stanford.edu/chemeng_index.html for description.

1 unit, Aut, Win, Spr (Robertson)

OVERSEAS STUDIES

Courses approved for the Biomedical Informatics major and taught overseas can be found in the "Overseas Studies" section of this bulletin, or in the Overseas Studies office, 126 Sweet Hall.

FLORENCE

BIOMEDIN 114. Genomics: A Technological and Cultural Revolution

3 units, Spr (Altman)

CANCER BIOLOGY PROGRAM

Chair and Program Director: Joseph S. Lipsick (Pathology and Genetics)
Committee on Cancer Biology: Steven Artandi (Medicine, Hematology), Laura Attardi (Radiation Oncology), Dean Felsher (Medicine, Oncology), Peter Jackson (Pathology), Joseph Lipsick (Pathology and Genetics), Anthony Oro (Dermatology), Michael Simon (Biological Sciences)

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.med.stanford.edu/group/cancerbio

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

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 our students with education and training that will enable 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 clinical diagnosis and treatment 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 (or their equivalents, except for the Cancer Biology course):
   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- and second-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.
5. Successful completion of a qualifying examination in Cancer Biology is also 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 Committee on Cancer Biology prior to the end of Autumn Quarter, second year. The qualifying examination must be taken prior to the end of Winter Quarter, second year. If necessary, one retake is permitted prior to the end of Spring 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. The student is expected to arrange annual meetings (more frequently, if required) 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 given. Completion of the annual committee meetings must be communicated in writing to the Program Director by the adviser.
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 chair 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 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 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 all first- and second-year graduate students in the Cancer Biology Program.

1 unit, Aut, Win, Spr (Staff)

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 Professor: Sherril Green, Shaul Hestrin, Glen Otto, Ravi Tolwani
Assistant Professors: Catherine Beckwith, Donna Bouley, Paul Buckmaster, Corinna Darian-Smith, Manuel Garcia
Department Offices: Edwards Building, Room R321
Mail Code: 94305-5342
Phone: (650) 498-5080
Web Site: http://www.med.stanford.edu/school/CompMed/

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

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, molecular genetics and anesthesiology.

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 81Q. Comparative Anatomy and Physiology of Mammals—Stanford Introductory Seminar. Preference to sophomores. 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 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 to the science of animal modeling for the purpose of studying human disease. Animal models provide an important tool to study mechanisms of disease and develop new therapies. Examples of animal models in several 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, Win (Green, Tolwani)

COMPMED 107/207. Comparative Neuroanatomy—The functional organization of the vertebrate nervous system. Focus is on laboratory animals commonly used in neuroscience research, and comparisons made with the human brain. Advantages and limitations of species chosen for neurobiological and biomedical research. Introduction to neuroanatomical methods and possible mechanisms of brain evolution. Discussion section primarily for graduate students; undergraduates by consent of instructor. Prerequisite: course in anatomy or physiology.

2-4 units, Aut (Buckmaster, Darian-Smith)

COMPMED 108/208. Animals Advancing Biomedical Technology—Open to graduate students and undergraduates in all degree programs. Students enrolled in computer science and engineering programs or who are affiliated with the BioX program are especially welcome. Lectures by faculty members in Comparative Medicine and invited speakers from the biomedical industry. Goal is to introduce 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, Aut (Cork)

COMPMED 459. Frontiers in Interdisciplinary Biosciences—(Cross-listed in multiple departments in the schools of Humanities and Sciences, Engineering, and Medicine. Students should enroll through their affiliated department; otherwise enroll in CHEMENG 459.) See CHEMENG 459 or http://biox.stanford.edu/chemeng_index.html for description.

1 unit, Aut, Win, Spr (Robertson)

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

COMPMED 199. Undergraduate Research—Individual research taken by arrangement with department faculty.

1-3 units (Staff)

FOR GRADUATE STUDENTS

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

1-18 units, Aut, Win, Spr, Sum, by arrangement

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, by arrangement

DEVELOPMENTAL BIOLOGY

Emeritus: (Professor) David A. Clayton, David S. Hogness
Chair: Margaret Fuller
Associate Chair: Lucy Shapiro
Professors: Gerald Crabtree, Margaret Fuller, A. Dale Kaiser, Roeland Nusse, Matthew Scott, Lucy Shapiro, James Spudich, Irving Weissman
Associate Professors: Ben Barres, Stuart Kim, David Kingsley, 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 B.

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 research 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 11N. Human Development: Egg to Embryo—Stanford Introductory Seminar. Preference to freshmen.
3-4 units, Spr (Porzig)

DBIO 198. Research
1-18 units, by arrangement (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 is 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. Interested undergraduates must contact Ellen Porzig (eporzig@stanford.edu).
4 units, Aut (Scott, Crabtree, Porzig, Kingsley, Kim)

DBIO 203. Advanced Genetics—(Same as BIOSCI 203, GENE 203.) For graduate students in biological sciences; 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 critical evaluation of papers. Students with minimal prior experience in genetics should prepare themselves by working out problems in college level textbooks.
4 units, Aut (Stearns, Kim, Sidow, Villeneuve)

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. How to critically evaluate biological research. Held in conjunction with a seminar series, hosted in alternate weeks by Biochemistry, Developmental Biology, and Genetics. Each Wednesday, distinguished investigators present their current work at the Frontiers in Biological Research seminar. Beforehand, students and faculty meet to discuss one or more papers from the speaker's primary research literature on a related topic. After the seminar, students meet with the speaker to discuss their research and future direction, the techniques most commonly used to study problems in biology, and a comparison between the genetic and biochemical approaches in biological research.

1 unit, Aut, Win, Spr (Harbury, Kingsley, Baker)

DBIO 225. Molecular Motor Proteins and the Cytoskeleton—(Same as BIOC 225.) The molecular basis of energy transduction leading to movements generated by microfilament-based and microtubule-based motors. Forms of myosin, dynein, and kinesin and their roles in the cell as a model for understanding the structural, biochemical, and functional properties of biological machines. Topics: structure of the molecular motors and their accessory proteins; regulation of the function of motile assemblies; functions of molecular motors in cells; spatial and temporal controls on the formation of motile assemblies in cells. Experimental approaches: genetic analysis, DNA cloning and expression, reconstitution of functional assemblies from purified proteins, x-ray diffraction, three-dimensional reconstruction of electron microscope images, spectroscopic methods, and high-resolution light microscopy. Prerequisites: basic biochemistry and cell biology.

3 units, Spr (Spudich) not given 2004-05

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

2 units (Kaiser) not given 2003-04

DBIO 237. Introduction to Biotechnology—(Enroll in CHEMENG 450, BIOC 450.)

3 units, Spr (Kao)

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

1-18 units, Aut, Win, Spr, Sum, by arrangement

DBIO 399. Research—Investigations sponsored by faculty members. Prerequisite: consent of instructor. See faculty list for section numbers.

1-18 units, Aut, Win, Spr, Sum, by arrangement

DBIO 459. Frontiers in Interdisciplinary Biosciences—(Crosslisted in multiple departments in the schools of Humanities and Sciences, Engineering, and Medicine. Students should enroll through their affiliated department; otherwise enroll in CHEMENG 459.) See CHEMENG 459 or http://biox.stanford.edu/chemeng_index.html for description.

1 unit, Aut, Win, Spr (Robertson)

EPIDEMIOLOGY PROGRAM

Director: Lorene Nelson (Associate Professor of Health Research and Policy)

Steering Committee: J. Martin Brown (Professor of Radiation Oncology), Stephen Fortmann (Professor of Medicine), Helena Kraemer (Professor of Psychiatry, Medicine), Lorene Nelson (Associate Professor of Health Research and Policy, Division of Epidemiology), Neil Risch (Professor of Genetics), Alice S. Whittemore (Professor of Health Research and Policy, Division of Epidemiology)

Cancer Biology: J. Martin Brown (Professor)

Genetics: Neil Risch (Professor), Richard Myers (Professor)

Gynecology and Obstetrics: Emmet Lamb (Professor, emeritus), Mary L. Polan (Professor)

Health Research and Policy: Rodney Beard (Professor, emeritus), Byron W. Brown, Jr. (Professor, emeritus), Kristin Cobb (Instructor), John Farquhar (Professor, emeritus), Gary Friedman (Consulting Professor), Trevor Hastie (Professor), Mark Hlatky (Professor), Jennifer Kelsey (Professor), Abby King (Professor), Philip Lavori (Professor), Yvonne Maldonado (Associate Professor), Lorene Nelson (Associate Professor), Richard Olshen (Professor), Ralph Paffenbarger, Jr. (Professor, emeritus), Julie Parsonnet (Associate Professor), Rita Popat (Research Scientist), Robert Tibshirani (Professor), Alice Whittemore (Professor), Marilyn Winkleby (Associate Professor)

Medicine: John Farquhar (Professor, emeritus), Stephen Fortmann (Professor), James Fries (Professor), Alan Garber (Professor), William Haskell (Professor, Research), Halstead Holman (Professor), Helen Hubert (Senior Research Scientist), Abby King (Professor), Helena Kraemer (Professor), Gordon Matheson (Professor), Julie Parsonnet (Associate Professor), Gary Schoolnik (Professor), Peter Small (Associate Professor), Marcia Stefanick (Associate Professor, Research), Lucy Tompkins (Professor), Marilyn Winkleby (Associate Professor, Research)

Microbiology and Immunology: Ann Arvin (Professor), Charles Prober (Professor), Gary Schoolnik (Professor), Lucy Tompkins (Professor)

Neurobiology: Denis Baylor (Professor)

Neurology and Neurological Sciences: Leslie Dorfman (Professor)

Orthopedic Surgery: Gordon Matheson (Professor)

Pediatrics: Ann Arvin (Professor), Laura Bachrach (Professor), Yvonne Maldonado (Associate Professor), Charles Prober (Professor)

Stanford Center for Research in Disease Prevention: John Farquhar (Professor, emeritus), Stephen Fortmann (Professor), William Haskell (Professor), Abby King (Professor), Helena Kraemer (Professor), Marcia Stefanick (Associate Professor, Research), Marilyn Winkleby (Associate Professor, Research)

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

GRADUATE PROGRAMS

The Epidemiology Program offers interdisciplinary instruction and research opportunities leading to the M.S. and Ph.D. degrees in Epidemiology. The program has strengths in the following areas of epidemiology: cancer; cardiovascular, infectious, and neurological diseases; clinical epidemiology; genetics; some aspects of epidemiologic methods; and environmental and occupational epidemiology.

MASTER OF SCIENCE

The M.S. program is designed to provide training in epidemiologic methods to professionals in a variety of related fields and to serve as an introduction to those with bachelor's degrees who are considering careers in epidemiology. Applicants to the M.S. program should have previous course work in biology and statistics or mathematics.

To receive the degree, students are expected to obtain a thorough grounding in epidemiologic methods and applied biostatistics and to demonstrate research skills through the completion of a master's thesis. A total of 45 units of course work, including a 12-credit master's thesis, must be successfully completed. Required courses are HRP 225, Design and Conduct of Epidemiologic Studies, HRP 226, Advanced Epidemiologic Methods, HRP 238, Seminar/Journal Club in Epidemiology, HRP 259, Introduction to Probability and Statistics for Epidemiology, HRP 261, Intermediate Biostatistics, and HRP 262, Regression, Prediction, Survival Analysis, and a master's thesis of 12 units or more. In addition, M.S. students are required to select two other courses in Epidemiology. The master's thesis must be read and approved by two faculty members.

A new curriculum in clinical research methods has been established specifically to enhance the training of clinical investigators. This program is aimed primarily at physicians who have completed residency, are entering clinical fellowships, and plan to engage in patient-oriented clinical research. It may also be suitable for physicians at other points in their careers. Requirements of the program are similar to those of the M.S. degree described above, with the addition of HRP 251, Design and Conduct of Clinical Trials, and MED 255, Responsible Conduct of Research.

DOCTOR OF PHILOSOPHY

The Ph.D. program in Epidemiology is designed to prepare individuals for careers in research and teaching in epidemiology. It is recommended that applicants have previous course work in biology and statistics or mathematics. Normally, successful applicants will have a master's degree in a relevant field or at least two years of relevant research experience.

Candidates for the Ph.D. degree must complete 135 units of graduate course work and research. Course requirements include all those listed for master's students (unless taken previously), HRP 224, Statistical Issues in Epidemiology, and GENE 344A, Genetic Epidemiology. A student must select a specialty area (for example, cardiovascular diseases, cancer, clinical epidemiology, genetics, infectious diseases, neurological diseases). Additional courses are required in each specialty area. Requirements for the specific specialty areas may be obtained from the office of the program coordinator.

Successful completion of three written qualifying examinations is required for admission to Ph.D. candidacy. The qualifying examinations cover: (1) epidemiologic methods, (2) biostatistics, and (3) a specialty area (for example, epidemiology and pathobiology of cancer, or cardiovascular diseases). Requirements also include the presentation of a Ph.D. dissertation as the result of independent investigation and constituting a contribution to knowledge in epidemiology. The candidate 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 conducted by a committee and is preceded by a public seminar in which the research is presented by the candidate.

COURSES

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

GENETICS

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

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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 B.

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 study in all the major areas of modern genetics research, including many aspects of human genetics (linkage mapping, physical mapping, cytogenetics, genetic epidemiology and population genetics), genomics, bioinformatics, bacterial genetics, yeast genetics, vertebrate and worm and fly developmental genetics, mouse genetics, gene therapy, immunogenetics, host/pathogen interactions, pharmacogenetics mathematical biology, and evolutionary genetics. The department also includes the Stanford Human Genome Center, which is engaged in large-scale genomic research on humans and other organisms, the *Saccharomyces* Genome Database (SGD) project, which is the repository for genetic information pertaining to the model organism *S. cerevisae* (Baker's or Brewer's yeast), and the Stanford Microarray Database (SMD) which is a local resource for DNA microarray data storage and analysis, and the Pharmacogenetics and Pharmacogenomics Knowledge base (PharmGKB), which houses genotype-phenotype information about variation in the response to drugs

The department believes that genetics should be viewed as a discipline that encompasses not just a set of tools but a coherent and fruitful way of thinking about biology and medicine. The department emphasizes the broad scope of genetic thinking, including not just molecular genetics, but also classical, medical, and population genetics as well as many aspects of genomics and quantitative analysis. The department provides training through laboratory rotations, dissertation research, a series of advanced courses in genetics and other areas of biomedical science, several 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.

The Department of Genetics is located in the School of Medicine and includes modern, well-equipped laboratories. Extensive computer support and advanced instrumentation are available for research projects. The department has 50 graduate students and 40-45 postdoctoral fellows. In addition to interacting with the faculty and laboratories in the department, students have contacts with a much larger number of students, fellows, and faculty in other biological and biomedical programs, as well as in biomedical informatics, computer science, engineering, mathematics, and statistics, throughout 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 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 spent on the 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 education outreach activities that are administered through the department, which involves numerous 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. 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 are admitted to the graduate program in the Autumn Quarter. Prospective students are encouraged to begin the application process early to ensure that they are able to submit a complete application by the previous December 15. 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 from the National Science Foundation. Prospective students are encouraged to apply for a fellowship by requesting an application from the National Science Foundation, Oakridge Associated Universities, P.O. Box 3010, Oak Ridge, TN 37831-3010, telephone (615) 483-3344; 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 department 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, and Structural Biology, Neuroscience, Biomedical Informatics, and Structural Biology.

GENE 104Q. Selected Legal and Social Issues in Human Genetics—Stanford Introductory Seminar. Preference to sophomores. Recent developments in human genetics. Two sessions devoted to scientific background. Issues include DNA databases for forensic use, human cloning, genetic testing for adult onset disease, genetic discrimination, pre-natal genetic trait selection by parents, state-sponsored eugenics, and gene patenting. Research paper on a topic of student's choice.

3 units, Spr (Greely)

GENE 106Q. The Heart of the Matter—(Same as BIOSCI 106Q.) 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:2a

3-4 units, Win (Myers, Simoni)

GENE 199. Undergraduate Individual Research—Prerequisite: consent of instructor.

1-18 units (Staff)

GENE 202. Human Genetics—The theoretical and experimental basis for the genetics of human health and disease. Lectures and clinical case discussions in molecular, chromosomal, biochemical, developmental, cancer, and medical genetics, emphasizing the latter. Prerequisites: knowledge of biochemistry and basic genetics.

4 units, Aut (Ford, Myers)

GENE 203. Advanced Genetics—(Same as BIOSCI 203, DBIO 203.) For graduate students in biological sciences; 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 critical evaluation of papers. Students with minimal prior experience in genetics should prepare themselves by working out problems in college level textbooks.

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

GENE 211. Genomics—Focus is on developing a knowledge base of facts about genome evolution, organization, and function; technical, computational, and experimental approaches; hands-on experience with a small but representative number of computational tools used in genome science; and a beginning working knowledge of PERL.

3 units, Win (Cherry, Myers, Sidow)

GENE 214. Human and Mouse Genetics: Principles and Approaches—Builds on 203. The mouse as a model system of human disease. Topics include methods to assess the genetic contribution to a phenotype in humans, parametric and non-parametric linkage analysis, linkage disequilibrium analysis, human genetic variation and evolution, experimentation using inbred strains of mice, positional closing of genes in mice and humans, recombinant inbred and congenic mouse strains for QTL analysis, peri-implantation development in mouse, the molecular pathogenesis of human disease, and medical applications of human genetics.

3 units, Spr (Risch)

GENE 215. Frontiers in Biological Research—(Same as BIOC 215, DBIO 215.) Literature discussion on how to critically evaluate biological research. Held in conjunction with a seminar series, hosted in alternate weeks by Biochemistry, Developmental Biology, and Genetics. Each Wednesday, distinguished investigators present their current work at the Frontiers in Biological Research seminar. Beforehand, students and faculty meet to discuss one or more papers from the speaker's primary research literature on a related topic. After the seminar, students meet with the speaker to discuss their research and future direction, the techniques most commonly used to study problems in biology, and a comparison between the genetic and biochemical approaches in biological research.

1 unit, Aut, Win, 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 primary literature, basic principles of biochemistry and cell and molecular biology, and the historical context of important scientific advances.

3 units, Win (Baker, Vollrath)

GENE 232. Readings in the History of Molecular Biology—(Enroll in DBIO 232.)

2 units, Win (Kaiser)

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. Prerequisite: consent of instructor.

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

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

1-18 units, Aut, Win, Spr, Sum, by arrangement

GENE 344A. Genetic Epidemiology—(Same as STATS 344A.) Methods for the design and analysis of studies in human genetics, focusing on the epidemiology of Mendelian disorders, and the genetic and environmental contributions to common, complex familial traits. Topics: study designs for assessing the importance of genetic factors (family, twin, and adoption studies); methods for determining modes of inheritance (segregation analysis); identification and mapping of major genes through linkage analysis and disease marker associations.

2-3 units, Win (Risch)

GENE 344B. Topics in Statistical Genetics—(Same as STATS 344B.) Topics depend on interests of students and instructors: concepts of likelihood as used in the genetic context; measures of familial aggregation including issues of censoring and age-dependent data; genetic modeling of quantitative traits; mode of inheritance analysis including segregation analysis; analysis of extended pedigrees; parametric and nonparametric approaches to linkage analysis and gene mapping including family studies; linkage disequilibrium; analysis of DNA profiles for individual identification.

2-3 units, Spr (Risch)

GENE 344C. Genetic Epidemiology: Applications—Sequel to 344A. Application of methods from genetic epidemiology to diseases: family studies, segregation analysis, linkage analysis, and population association studies. Disease topics are tailored to student interests, including cancer (breast or colon), neurological disorders (multiple sclerosis, epilepsy), birth defects (cleft lip and palate, pyloric stenosis), psychiatry (schizophrenia, manic depression, Alzheimer's disease), cardiovascular disease, and autoimmune disease (diabetes, coeliac disease).

2 units (N. Risch) alternate years, given 2004-05

GENE 399. Research—Prerequisite: consent of instructor.

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

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

3 units, Spr (Kao)

GENE 459. Frontiers in Interdisciplinary Biosciences—(Crosslisted in multiple departments in the schools of Humanities and Sciences, Engineering, and Medicine. Students should enroll through their affiliated department; otherwise enroll in CHEMENG 459.) See CHEMENG 459 or http://biox.stanford.edu/chemeng_index.html for description.

1 unit, Aut, Win, Spr (Robertson)

HEALTH RESEARCH AND POLICY

Emeriti: (Professors) Rodney Beard, Byron Wm. Brown, Jr., John Farquhar, Victor R. Fuchs, Jennifer L. Kelsey, Lincoln E. Moses, Ralph S. Paffenbarger, Jr.

Chair: Mark Hlatky

Professors: Bradley Efron, Trevor Hastie, Mark Hlatky, Iain M. Johnstone (on leave), Abby C. King, Richard A. Olshen, Robert Tibshirani, Alice S. Whittemore

Associate Professors: Laurence Baker, Lorene M. Nelson, Julie Parsonnet

Assistant Professor: M. Kate Bundorf

Professor (Research): Dan Bloch, Philip W. Lavori

Assistant Professor (Research): Laura Lazzeroni

Courtesy Professors: Stephen P. Fortmann, Alan M. Garber, Neil Risch

Courtesy Associate Professors: Mary Goldstein, Alex Macario, Yvonne Maldonado, Mark McClellan, Douglas Owens, David R. Rogosa, Marilyn Winkleby

Courtesy Assistant Professors: Jay Bhattacharya, Michael K. Gould, Paul Heidenreich

Courtesy Assistant Professor (Research): Gillian Sanders

Senior Lecturer: Irene Corso

Lecturers: Raymond Balise, Kristin Cobb, Margaret Eaton, Sally Glaser, Laurel Habel, Lisa Herrington, Pamela Horn-Ross, Esther John, Andy Karter, Caroline Tanner, Timothy K. Stanton, Stephen Van Den Eeden, Dee West

Consulting Professors: Gary Friedman, Elizabeth Holly, Joseph Selby

Consulting Associate Professors: Ciaran Phibbs

Consulting Assistant Professors: Paul Barnett, John Piette

Visiting Associate Professor: Marion Lee

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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 B.

The Department of Health Research and Policy has three divisions:

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

The department, and each division, offers courses in its areas of specialization. These are described fully in the Stanford University *School of Medicine Catalog.*

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 are described separately within the School of Medicine listings of 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.

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.

3 units, Win (Corso)

HRP 120. International Epidemiology of Infectious Diseases—Two-week intensive course at the National School of Public Health (INSP) in Cuernavaca, Mexico. Topics include impact of geography and socioeconomic status on infectious disease epidemiology, global aspects of human, bacterial, and ecologic factors of disease prevalence and incidence, public health measures employed to intervene in infection transmission, disease modeling and molecular techniques in infectious disease investigations, and the role of infectious agents in chronic diseases. Students observe a clinical field trial. Room and board provided. Enrollment limited to 8. Prerequisites: undergraduate standing, consent of instructor. Recommended: proficiency in Spanish.

2 units, Sum (Maldonado)

HRP 199. Undergraduate Research—Student investigations sponsored by faculty members. Prerequisite: consent of the instructor.

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

HRP 202. Fundamentals of Clinical Investigations—Required for medical students. Introduces epidemiological concepts, techniques, and studies: statistical reasoning and the application of common statistical procedures used in lab and clinical investigations. Student-designed research project.

4 units, Win (Lavori, Parsonnet)

HRP 205. U.S. Health Care Systems and Health Policy—Introduces issues in health care systems, organization, and financing including health insurance, managed care, health care costs, the uninsured, and health reform, focusing on the U.S. health care system.

2 units, Win (Baker)

HRP 206. Statistical Methods in Meta-Analysis—(Enroll in STATS 211.)
3 units, Win (Olkin)

HRP 209. Medicine and 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 all law or medical students, and to qualified undergraduates by consent of instructor. Introduction to the American health care system and its legal and policy problems. Topics: the special characteristics of medical care as compared with other goods and services, the difficulties of assuring quality care, the complex patchwork of the financing system, and the ethical problems the system raises. Course begins September 4.
5 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, Spr, Sum (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 224. Statistical Issues in Epidemiology—Advanced problems in the design and analysis of epidemiological studies, motivated by published investigations. Possible topics: issues in matching controls to cases in case-control studies, methods for analyzing data from cohort studies, and methods for the design and analysis of family and genetic studies. Prerequisites: 203, 225, 226, or equivalents.
3 units (Whittemore) alternate years, given 2004-05

HRP 225. Design and Conduct of 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: 202 or equivalent, or consent of instructor.
3-4 units, Aut (Popat, Friedman)

HRP 226. Advanced Epidemiologic 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 228. Molecular Epidemiology—Molecular and biochemical biomarkers for measuring exposure, host susceptibility, and endpoint (disease) as applied to epidemiologic studies of infectious diseases, cancer, and other chronic diseases. Topics: DNA fingerprinting to determine transmission pathways; biochemical markers of environment exposures; study design and methodological consideration; ethical and legal issues. Prerequisite: 202 or 225, or consent of instructor.
3 units (Staff) not given 2003-04

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: 202 or 225, or consent of instructor.
3 units (Staff) not given 2003-04

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) alternate years, given 2004-05

HRP 236. Clinical Research Seminar—Weekly forum for ongoing patient-oriented research projects and recent journal articles by students, faculty, staff, and guests. Methodological and practical issues relevant to clinical epidemiologic research are also discussed.
1 unit, Aut, Win, Spr (Friedman)

HRP 238. Journal Club in Epidemiology—Ongoing research presented by faculty, staff, students, and guests. Recent journal articles.
1 unit, Aut, Win, Spr (Staff)

HRP 240. Contemporary Issues in Health Policy: Public and Private Solutions—(Same as PUBLPOL 60/160.) Invited lecture series. Public and private policy makers address how they and their organizations aim to improve quality, access, and cost of health care in the U.S. Initiatives that address current problems of the health care system and the challenges and complexities of achieving these aims. Recommended: HUMBIO 160 and some economics background.
1 unit (Staff) not given 2003-04

HRP 241. Contemporary Issues in Health Policy: Improving Quality of Care—(Same as PUBLPOL 61/161.) Invited lecturer series. Health care, pharmaceutical, and information technology leaders review their efforts to improve quality of health care. Improvement strategies currently employed by high-performing organizations, and obstacles to widespread implementation.
1 unit (Staff) not given 2003-04

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—(Enroll in BIOMEDIN 251.)
3 units, Spr (Bhattacharya)

HRP 256. Economics of Health and Medical Care—(Enroll in BIOMEDIN 156/256, ECON 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,B,C.) 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 the instructor.

HRP 260A: *1-5 units, Aut (Lazzeroni, Olshen, Bloch, Efron, Hastie, Lavori, Tibshirani)*

HRP 260B: *1-2 units, Win (Lazzeroni, Olshen, Bloch, Efron, Hastie, Lavori, Tibshirani)*

HRP 260C: *1-5 units, Spr (Lazzeroni, Olshen, Bloch, Efron, Hastie, Lavori, Tibshirani)*

HRP 261. Intermediate Biostatistics: Analysis of Discrete Data—(Same as BIOMEDIN 233, STATS 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 (Tibshirani, Cobb)

HRP 262. Intermediate Biostatistics: Regression, Prediction, Survival Analysis—(Same as STATS 262.) Linear and inherently nonlinear models. Prediction versus testing. Sample reuse methods. Analysis of variance. Components of variance. Introduction to multivariate analysis: the normal distribution. Principle components and *k*-means clustering. Survival analysis: the actuarial and Kaplan-Meier methods. The log-rank test. Weibull models. The Cox model, including estimation of baseline hazard.

3 units, Spr (Taylor, 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 Reading—Aspects of preventive medicine, public health, social aspects of disease and health, economics of medical care, occupational or environmental medicine, epidemiology, international health, or related fields. Prerequisite: consent of instructor.

1-18 units, Aut, Win, Spr, Sum, by arrangement with faculty

HRP 391. Political Economy of Health Care in the United States—(Same as PUBLPOL 231.) 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, patients 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 (Staff) not given 2003-04

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 (Garber) not given 2003-04

HRP 399. Research—Graduate students investigations sponsored by individual faculty members. Prerequisite: consent of instructor.

1-18 units, Aut, Win, Spr, Sum, by arrangement with faculty

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)

Business: Alain Enthoven (Professor, emeritus), Daniel Kessler (Associate Professor)

Health Research and Policy: Laurence Baker (Associate Professor), Paul Barnett (Consulting Assistant Professor), Byron W. Brown (Professor, emeritus), M. Kate Bundorf (Assistant Professor), Victor Fuchs (Professor, emeritus), Trevor Hastie (Professor), Mark Hlatky (Professor), Philip Lavori (Professor, Research), Richard Olshen (Professor), Ciaran Phibbs (Consulting Associate Professor), Joseph Selby (Consulting Professor), Anita Stewart (Visiting Scholar), Robert Tibshirani (Professor)

Law: Henry Greely (Professor)

Medicine: Jay Bhattacharya (Assistant Professor), Alan Garber (Professor), Mary Goldstein (Associate Professor), Michael Gould (Assistant Professor), Paul Heidenreich (Assistant Professor), Douglas Owens (Associate Professor), Gillian Sanders (Assistant Professor, Research)

Psychiatry: Rudolph Moos (Professor)

Sociology: Richard Scott (Professor, emeritus)

Program Offices: HRP Redwood Building, Room 150
Mail Code: 94305-5405
Phone: (650) 723-6426
Email: steel@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, 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; 391, Political Economy of Health Care; 392, Cost-Benefit Analysis in Health Care.
2. At least 6 units of graduate-level statistics courses. The sequence of HRP 261 and 262 is strongly recommended. (Note: HRP 202 does not count toward the statistics requirement.)
3. At least 3 units of HRP 283, 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 Program Administrator, Department of Health Research and Policy, Division of Health Services Research, Stanford University School of Medicine, HRP Redwood Building, Room T150, 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 of Neurology and Neurological Sciences)
Director for Immunology Program: Eugene Butcher (Professor of Pathology)
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; and Pediatrics)
Chemistry: Harden M. McConnell (Professor, emeritus)*
Genetics: Leonard A. Herzenberg (Professor, emeritus), Lenore A. Herzenberg (Professor, Research)
Medicine/Bone Marrow Transplantation Program: Robert Negrin (Associate Professor), Judith Shizuru (Assistant 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), 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), Hugh O. McDevitt (Professor), David Schneider (Assistant Professor)
Molecular and Cellular Physiology: Richard S. Lewis (Associate 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), 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), Rosemarie DeKruyff (Assistant Professor, Research), Alan M. Krensky (Professor), Carol Clayberger (Professor, Research), David B. Lewis (Associate Professor), Elizabeth Mellins (Associate Professor), Dale T. Umetsu (Professor)
Structural Biology: Peter Parham (Professor, and Microbiology and Immunology)
Surgery: Sheri Krams (Associate Professor, Research), Olivia Martinez (Professor, Research)

* Recalled to active duty

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Email: mopan@stanford.edu
Web Site: http://immunol.stanford.edu/index.html

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

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. Three quarters of graduate research (IMMUNOL 300), consisting of rotations in the labs of three faculty members
4. Course work in Immunology as follows: one course in basic immunology (BIOSCI 230, MI 200 or equivalent, advanced Immunology such as IMMUNOL 200 and 201), GENE 203, Advanced Genetics, MI 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. One written qualifying exam and proposal before candidacy

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 15. 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 recommenda-

tion, 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; they should contact the program director.

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 and the Howard Hughes Medical Institute. Fellowship applications are due in November of the year prior to matriculation in the graduate program. 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 and nine full-tuition quarters of residency. 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)
   c) Biochemistry and Molecular Biology (BIOC 200)
   d) Cell Biology of Physiological Processes (MCP 221)
   e) Statistics (BIOSCI 141 or HRP 202)
   f) Principles of biological technologies (MI 215)
   g) Graduate level genetics (GENE 203)
   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. Students attend the weekly Immunology Seminar Series (5-6 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 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 and the Immunology community at large.
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.
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 23, 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 two years (IMMUNOL 305). 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 200. Immunology for Medical Students—(Same as PATH 220, MI 200; medical students register for MI 200 only.) The basic concepts of immunology and the role of the immune system in a variety of diseases, utilizing case presentations of diseases including autoimmune diseases, infectious disease, transplantation, immunodeficiency diseases, hypersensitivity reactions, and allergic diseases. Weekly problem sets based on case reports and publications drawn from the clinical literature. Emphasis is on application of the fundamental concepts of immunology.

4 units, Win (Lewis, Staff)

IMMUNOL 201. Advanced Immunology I—(Same as MI 211.) For graduate students and advanced undergraduates. Topics: genetics and structure/function relationships of antibodies, T-cell receptors, MHC antigens; accessory molecules; lymphocyte differentiation and activation; cellular regulation of immune responses; autoimmunity and other problems in clinical immunology. Prerequisites: biochemistry, basic immunology course; consent of instructor for undergraduates.

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: 201.

3 units, Spr (Garcia, Staff)

IMMUNOL 203. Advanced Immunology III—(Same as MI 213.) Immunological literature. Possible themes: the history of immunology, classic problems and emerging areas, or new topics in immunology.

3 units, Sum (Staff)

IMMUNOL 215. Principles of Biological Technologies—(Same as MI 215.) Required of first-year graduate students in Microbiology and Immunology. The principles underlying commonly utilized technical procedures in biological research. Lectures on gel electrophoresis, nucleic acid hybridization, protein purification and stabilization, light microscopy and computer search algorithms for protein and nucleic acid databases. Prerequisites: biochemistry, organic chemistry, and physics.

2 units, Spr (Kirkegaard)

IMMUNOL 230. Introduction to Medicine—(Same as BIOMEDIN 207.) For graduate students in biological sciences, bioengineering, and biomedical informatics. Information and approaches used by physicians to understand human disease by focusing on two multisystem disorders: type I and type II diabetes mellitus. Lectures by medical school and outside faculty, and field trips to clinics, the clinical laboratory, clinical research center, and a relevant biotech company. Students carry out quarter-long, team projects.

3-4 units, Spr (Mellins, Parnes)

IMMUNOL 230A. Independent Study in Medical Sciences—For doctoral students who have taken 230. Completion of team projects begun in 230.
1-2 units (Staff)

IMMUNOL 290. Teaching in Immunology—Practical experience in teaching by serving as a teaching assistant in an immunology course.
1-15 units, Aut, Win, Spr, Sum (Staff)

IMMUNOL 299. Directed Reading in Immunology
1-15 units, by arrangement (Staff)

IMMUNOL 300. Research—For Ph.D. students in Immunology.
1-15 units, by arrangement (Staff)

IMMUNOL 305. Immunology Journal Club—Graduate students present and discuss recent papers in the literature. Required of first to fourth-year graduate students.
1-15 units, Aut, Win, Spr (Staff)

IMMUNOL 311. Seminar in Immunology—Enrollment limited to Ph.D. students in Immunology. Current research topics.
1 unit, Aut, Win, Spr (Fathman, Steinman)

IMMUNOL 311A. Immunology Seminar Discussion—Limited to Ph.D. students in Immunology; required of first-year students. Students discuss papers of speakers in 311, and meet with the speakers.
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.
3 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.
1-3 units, Aut, Win, Spr, Sum (Staff)

MICROBIOLOGY AND IMMUNOLOGY

Emeriti: (Professors) Sidney Raffel, Leon T. Rosenberg, Bruce A. D. Stocker; *(Professor, Research)* 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: Garry Nolan, David Relman
Assistant Professors: Christopher Garcia, Peter Jackson, David Schneider, Upinder Singh, Julie Theriot
Associate Professor (Teaching): Robert D. Siegel
Courtesy Assistant Professor: Christopher Contag (Pediatrics)

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Mail Code: 94305-5124
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Email: juwong@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 B.

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 and Howard Hughes Medical Institute.

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 several new and old microorganisms that infect humans. Goal: to place modern human plagues in scientific and historical perspective and to provide an introduction to the fields of molecular biology and microbiology.
3 units, Spr (Boothroyd)

MI 103. Parasites/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 reservoirs in historical context to understand public health policy approaches to halting disease transmission. Focus is on WHO TDR (World Health Organization Tropical Disease Research) targeted disease entities: river blindness (onchocerciasis), sleeping sickness (African Trypanosomiasis), leishmaniasis, schistosomiasis, mycobacterial disease (tuberculosis and leprosy), malaria, toxoplasmosis, dracunculiais, intestinal helminthes, and miscellaneous and emerging infections. Guest lecturers and experts in disease control and research of local and international renown. Problem sets, exams, and original proposal to solve a current disease.

3 units, Spr (Smith)

MI 115A. Humans and Viruses—(Same as HUMBIO 115A.) Overview of human virology. Topics illustrate 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.

4-6 units, Win (Siegel)

MI 115B. The Vaccine Revolution—(Same as HUMBIO 115B.) Advanced seminar. The human aspects of viral disease, focusing on recent discoveries, especially 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 four oral presentations and lead discussions based on their scientific journal reading. Enrollment limited to 10. Prerequisite: 115A.

5 units, Spr (Siegel) alternate years, given 2004-05

MI 127N. Infectious Disease: Fact and Fiction—Stanford Introductory Seminar. Preference to freshmen. Modern science has developed methods of fighting infectious diseases and their human toll including public sanitation, vaccination, and antibiotics, but infections such as HIV, ebola, and dengue, and bioterrorism, remain a threat. Civilizations have historically dealt with frightening topics like this through the arts. The science behind infectious diseases and their treatments, and its portrayal in the movies. Old and new horror and science fiction films including *Invasion of the Body Snatchers*, *Outbreak*, *The Andromeda Strain*, *Blade*, *Alien*, and *X-Files* episodes. Readings include *Scientific American* and other primary scientific journals. Students critique a film from the perspective of a scientist.

3 units, Aut (Schneider)

MI 185. Topics in Microbiology—In-depth coverage of basic topics: diversity, molecular regulation, growth, bioenergetics, and unique metabolic processes. Student papers on current topics (e.g., antibiotic resistance, molecular approaches to bioremediation) for presentation. Prerequisites: Chemistry 31, 33, 35. Recommended: Biological Sciences 31.

3 units, Win (Matin, Staff)

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

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

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 200. Immunology for Medical Students—(Same as PATH 220, IMMUNOL 200; medical students register for MI 200 only.) The basic concepts of immunology and the role of the immune system in a variety of diseases, utilizing case presentations of diseases including autoimmune diseases, infectious disease, transplantation, immunodeficiency diseases, hypersensitivity reactions, and allergic diseases. Weekly problem sets based on case reports and publications drawn from the clinical literature. Emphasis is on application of the fundamental concepts of immunology.

0-4 units, Win (Lewis, Staff)

MI 201. Infectious Basis of Disease—The spectrum of human illness induced by viruses, bacteria, fungi, and medical parasites, including protozoans and helminths. Classification, epidemiology, transmission, pathogenesis, diagnosis, treatment, control, vaccination, and other preventive measures. Emphasis is on the syndromic approach to disease. Lectures, demonstrations, lab sessions, and small group evaluation of clinical correlates. Use of CWP, laboratory demos, and interactive multimedia instructional program, MICROBE. Prerequisite: second-year medical student.

0-9 units, Aut (Siegel, 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, Spr (Matin, Staff) alternate years, not given 2004-05

MI 206. Animal Viruses—For advanced graduate and medical students. The structure, molecular biology, and genetics of RNA and DNA animal viruses. Lectures on the molecular biology of virus replication and gene expression and the nature of the host-virus interaction. Concise treatment of eukaryotic molecular and cell biology in the context of viruses. Problem sets, discussion groups. Prerequisites: Biological Sciences core, an understanding of molecular biology, biochemistry.

3 units (Mocarski, Staff) alternate years, given 2004-05

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, Aut (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. Prerequisite: 209.

5 units, Win (Sarnow, Staff)

MI 211. Advanced Immunology I—(Same as IMMUNOL 201.) For graduate students and advanced undergraduates. Topics: genetics and structure/function relationships of antibodies, T-cell receptors, MHC antigens; accessory molecules; lymphocyte differentiation and activation; cellular regulation of immune responses; autoimmunity and other problems in clinical immunology. Prerequisites: biochemistry, basic immunology course; consent of instructor for undergraduates.

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: 201.

3 units, Spr (Garcia, Staff)

MI 213. Advanced Immunology III—(Same as IMMUNOL 203.) Immunological literature and. Possible themes: the history of immunology, classic problems and emerging areas, or new topics in immunology.

3 units, Sum (Staff)

MI 215. Principles of Biological Technologies—(Same as IMMUNOL 215.) Required of first-year graduate students in Microbiology and Immunology. 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 231. Stem Cells and Gene Therapy—Cell mediated and gene therapy as a novel form of drug delivery. Vectors, cell types, and relevant genetic and acquired diseases are discussed in a series of lectures, and in student and guest presentations. Prerequisites: biochemistry and molecular biology.

2-3 units, Spr (Nolan, Blau)

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

1-18 units, Aut, Win, Spr, Sum, by arrangement

MI 399. Graduate Research—Students who have satisfactorily completed the necessary 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. See faculty list for section numbers.

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

MI 459. Frontiers in Interdisciplinary Biosciences—(Crosslisted in multiple departments in the schools of Humanities and Sciences, Engineering, and Medicine. Students should enroll through their affiliated department; otherwise enroll in CHEMENG 459.) See CHEMENG 459 or http://biox.stanford.edu/chemeng_index.html for description.

1 unit, Aut, Win, Spr (Robertson)

MOLECULAR AND CELLULAR PHYSIOLOGY

Chair: Richard W. Aldrich

Professors: Richard W. Aldrich, Axel T. Brunger, Brian K. Kobilka, W. James Nelson, Stephen J. Smith, Richard W. Tsien

Associate Professors: Richard S. Lewis, V. Daniel Madison, William Weis

Assistant Professors: Miriam Goodman, Merritt Maduke

Courtesy Associate Professor: Anson W. Lowe

Courtesy Assistant Professor: Michael McConnell

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 B.

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
6 units, Spr (Kobilka)

MCP 201. Endocrine Physiology
1-4 units, Win (Hoffman)

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

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

MCP 204. Respiratory Physiology
1-2 units (Kao, Peter)

MCP 213. Special Topics in Molecular and Cellular Physiology—Seminar. Introductory and advanced physiological topics agreed on by an individual instructor and interested students. Prerequisite: consent of instructor.
1-18 units (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. Relevant research papers.
5 units, Aut (Smith, Madison)

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 221A,C,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.
3 units, Spr (S. Smith, Meyer)

MCP 255. Molecular Physiology of Membranes—Recommended for all 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 all 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: MCP 255; basic cell and molecular biology.
4 units, Spr (Lewis, Goodman)

MCP 299. Directed Reading—Prerequisite: consent of instructor. See faculty list for section numbers.
1-18 units, Aut, Win, Spr, Sum, by arrangement

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)

MCP 459. Frontiers in Interdisciplinary Biosciences—(Crosslisted in multiple departments in the schools of Humanities and Sciences, Engineering, and Medicine. Students should enroll through their affiliated department; otherwise enroll in CHEMENG 459.) See CHEMENG 459 or http://biox.stanford.edu/chemeng_index.html for description.
1 unit, Aut, Win, Spr (Robertson)

MOLECULAR PHARMACOLOGY

Emeriti: (Professors) Robert H. Dreisbach, Avram Goldstein, Dora B. Goldstein, Tag E. Mansour
Chair: Daria Mochly-Rosen
Professors: James E. Ferrell, Jr., Oleg Jardetzky, Daria Mochly-Rosen, Richard A. Roth, James P. Whitlock, Jr.
Associate Professor: Tobias Meyer
Assistant Professor: James K. Chen, Karlene A. Cimprich, Ricardo Dolmetsch, 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 B.

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, drugs, and toxic compounds alter cell function, and on the development of new therapeutic technologies. At the heart of these issues lies the analysis of cell signaling and gene expression.

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 a limited number of undergraduate students. The limited size of the labs in the department allows for close tutorial contact between students, postdoctoral fellows, and faculty.

The department presents two basic courses in medical pharmacology (201 and 202) and advanced courses open to qualified medical and other graduate students. Consult the *Time Schedule* for additional advanced courses.

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.

BASIC

201 and 202 provide a broad exposure to the principles of pharmacology and the properties of the major drug groups.

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

MPHA 201. Pharmacology—Topics: receptors; pharmacokinetics; and autonomic, CNS, and cardiovascular pharmacology. Emphasis is on the mechanisms of drug action in humans. Prerequisite: biochemistry.
5 units, Aut (Ferrell, Whitlock)

MPHA 202. Pharmacology—Continuation of 201. Topics: antimicrobial chemotherapy, cancer chemotherapy, endocrine and GI pharmacology, and toxicology.
5 units, Win (Whitlock)

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—(Same as BIOSCI 210.) 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: a working knowledge of biochemistry and genetics.
4 units, Win (Ferrell, Meyer)

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, with emphasis on molecular and genetic issues. Prerequisite: knowledge of biochemistry, chemistry, or bioengineering.
4 units, Spr (Mochly-Rosen, Cimprich) alternate years, not given 2004-05

MPHA 250. Fundamentals of Drug-Receptor Interactions and Drug Design—The principles of biological structure determination, scope, and the limits of the methods and of the structural information derived from them. Enrollment limited to 15.
3 units (Jardetzky) not given 2003-04

MPHA 260. Quantitative Chemical Biology—Principles governing chemical and biological processes and recent advances at the interface of chemistry and biology. Topics include protein and small molecule engineering, chemical genetics, combinatorial chemistry, and in vitro evolution. Prerequisites: undergraduate organic chemistry, and biochemistry or cell biology.
4 units (Cimprich, Wandless, Jackson) not given 2003-04

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. See faculty list for section numbers.
1-18 units, Aut, Win, Spr, Sum, by arrangement

MPHA 299. Directed Reading—See faculty list for section numbers.
1-18 units, Aut, Win, Spr, Sum, by arrangement

MPHA 399. Research—Investigations sponsored by individual faculty members. See faculty list for section numbers.
1-18 units, Aut, Win, Spr, Sum, by arrangement

MPHA 450. Introduction to Biotechnology—(Enroll in CHEMENG 450, BIOC 450.)
3 units, Spr (Kao)

MPHA 459. Frontiers in Interdisciplinary Biosciences—(Crosslisted in multiple departments in the schools of Humanities and Sciences, Engineering, and Medicine. Students should enroll through their affiliated department; otherwise enroll in CHEMENG 459.) See CHEMENG 459 or http://biox.stanford.edu/chemeng_index.html for description.
1 unit, Aut, Win, Spr (Robertson)

NEUROBIOLOGY

Chair: Eric I. Knudsen
Professors: Ben Barres, Eric I. Knudsen, Uel J. McMahan, William T. Newsome, Eric M. Shooter, Howard Schulman, Lubert Stryer
Assistant Professor: Thomas Clandinin, Tirin Moore, Jennifer Raymond
Department Offices: Fairchild Building, Second Floor
Mail Code: 94305-5125

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

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 (Neurobiology 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. Directed Reading (Undergraduate)—Prerequisite: consent of instructor.

1-18 units, Aut, Win, Spr, Sum (Barres, Clandinin, Knudsen, McMahan, Moore, Newsome, Raymond, Shooter, Stryer)

NBIO 200. 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.

7-9 units, Win (Barres, Knudsen, Newsome, Raymond, Stryer, Clandinin)

NBIO 204. Computational Neuroimaging—(Same as PSYCH 204A.) Advanced seminar. For students working with functional magnetic resonance imaging (fMRI). Review of current understanding of 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 2004-05

NBIO 216. Genetic Analysis of Behavior—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, Aut (Clandinin, Goodman) alternate years, not given 2004-05

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 (Knudsen, Raymond) alternate years, given 2004-05

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, Spr (Newsome) alternate years, not given 2004-05

NBIO 221. Frontiers in Translational Medicine—Pathways for combining science and medicine during graduate and postdoctoral training and in one's career. Practical aspects of translational medicine. Guest lecturers include physician-scientists who have advanced the frontiers of translational medicine. Speakers last year included Rob Malenka, Judy Swain, Bob Fisher, Jeff Bird, Ching Wang, Lubert Stryer, Jamie Topper, Ben Barres, and Gary Steinberg.

1 unit, Spr (Barres)

NBIO 240. High Level Vision—(Enroll in PSYCH 250.)

1-3 units (Grill-Spector) not given 2003-04

NBIO 254. Molecular and Cellular Neurobiology—(Same as BIOSCI 154/254.) For advanced undergraduates and graduate students. Focus is on cellular and molecular mechanisms in the organization and functions of the nervous system. Topics: cell biology of the neuron, wiring of the neuronal network, synapse structure and synaptic transmission, signal transduction in the nervous system, molecular basis of behavior including learning and memory, molecular pathogenesis of neurological diseases. Prerequisite for undergraduates: Biological Sciences core or equivalent, plus at least one of BIOSCI 118, 128, 129, or 153, or consent of the instructors.

4 units (Luo, Stryer) not given 2003-04

NBIO 299. Directed Reading—Prerequisite: consent of instructor.

1-18 units, Aut, Win, Spr, Sum (Barres, Clandinin, Knudsen, McMahan, Moore, Newsome, Raymond, Shooter, Stryer)

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 (Barres, Clandinin, Knudsen, McMahan, Moore, Newsome, Raymond, Shooter, Stryer)

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

3 units, Spr (Kao)

NBIO 459. Frontiers in Interdisciplinary Biosciences—(Crosslisted in multiple departments in the schools of Humanities and Sciences, Engineering, and Medicine. Students should enroll through their affiliated department; otherwise enroll in CHEMENG 459.) See CHEMENG 459 or http://biox.stanford.edu/chemeng_index.html for description.

1 unit, Aut, Win, Spr (Robertson)

NEUROSCIENCES PROGRAM

Director: William T. Newsome (Professor of Neurobiology)

Committee: Richard Aldrich, Corinna Darian-Smith, Craig Garner, Kalanit Grill-Spector, John A. Huguenard, Liqun Luo, M. Bruce MacIver, William Mobley, William T. Newsome, Jennifer Raymond, Krishna Shenoy, Edith Sullivan

Participating Faculty:

Anesthesia: Rona Giffard (Associate Professor), Joan E. Kendig (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), 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), Marc Tessier-Lavigne (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: David R. Cox (Professor)

Molecular and Cellular Physiology: Richard Aldrich (Professor), Miriam B. Goodman (Assistant Professor), Brian Kobilka (Professor), Richard S. Lewis (Associate Professor), V. Daniel Madison (Associate Professor), Merritt C. Maduke (Assistant Professor), Stephen Smith (Professor), Richard Tsien (Professor)

Molecular Pharmacology: Helen Blau (Professor), Ricardo Dolmetsch (Assistant Professor), Tobias Meyer (Associate Professor), Daria Mochly-Rosen (Professor)

Neurobiology: Ben Barres (Associate Professor), Tom Clandinin (Assistant Professor), Eric I. Knudsen (Professor), U. J. McMahan (Professor), Tirin Moore (Assistant Professor), William T. Newsome (Professor), Jennifer Raymond (Assistant Professor), Eric M. Shooter (Professor), Lubert Stryer (Professor)

Neurology and Neurological Sciences: Robert S. Fisher (Professor), John A. Huguenard (Associate Professor, Research), William C. Mobley (Professor), David A. Prince (Professor), Thomas A. Rando (Assistant Professor), Richard Reimer (Assistant Professor), Terence Sanger (Assistant Professor), Lawrence Steinman (Professor), Yanmin Yang (Assistant Professor)

Neurosurgery: Pak H. Chan (Professor), Theo Palmer (Assistant Professor), Gary K. Steinberg (Professor)

Pathology: Raymond Sobel (Associate Professor)

Psychiatry and Behavioral Sciences: William C. Dement (Professor), Judith Ford (Associate Professor, Research), 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: Russell D. Fernald (Professor, Teaching), John Gabrieli (Associate Professor), Ian Gotlib (Professor), Kalanit Grill-Spector (Assistant Professor), Brian Knutson (Assistant Professor), Anthony Wagner (Assistant Professor), Brian Wandell (Professor), Jeffrey J. Wine (Professor)

Radiology: John Desmond (Assistant Professor)

Program Offices: Alway Bldg., M-103D
Mail Code: 94305-5121
Phone: (650) 723-9855
Web Site: http://sbri.stanford.edu/phd/index.html

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

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 200 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 GYOB. For a complete list of subject codes, see Appendix B.

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.

PATHOLOGY

Emeriti: (Professor) Richard L. Kempson; *(Professor, Clinical)* P. Joanne Cornbleet, Dikran S. Horoupian

Chair: Stephen J. Galli

Professors: Daniel Arber, Ellen Jo Baron, Eugene C. Butcher, Michael L. Cleary, Gerald R. Crabtree, Lawrence F. Eng, Edgar G. Engleman, Luis F. Fajardo, Heinz Furthmayr, Stephen J. Galli, F. Carl Grumet, 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: Gerald J. Berry, Athena M. Cherry, Tina Cowan, James D. Faix, Steven K. H. Foung, Susan A. Galel, Sharon M. Geaghan, Peter K. Jackson, Sabine Kohler, Teri A. Longacre, Sara A. Michie, Kent W. Nowels, Donald P. Regula, Raymond A. Sobel, Jan Matthijs van de Rijn, Hannes Vogel, James L. Zehnder

Assistant Professors: Jeffrey D. Axelrod, Dean Felsher, John P. Higgins, Christina Kong, Yasodha Natkunam, Jonathan R. Pollack, Arend Sidow

Acting Assistant Professors: Matthew Bogyo, Bingwei Lu
Courtesy Professor: Lucy Tompkins
Courtesy Assistant Professor: Donna Bouley
Clinician Educators: Carey D. Austin, David B. Bingham, Christopher A. Callahan, Barbara Egbert, Tracey George, Neereja Kambham, Norman Lehman, James M. Malone, Melanie Manning, Jesse McKenney, Terry Morgan, Bruce Patterson, Iris Schrijver, Uma Sundram, Maurene Viele, Robert West
Adjunct Clinical Faculty: Robert Archibald, Jerome S. Burke, Stephen Shi-Hua Chen, Andrew J. Connolly, Seth Haber, Bijan Haghighi, Maie K. Herrick, Paul W. Herrmann, Charles Lombard, John E. McNeal, Mahendra Ranchod, Thomas W. Rogers, William Ruehl, Gregory Schmunk, Joshua Sickel, Sharon Van Meter

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

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

PROGRAMS OF STUDY

The Department of Pathology offers a sequence of basic courses in general and special pathology, including neuropathology, which is open to medical students only. Interested and qualified graduate students may petition the course director to audit the lecture portion of these courses. In addition, there are a number of advanced courses in selected 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 research laboratories of the Department of Pathology. The discipline of pathology has traditionally 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 disease in man and to 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 encompass a broad range that extends from fundamental molecular biology to clinical-pathological correlations, with a primary 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 on request.

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 105Q. Final Analysis: The Autopsy as a Tool of Medical Inquiry—Stanford Introductory Seminar.
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 215. Molecular Mechanisms of Disease—Provides graduate students in the basic sciences with an exposure to current research topics in human disease. Each week, one scientist from academia or industry presents a seminar on the pathogenesis of a particular disease, with an emphasis on molecular approaches, followed by a discussion. A review article and one or two research papers from the current literature are assigned prior to each meeting.
1 unit, Win (Lipsick, Staff)

PATH 220. Immunology for Medical Students—(Same as IMMUNOL 200, MI 200; medical students register for MI 200 only.) The basic concepts of immunology and the role of the immune system in a variety of diseases, utilizing case presentations of diseases including autoimmune diseases, infectious disease, transplantation, immunodeficiency diseases, hypersensitivity reactions, and allergic diseases. Weekly problem sets based on case reports and publications drawn from the clinical literature. Emphasis is on application of the fundamental concepts of immunology.
4 units, Win (Lewis, Staff)

PATH 230A,B,C. General and Special Pathology—Three quarter introduction to principles in general pathology and a detailed pathology of human disease based on the disordered structure and function of individual organ systems (special pathology). Lecture and lab discussion groups. Course director: Regula.

PATH 230A. General and Special Pathology
1-6 units, Spr (Regula, Staff)

PATH 230B. General and Special Pathology
6 units, Aut (Regula, Lombard, Staff)

PATH 230C. General and Special Pathology
0-6 units, Win (Regula, Staff)

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

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, George M. Hahn, Robert F. Kallman, Clarence J. Karzmark, Kendric Smith
Chair: Richard T. Hoppe
Professors: Arthur Boyer, J. Martin Brown, Sarah S. Donaldson, Amato J. Giaccia, Don R. Goffinet, Steven L. Hancock, Richard T. Hoppe, Daniel S. Kapp
Associate Professors: Susan J. Knox, Quynh-Thu Le, Gary Luxton, Melanie C. Smitt
Assistant Professors: Laura Attardi, Nicholas Denko, Iris C. Gibbs, Christopher R. King, Albert C. Koong, Todd Pawlicki
Associate Professor (Research): Lei Xing
Consulting Professor: Robert M. Sutherland

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

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 undergraduate and postgraduate students.

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

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

RADO 202. The Basic Science of Radiation Therapy—For residents or fellows in the training program in the Division of Radiation Therapy, and for interested students. Focus is on the basic processes of radiation biology that underly the treatment of malignant diseases by radiation, and carcinogenesis and mutagenesis by radiation. Prerequisite: familiarity with cell biology and physiology.
1 unit, Aut (Brown, Staff) by arrangement

RADO 202B. The Basic Science of Radiation Therapy II—Primarily for residents or fellows in the Radiation Therapy division training program; open to medical or graduate students. Focus is on the basic biological processes underlying the treatment of malignant disease by radiation. Prerequisites: some familiarity with cell biology and physiology, and consent of instructor.
1 unit, Aut, Win, Spr (Brown)

RADO 204. Clinical Experience with the Cancer Patients—For residents or fellows in the training program in the Division of Radiation Therapy, and for interested students. Focus is on the basic processes of radiation biology that underly the treatment of malignant diseases by radiation, and carcinogenesis and mutagenesis by radiation. Prerequisite: familiarity with cell biology and physiology.
2 units, Aut (Goffinet, Staff) by arrangement

RADO 299. Directed Reading—Prerequisite: consent of instructor. See faculty list for section numbers.
1-18 units, Aut, Win, Spr, Sum, by arrangement

RADO 399. Research—Sponsored by individual faculty members. Prerequisite: consent of instructor. See faculty list for section numbers.
1-18 units, Aut, Win, Spr, Sum, by arrangement

RADO 459. Frontiers in Interdisciplinary Biosciences—(Crosslisted in multiple departments in the schools of Humanities and Sciences, Engineering, and Medicine. Students should enroll through their affiliated department; otherwise enroll in CHEMENG 459.) See CHEMENG 459 or http://biox.stanford.edu/chemeng_index.html for description.
1 unit, Aut, Win, Spr (Robertson)

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, Gary M. Glazer, Gary H. Glover, Michael L. Goris, Robert J. Herfkens, R. Brooke Jeffrey, Barton Lane, I. Ross McDougall, Robert E. Mindelzun, Norbert J. Pelc, F. Graham Sommer

Associate Professors: Patrick D. Barnes, Christopher F. Beaulieu, Robyn L. Birdwell, Francis Blankenberg, R. Kim Butts, Michael D. Dake, Debra M. Ikeda, Ann Leung, Michael Marks, Michael F. Moseley, Sandy Napel, Matilde Nino-Murcia, Eric W. Olcott, Mahmood Razavi, Geoffrey D. Rubin, George M. Segall, Daniel M. Spielman, Daniel Y. Sze

Assistant Professors: Sandip Biswal, Frandics P. Chan, Lawrence Chow, Bruce Daniel, Terry Desser, Huy M. Do, Dominik Fleischmann, Joan K. Frisoli, Garry E. Gold, Stephen Kee, Kathryn J. Stevens

Assistant Professors (Research): Mark Bednarski, John Desmond, Rebecca Fahrig, Sylvia Plevritis

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 B.

The Department of Radiology 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. Undergraduate students 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 open to undergraduate and postgraduate students are listed below.

COURSES

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

RAD 199. Undergraduate Research
1-18 units, Aut, Win, Spr, Sum (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) by arrangement

RAD 210. Clinical Nuclear Medicine—The application of nuclear medicine procedures to clinical cases. Prerequisite: consent of instructor.
2 units, Win (Goris, Staff)

RAD 220. Introduction to Imaging and Image-based Human Anatomy—Fundamentals of medical imaging and image-based human anatomy. Emphasis is on contrast mechanisms and the relative strengths of each imaging modality. Laboratory component shows imaging and anatomy in real time. Recommended: basic understanding of biology, physics, and math.
3 units, Aut (Gold, Butts)

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 (Gold, Staff)

RAD 226. In Vivo Magnetic Resonance Spectroscopy and Imaging—(Same as EE 469A.) 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 299. Directed Reading—Prerequisite: consent of instructor. Search for instructor name on Axess.

1-18 units, Aut, Win, Spr, Sum, by arrangement

RAD 399. Research—Investigations sponsored by individual faculty members. Prerequisite: consent of instructor. Search for instructor name on Axess.

1-18 units, Aut, Win, Spr, Sum, by arrangement

STRUCTURAL BIOLOGY

Chair: Michael Levitt (on leave)
Associate Chair: Joseph D. Puglisi
Professors: Roger D. Kornberg, Michael Levitt (on leave), David B. McKay, Uel J. McMahan, Peter Parham, William I. Weis
Associate Professor: Joseph D. Puglisi
Professor (Teaching): Patricia Cross
Associate Professor (Research): Yahli Lorch
Assistant Professor: Kenan C. Garcia
Courtesy Assistant Professor: Vijay Pande

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 B.

The department offers opportunities for course work and research in cell biology. Courses fall into two categories: (1) a series of one quarter courses that treat special topics of current interest in cell biology at an advanced level; and (2) Structure of Cells and Tissues (211), a one quarter course tailored to the needs of medical students that includes both 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 organelles and molecular assemblies. Techniques used include standard methods of biochemistry, cell culture, fluorescence microscopy, genetic engineering, and image processing and three-dimensional reconstruction from electron micrographs, x-ray and electron diffraction, and 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 the 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. Completion of the following courses or their equivalents:
   a) BIOC 200, 201
   b) CHEM 131, 171, 173, and 175
   c) SBIO 241 and 242
   d) MED 255
   e) additional courses as required for the individually tailored program
2. Opportunities for teaching are available during the first nine quarters at the discretion of the advising committee.
3. 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.
4. 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.
5. 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 204. Cells to Tissues—The structural organization of cells and tissues in relation to their function. Topics include light and electron microscopy of epithelia, muscle, connective tissue, bone and cartilage, blood, lymphoid tissue, nerve tissue, and integument. Lab.

2-3 units, Aut (Cross)

SBIO 228. Computational Structural Biology—(Same as BIOPHYS 228.) 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 protein via their amino acid sequences and their three-dimensional structures. Structure prediction via simple comparative modeling. How remote homologues can be detected and modeled. Predicting the structure of a protein from knowledge of its amino acid sequence.

3 units, Win (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: basic biochemistry and cell biology.

3 units, Spr (Kornberg)

SBIO 241. Biological Macromolecules—Introduction to 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: introductory biochemistry

3-5 units, Aut (Puglisi, Block, Herschlag, Kirkegaard, McKay)

SBIO 242. Methods in Molecular Biophysics—(Same as BIOC 242.) 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 (McKay, Puglisi) alternate years, given 2004-05

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

1-18 units, Aut, Win, Spr, Sum, by arrangement

SBIO 399. Individual Research—Investigations sponsored by individual faculty members. Prerequisite: consent of instructor. See faculty list for section numbers.

1-18 units, Aut, Win, Spr, Sum, by arrangement

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

3 units, Spr (Kao)

SBIO 459. Frontiers in Interdisciplinary Biosciences—(Crosslisted in multiple departments in the schools of Humanities and Sciences, Engineering, and Medicine. Students should enroll through their affiliated department; otherwise enroll in CHEMENG 459.) See CHEMENG 459 or http://biox.stanford.edu/chemeng_index.html for description.

1 unit, Aut, Win, Spr (Robertson)

SURGERY

The following courses are open to undergraduates. For graduate and Medical School course offerings, see the Stanford University bulletin *School of Medicine*.

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

COURSES

SURG 67Q. Medical Experience in Foreign Lands—Stanford Introductory Seminar.

3 units, Win (Chase, Wang)

SURG 68Q. Current Concepts in Transplantation—Stanford Introductory Seminar. Preference to freshmen. Will tissues and organs be grown in a laboratory for transplantation to humans? The biological aspects of cell and organ transplantation, including many of the issues that arise in the media. The 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 the 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. Research opportunities available.

3 units, Spr (Krams, Martinez)

SURG 101. An Undergraduate Course in Anatomy—A 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.

7 units, Win (Dolph, Gosling)

SURG 199. Undergraduate Research

1-18 units, by arrangement (Staff)