

SCHOOL OF MEDICINE

Dean: Philip Pizzo

Senior Associate Dean for Graduate Education and Postdoctoral Affairs: John Pringle

Senior Associate Dean for Medical Student Education: Charles Prober

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

UNDERGRADUATE PROGRAMS IN THE SCHOOL OF MEDICINE

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

M.S. AND PH.D. PROGRAMS IN THE SCHOOL OF MEDICINE

The School of Medicine is home to graduate programs covering a broad range of disciplines within biomedicine leading to Ph.D. or M.S. degrees. These programs focus on interdisciplinary training with in-depth investigation of an original problem of fundamental importance to the biosciences. Each degree program sets its own curriculum, but many courses are taught by groups of faculty from multiple programs and departments. Flexibility is a priority to ensure that all students obtain the best possible training for pursuing careers in their areas of interest. The school is dedicated to training students from diverse backgrounds, and to the promotion of diversity in graduate education. Admission is through one of about 15 home programs. These home programs enable students to carry out dissertation research and training with School of Medicine faculty, as well as investigators in the departments of Biology and Biophysics in the School of Humanities and Sciences. Detailed information on School of Medicine M.S. and Ph.D. programs, curricula, and research can be found at <http://med.stanford.edu/ms> and <http://med.stanford.edu/phd>. Application information can be found at <http://gradadmissions.stanford.edu>.

M.D. PROGRAM IN THE SCHOOL OF MEDICINE

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

Broad clinical science education occurs throughout the curriculum with exposure to patient care and the practice of medicine beginning on the first day of medical school. Students may begin clinical clerkships as early as May of the second year. A population health course combines classroom and experiential learning to

provide understanding of the socioeconomic determinants of the health of patients and communities.

Scholarly concentrations offer opportunities for developing skills that enhance basic science and clinical training in areas such as bioengineering, biomedical ethics and medical humanities, biomedical informatics, clinical research, community health, health services and policy research, and the molecular basis of medicine. Through the scholarly concentration program, these skills may be applied in clinical areas housed within centers at Stanford such as the Comprehensive Cancer Center, the Cardiovascular Institute, the Neuroscience Institute, the Institute of Immunity, Transplantation, and Infection, and Women's Health at Stanford. Study in a scholarly concentration typically includes course work and research activities. Research for scholarly concentrations can be supported through the Medical Scholars program, which funds student research projects at Stanford and overseas.

Students with interests in medical research as a career are encouraged to investigate opportunities available through the Medical Scientist Training Program (MSTP). Stanford also collaborates with the University of California, Berkeley, to offer students opportunities for M.D./M.P.H. training. Details about these programs may be found at http://med.stanford.edu/combined_degree.

Stanford is committed to representing the diversity of the U.S. and California populations by seeking a diverse body of students who are interested in the intellectual substance of medicine and committed to advancing the field of health care, broadly defined. Provided an applicant to the school has completed 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 advanced biology such as biochemistry, molecular biology, or genetics and the behavioral sciences is recommended because of their importance in understanding health care. Breadth of interests and depth of experiences play an important role in the selection of students from among those applicants having superior academic records.

The M.D. degree requires 13 quarters of registration at full Med-MD tuition; the joint M.D./Ph.D. degree requires 16 quarters. All additional quarters are charged at the reduced Terminal Medical Registration (TMR) tuition rate, which is \$2,251 per quarter in 2009-10. Completion of the M.D. degree must be achieved within six years, unless a petition is granted to extend this time frame. For further details on the M.D. degree, including admission requirements, see <http://med.stanford.edu/md>.

MULTIPLE-DEGREE PROGRAMS IN THE SCHOOL OF MEDICINE

MEDICAL SCIENTIST TRAINING PROGRAM

The Medical Science Training Program (MSTP) provides medical students with an opportunity to pursue an individualized program of research and course work leading to both the M.D. and Ph.D. degrees. It is designed to equip students for careers in academic investigative medicine, and emphasizes individualization of curricular and research programs for each trainee. Training for a combined M.D./Ph.D. should include the same content encountered by students who pursue each degree separately, but the total training time should be less than the sum of the time normally required for each degree. The flexible curriculum at Stanford's School of Medicine allows each student, in consultation with a preceptor and other advisers, to pursue a plan of study that satisfies the requirements for the M.D. degree and allows performance of doctoral-level research leading to the Ph.D. Students interested in joining the MSTP are considered for admission at the time of their application to the School of Medicine M.D. program and are asked to provide supplemental information relevant to their research background. Current Stanford M.D. students may also apply for admission to the MSTP. Further information regarding admission may be obtained from the MSTP administrator; details about the MSTP may be found at <http://mstp.stanford.edu>.

MASTER OF SCIENCE IN MEDICINE PROGRAM

The Master of Science in Medicine program admits Ph.D. students who have a commitment to translational research, but are not interested in becoming clinicians. The goal of the program is to train researchers in human biology and disease so they are better equipped to translate new scientific discoveries into useful medical advances. Students offered admission into any Ph.D. program at Stanford may apply for admission to the master's program. During their first five quarters, students take basic biomedical science courses with Stanford M.D. students. The School of Medicine M.D. curriculum is presented in a succinct format that allows time for students to concurrently complete their Ph.D. course requirements and lab rotations. By early in their second year, students choose a lab for their Ph.D. thesis research and complete their medical course work. They also elect a clinical mentor to discuss translational research needs and help to arrange a short clinical experience. Upon completion of the Ph.D., participating students receive an M.S. in Medicine. Details about the program can be found at <http://msm.stanford.edu>.

BIOCHEMISTRY

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

Professors: Patrick O. Brown, Gilbert Chu, Ronald W. Davis, James E. Ferrell, Jr., Daniel Herschlag, Mark A. Krasnow, Suzanne R. Pfeffer, James A. Spudich

Associate Professors: Pehr A. B. Harbury, Julie A. Theriot

Assistant Professors: Rhiju Das, Aaron F. Straight

Courtesy Professors: Chaitan S. Khosla, Sharon Long, Rajat Rohatgi

Department Offices: Beckman Center, B400

Mail Code: 94305-5307

Phone: (650) 723-6161

Web Site: <http://biochemistry.stanford.edu>

Courses offered by the Department of Biochemistry are listed under the subject code BIOC on the *Stanford Bulletin's* Explore-Courses web site.

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 offered in more specialized areas emphasize recent developments in biochemistry, cell biology, and molecular biology. These courses include the physical and chemical principles of biochemistry, enzyme reaction mechanisms, membrane trafficking and biochemistry, molecular motors and the cytoskeleton, mechanisms and regulation of nucleic acid replication and recombination, the biochemistry of bacterial and animal viruses, the molecular basis of morphogenesis, the molecular and cell biology of yeast, and the structure and function of both eukaryotic and prokaryotic chromosomes.

Opportunities exist for directed reading and research in biochemistry and molecular biology, utilizing the most advanced research facilities, including those for light and electron microscopy, chromatography and electrophoresis, protein and nucleic acid purification, rapid kinetic analysis, synthesis and analysis, single molecule analyses using laser light traps, microarray generation and analysis and computer graphic workstation facilities for protein and nucleic acid structural analysis. Ongoing research utilizes a variety of organisms, from bacteria to animal cells.

DOCTOR OF PHILOSOPHY IN BIOCHEMISTRY

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 among the 135 total units required for the Ph.D. Selection of these courses is tailored to fit the background and interests of each student. A second requirement involves the submission of two research proposals which are presented by the student to a small committee of departmental faculty members who are also responsible for monitoring the progress of student curricular and research programs, and a journal club presentation. All Ph.D. students are expected to participate actively in the department's seminar program, and students are encouraged to attend and to present papers at regional and national meetings in cellular biochemistry and molecular biology. Teaching experience is an integral part of the Ph.D. curriculum and is required for the degree.

The Department of Biochemistry offers an M.S. degree only to students already enrolled in the Ph.D. program. Students should contact the Graduate Studies adviser for more details.

Those applying for graduate study should have at least a baccalaureate degree and should have completed work in cell and developmental biology, basic biochemistry and molecular biology, and genetics. Also required are: at least one year of university physics; differential and integral calculus; and 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 (see web site) for admission in the following Autumn Quarter.

Applications should be submitted at <http://gradadmissions.stanford.edu>. Applicants are notified by March 31 of decisions on their applications. Stanford University requires scores from the Graduate Record Examination (GRE) (verbal, quantitative, and analytical), and applicants are encouraged to submit scores from the GRE Subject Test in 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. 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.

CENTER FOR BIOMEDICAL ETHICS

Director: David C. Magnus

Director Emeritus: Thomas A. Raffin

Associate Director: Mildred K. Cho

Participating Faculty and Staff: Clarence H. Braddock, Julie A. Collier, LaVera M. Crawley, Maren Grainger-Monsen, Henry Greeley, Katrina A. Karkazis, Sandra S. Lee, Jose R. Maldonado, Kelly E. Ormond, Christopher T. Scott, Audrey Shafer, Sara L. Tobin, Abraham C. Verghese, Lawrence I. Zaroff

Center Offices: 701 Welch Road, Building A, Suite 1105

Mail Code: 94304-5748

Phone: (650) 723-5760

Web Site: <http://bioethics.stanford.edu>

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

SCBE offers a scholarly concentration in Biomedical Ethics and Medical Humanities (BEMH) to medical students. This program allows medical students to study in depth the moral, social, and humanistic dimensions of medicine and biomedical science. Using cross-disciplinary methods such as those from philosophy, social science, film, literature, art, and law, students examine the meaning and implications of medicine and medical research.

Requirements: Students who pursue Biomedical Ethics and Medical Humanities in conjunction with an application area, such as Immunology, are required to complete 6 units including: INDE 212. The Human Condition: Medicine, Arts, and Humanities (2 units)

MED 250A. Medical Ethics I (2 units)

Students may select the other two core BEMH units from a wide variety of university, Medical School, and Law School courses, and students interested in completing all 12 units in the BEMH scholarly area may do the same. Students are encouraged to go through the various offerings and devise a course plan to present to the directors, David Magnus, Ph.D., and Audrey Shafer, MD. Additional information on requirements for the scholarly concentration, is available at <http://bioethics.stanford.edu/education/bemh>.

BIOMEDICAL INFORMATICS

Committee: Russ B. Altman (*Chair and Program Director*); Lawrence M. Fagan, Mark A. Musen (*Co-Directors*); Betty Cheng (*Associate Director*); Atul Butte, Amar K. Das, David Paik, Daniel L. Rubin

Participating Faculty and Staff by Department:

Research opportunities are not limited to faculty and departments listed.

Biochemistry: Douglas L. Brutlag (Professor, emeritus), Rhiju Das (Assistant Professor), Ronald Davis (Professor), James Ferrell (Professor), Julie Theriot (Associate Professor)

Bioengineering: Russ B. Altman (Professor), Kwabena Boahen (Associate Professor), Markus Covert (Assistant Professor), Scott Delp (Professor), Charles A. Taylor (Associate Professor)

Biology: Markus Feldman (Professor), Dmitri Petrov (Associate Professor)

Chemistry: Vijay Pande (Associate Professor)

Chemical and Systems Biology: Joshua Elias (Assistant Professor), James Ferrell (Professor)

Computer Science: Serafim Batzoglou (Associate Professor), Gill Bejerano (Assistant Professor), David Dill (Professor), Leo Guibas (Professor), Daphne Koller (Associate Professor), Jean-

Claude Latombe (Professor), Chris Manning (Associate Professor), Terry Winograd (Professor)

Developmental Biology: Gill Bejerano (Assistant Professor), Stuart Kim (Professor), Harley McAdams (Professor, Research)

Genetics: Russ B. Altman (Professor), Mike Cherry (Associate Professor, Research), Stanley N. Cohen (Professor), Ronald Davis (Professor), Stuart Kim (Professor), Teri E. Klein (Senior Research Scientist), Gavin Sherlock (Assistant Professor), Michael P. Snyder (Professor)

Health Research and Policy: Mark A. Hlatky (Professor), Richard A. Olshen (Professor), Robert Tibshirani (Professor)

Management Science and Engineering: Margaret Brandeau (Professor), Ross D. Shachter (Associate Professor)

Medicine: Russ B. Altman (Professor), Jayanta Bhattacharya (Assistant Professor), Atul Butte (Assistant Professor), Robert W. Carlson (Professor), Betty Cheng (Associate Director), Amar K. Das (Assistant Professor), Lawrence M. Fagan (Co-Director), Alan M. Garber (Professor), Mary Goldstein (Professor), Peter D. Karp (Consulting Assistant Professor), Henry Lowe (Associate Professor, Research; Senior Associate Dean for Information Resources and Technology), Mark A. Musen (Professor), Douglas K. Owens (Associate Professor), Robert W. Shafer (Assistant Professor, Research), Samson Tu (Senior Research Scientist), P.J. Utz (Associate Professor), Michael G. Walker ((Consulting Associate Professor)

Microbiology and Immunology: Karla Kirkegaard (Professor), Garry Nolan (Professor), Julie Theriot (Associate Professor)

Pediatrics: Atul Butte (Assistant Professor)

Psychiatry and Behavioral Sciences: Amar K. Das (Assistant Professor), Vinod Menon (Associate Professor)

Radiation Oncology: Lei Xing (Professor)

Radiology: Sam Gambhir (Professor), Gary H. Glover (Professor), Sandy A. Napel (Professor), David Paik (Assistant Professor), Norbert J. Pelc (Professor), Sylvia Plevritis (Associate Professor), Daniel L. Rubin (Assistant Professor), Geoffrey D. Rubin (Professor)

Structural Biology: Michael Levitt (Professor)

Statistics: Trevor J. Hastie (Professor), Susan Holmes (Professor), Art Owen (Professor), Robert Tibshirani (Professor), Michael G. Walker (Consulting Associate Professor), Nancy Zhang (Assistant Professor)

Surgery: Thomas Krummel (Professor), Charles A. Taylor (Associate Professor, Research)

Program Offices: Medical School Office Building (MSOB), room X-215, 251 Campus Drive

Mail Code: 94305-5479

Phone: (650) 723-6979

Fax: (650) 725-7944

Web Site: <http://bmi.stanford.edu>

Courses offered by the Program in Biomedical Informatics are listed under the subject code BIOMEDIN on the *Stanford Bulletin's* ExploreCourses web site.

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 IN BIOMEDICAL INFORMATICS

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, 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. Candidates must maintain a 3.0 GPA in each of the five core areas, and an overall GPA of 3.0. If the candidate's GPA does not meet the minimum requirement, the Biomedical Informatics Executive Committee may require corrective courses of action. In addition, prior to being formally admitted to candidacy for the Ph.D. degree, the student must demonstrate knowledge of biomedical informatics fundamentals and a potential for research by passing a qualifying exam.

The core curriculum is common to all degrees offered by the program but is adapted or augmented depending on the interests and experience of the student. Deviations from the core curriculum must be justified in writing and approved by the student's Biomedical Informatics academic adviser and the chair of the Biomedical Informatics Executive 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 may have the curriculum adjusted to eliminate requirements met as part of prior training.

CORE CURRICULUM AND PROGRAM REQUIREMENTS IN BIOMEDICAL INFORMATICS

CORE CURRICULUM IN BIOMEDICAL INFORMATICS

Students are expected to participate regularly in the Biomedical Informatics Student Seminar (BIOMEDIN 201) and a research Colloquium, such as BIOMEDIN 200 or BIOMEDIN 205. In addition, all students are expected to fulfill requirements in the following five categories:

1. *Core Biomedical Informatics* (17 units): students are expected to understand current applications of computers in biology and medicine and to develop a broad appreciation for research in the management of biomedical information. Required courses are: BIOMEDIN 210, 211, 212, 214, and 217, all of which should be taken during the first and second year in the program.
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 prior to matriculation students have 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. 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 161, a class in artificial intelligence or learning (for example, CS 121, CS 228, CS 229, STATS 315A, STATS 315B), and a course that requires significant programming and knowledge of machine architectures (for example, CS 108). For those who have taken such courses previously, replacement units may be taken from any other course in CS selected by the student and approved by the academic adviser. A course in databases is especially recommended. With the exception of CS 108 and 121, all other CS 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 from 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 220, STATS 116, or MS&E

221. For the statistics requirements, students should take STATS 141 or STATS 212, if they have not had an equivalent class prior to entry to the program. Otherwise, sequences (taken after STATS 116) may include STATS 200 followed by a course in stochastic modeling, machine learning or data mining, such as STATS 202 or 315A,B, or CS 228 or 229. Options for decision analysis include MS&E 152 or 252, or cost effectiveness analysis (BIOMEDIN 432). Also recommended is a course in the psychology of human problem solving. Specific courses should be chosen in consultation with the student's academic adviser.

4. *Biomedical Domain Knowledge* (6 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 BIO 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 are encouraged to take IMMUNOL 230 (formerly BIOMEDIN 207).
5. *Social and Ethical Issues* (4 units): candidates are expected to be familiar with issues regarding ethics, public policy, financing, organizational behavior, management, and pertinent legal topics. Students are required to take MED 255, The Responsible Conduct of Research, or the equivalent. Students may choose at least 3 units from suitable courses, including BIOMEDIN 432; CS 201; MS&E 284, 197; HRP 391, 392; or any other advanced course in policy and social issues proposed by the student and approved by the Biomedical Informatics academic adviser.

The core curriculum generally entails a minimum of 45 units of course work for master's students and 54 units of course work for Ph.D. students, but can require substantially more or less depending upon the courses selected and the previous training of the student. All courses must be taken for a letter grade. Students may request an elective course be taken for a grade of credit/no credit by submitting a petition to the BMI executive committee. BIOMEDIN 299, 801 and 802 may be taken for satisfactory/no credit (S/NC). 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 45 units that meet the following guidelines are normally approved:

1. Completion of the core curriculum.
2. Masters candidates who are able to attend classes on campus should sign up at least once for BIOMEDIN 201, Student Seminar, plus a Research Colloquium in their field of research, such as BIOMEDIN 200 or BIOMEDIN 205. Regardless of their registration status, students should participate in the Student Seminar and Research Colloquium every quarter.
3. Electives: additional courses to bring the total to 45 or more units as necessary.
4. Masters candidates should sign up for BIOMEDIN 801 for their project units.

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

MASTER OF SCIENCE IN BIOMEDICAL INFORMATICS (ACADEMIC)

This degree is designed for individuals who wish to undertake in-depth study of biomedical informatics with research on a full-time basis. 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 IN BIOMEDICAL INFORMATICS (PROFESSIONAL/HONORS COOPERATIVE PROGRAM)

This degree is designed primarily for the working professional who already has advanced training in one discipline and wishes to acquire interdisciplinary skills. All classes necessary for the degree are available online. The professional M.S. is offered in conjunction with Stanford Center for Professional Development (SCPD), which establishes the rates of tuition and fees. The program uses 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 IN BIOMEDICAL INFORMATICS (COTERMINAL)

The coterminal degree program allows Stanford University 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 available only to current Stanford undergraduates. Coterminal students are enrolled full-time and courses are taken on campus. Research projects are optional and the student must make arrangements with program faculty. Graduates of this program are prepared to contribute creatively to basic or applied projects in biomedical informatics.

For University coterminal degree program rules and University application forms, see <http://registrar.stanford.edu/pdf/CotermAppRules.pdf>

DOCTOR OF PHILOSOPHY IN BIOMEDICAL INFORMATICS

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 Executive Committee:

1. A student plans and completes a coherent program of study including the core curriculum and additional requirements as for the master's program. In addition, doctoral candidates are

expected to take at least nine more units of advanced courses to bring the total to 54 units. Recommended classes include: Computer Sciences courses numbered 135 or higher, courses in Management Science and Engineering or Statistics numbered 200 or higher, PSYCH 256 or 225, or relevant courses in other departments approved by the student's academic adviser. In the first year, two or three research rotations are encouraged. The master's requirements should be completed by the end of the second year in the program (six quarters of study, excluding summers). Doctoral students are generally advanced to Ph.D. candidacy after passing the qualifying exam, which takes place during the end of the second year of training. A student's academic adviser has primary responsibility for the adequacy of the program, which is regularly reviewed by the Biomedical Informatics Executive Committee.

2. To remain in the Ph.D. program, each student must attain a grade point average (GPA) of 3.0 (B) in each of the five core areas and an overall GPA of 3.0 for the required courses. 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 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.
4. By the end of nine quarters (excluding summers), each student must orally present a written thesis proposal for the written dissertation and must orally defend the proposal before a dissertation committee that generally includes at least one member of the Biomedical Informatics Executive Committee. The committee determines whether the student's general knowledge of the field and the details of the planned thesis are sufficient to justify proceeding with the dissertation.
5. After application for Terminal Graduate Registration (TGR) status, the Ph.D. candidate should register each quarter for BIOMEDIN 802 so their research effort may be counted toward the degree.
6. As part of the training for the Ph.D., each student is required to be a teaching assistant for two courses approved by the Biomedical Informatics Executive Committee; one should be completed in the first two years of study.
7. 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.
8. At the completion of training, while still matriculated and shortly prior to deposit of the dissertation, the student gives a final talk describing his or her results. No official additional oral examination is required upon completion of the written dissertation. The oral defense of the dissertation proposal satisfies the University oral examination requirement.
9. The student is expected to demonstrate an ability to present scholarly material and research in a lecture at a formal seminar.
10. 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.
11. The dissertation must be accepted by a reading committee composed of the principal dissertation adviser, a member of the program faculty, and a third faculty member chosen from anywhere within the University.

CANCER BIOLOGY

Program Director: Amato Giaccia (Radiation Oncology)
Committee on Cancer Biology: Nicholas Denko (Radiation Oncology), Howard Chang (Dermatology), Jeffrey Axelrod (Pathology), Katrin Chua (Medicine, Endocrinology), Julien Sage (Pediatrics), Alexandro Sweet-Cordero (Pediatrics), Timothy Stearns (Biology, Genetics), Jonathan Pollack (Pathology)

Program Office: 4235A 269 Campus Drive
Mail Code: 94305-5173
Phone: (650) 723-6198
Email: dalima@stanford.edu
Web Site: <http://stanford.edu/group/cancerbio>

Participating Departments And Faculty:

Biochemistry: Patrick O. Brown (Professor)
Bioengineering: Jennifer Cochran (Assistant Professor)
Biology (School of Humanities and Sciences): William Burkholder (Assistant Professor), Martha Cyert (Professor), Guowei Fang (Assistant Professor), Judith Frydman (Associate Professor), Or Gozani (Assistant Professor), W. James Nelson (Professor), Virginia Walbot (Professor), Tim Stearns (Professor)
Chemical And Systems Biology: James K. Chen (Assistant Professor), Karlene Cimprich (Associate Professor), James E. Ferrell (Professor)
Dermatology: Howard Y. Chang (Associate Professor), Paul A. Khavari (Professor), M. Peter Marinkovich (Associate Professor), Anthony Oro (Associate Professor)
Developmental Biology: Roeland Nusse (Professor), Matthew Scott (Professor)
Genetics: Anne Brunet (Assistant Professor), Michele Calos (Professor), Stanley Cohen (Professor)
Medicine/Cardiovascular Medicine: Ching-pin Chang (Assistant Professor)
Medicine/Endocrinology/Gerontology/Metabolism: Katrin Chua (Assistant Professor), Andrew R. Hoffman (Professor)
Medicine/Gastroenterology and Hepatology: Christine Cartwright (Professor), Anson Lowe (Assistant Professor)
Medicine/Hematology: Steven Artandi (Associate Professor), Calvin Kuo (Associate Professor), Ravindra Majeti (Assistant Professor)
Medicine/Oncology: Gilbert Chu (Professor), Dean Felsher (Associate Professor), James Ford (Associate Professor), Ronald Levy (Professor), Beverly S. Mitchell (Professor; Director, Stanford Cancer Center)
Medicine/Pulmonary and Critical Care Medicine: Glenn Rosen (Associate Professor)
Microbiology and Immunology: Helen M. Blau (Professor)
Neurology and Neurological Sciences: Thomas Rando (Professor)
Neurosurgery: Albert J. Wong (Professor)
Otolaryngology: John Sunwoo (Assistant Professor)
Pathology: Jeff Axelrod (Associate Professor), Matthew Bogoy (Associate Professor), Michael Cleary (Professor), Gerald Crabtree (Professor), Edgar Engleman (Professor), Andrew Fire (Professor), Isabella Graef (Assistant Professor), Joseph Lipsick (Professor), Bingwei Lu (Assistant Professor), Jonathan Pollack (Associate Professor), Irving Weissman (Professor; Director, Stanford University School of Medicine Institute of Stem Cell Biology and Regenerative Medicine), Marius Wernig (Assistant Professor)
Pediatrics/Cancer Biology: Julien Sage (Assistant Professor), Alexandro Sweet-Cordero (Assistant Professor)
Pediatrics/Cardiology: Marlene Rabinovitch (Professor)
Radiation Oncology/Radiation Biology: Laura Attardi (Associate Professor), J. Martin Brown (Professor), Nicholas Denko (Assistant Professor), Amato Giaccia (Professor; Director, Stanford University Cancer Biology Program)
Radiation Oncology/Radiation Physics: Edward Graves (Assistant Professor)

Radiation Oncology/Radiation Therapy: Susan Knox (Associate Professor), Albert Koong (Assistant Professor), Quynh-Thu Le (Professor)

Radiology/Diagnostic Radiology: Samira Guccione (Assistant Professor, Research), Jianghong Rao (Assistant Professor)

Structural Biology: William Weis (Professor)

Urology: Donna Peehl (Professor, Research), Zijie Sun (Associate Professor)

Courses offered by the Cancer Biology Program are listed under the subject code CBIO on the *Stanford Bulletin's* Explore-Courses web site.

The Cancer Biology Program at Stanford University is an interdisciplinary program leading to the Ph.D. degree. During the past three decades, understanding of cancer has increased with the discovery of oncogenes, tumor suppressor genes, pathways of DNA damage and repair, chromatin remodeling, cell cycle regulation, angiogenesis and responses to hypoxia, and recent glimpses into the molecular basis of metastasis and cancer stem cell biology. 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 resulted in the first successful cancer chemotherapies and immunotherapies based on the knowledge of specific molecular targets. Stanford presents a unique environment to pursue interdisciplinary cancer research because the schools of Medicine, Humanities and Sciences, and Engineering are located on a single campus.

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

Students are not limited to a single department in choosing their research adviser. The Cancer Biology Ph.D. program currently has approximately 60 graduate students located in basic science and clinical departments throughout the School of Medicine and the School of Humanities and Sciences.

DOCTOR OF PHILOSOPHY IN CANCER BIOLOGY

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

A small number of 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 complete a minimum of three, one quarter laboratory rotations. Students must choose a dissertation adviser prior to the end of Summer Quarter, first year, but not before the end of Spring Quarter, first year.

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

1. Training in biology equivalent to that of an undergraduate biology major at Stanford.
2. Completion of the following courses:
 - a. CBIO 241. Molecular, Cellular, and Genetic Basis of Cancer
 - b. GENE 203. Advanced Genetics
 - c. BIO 214. Cell Biology of Physiological Processes

- d. CSB 210. Signal Transduction Pathways and Networks. Students can take GENE 211, Genomics, or SBIO 214, Biological Macromolecules, in lieu of CSB 210.
 - 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 consent, may be audited.
3. At least 6 units of additional cancer biology-related, graduate-level courses. Course work taken is determined in consultation with the student's adviser and/or the Program Director.
 4. Presentation of research results at the annual Cancer Biology Conference on at least three occasions, at least one being an oral presentation.
 5. Completion of a qualifying examination in Cancer Biology is required for admission to Ph.D. candidacy. The exam consists of an NIH-style written grant proposal not to exceed ten pages (excluding references), and an oral examination. The examining committee consists of three faculty members from the Cancer Biology Program and does not include the student's dissertation adviser. The composition of this committee is chosen by the student and dissertation adviser and must be submitted to and approved by the program director prior to the end of Autumn Quarter, second year. The qualifying examination must be taken prior to the end of Spring Quarter, second year. If necessary, one retake is permitted prior to the end of Summer Quarter, second year. After the qualifying examination has been completed, the student is required to form a dissertation reading committee that includes the student's adviser and three other members of the Academic Council with appropriate expertise. Each student is required to arrange annual meetings (more frequently, if necessary) of the dissertation reading committee, at which time oral presentations of progress during the past year and a plan of study for the coming year are presented and discussed. Completion of each annual committee meeting must be communicated in writing to the program director by the adviser by the end of Spring Quarter each year.

The major accomplishment of each successful Ph.D. student is the presentation of a written dissertation resulting from independent investigation that contributes to knowledge in the area of cancer biology. An oral examination is also required for the Ph.D. degree. In the Cancer Biology Program, a public seminar (one hour) is presented by the Ph.D. candidate, followed by a closed-door oral examination. The oral examination committee consists of at least four examiners (the members of the doctoral dissertation reading committee) and a chair. The oral examination chair may not have a full or joint appointment in the adviser's or student's home department. However, a courtesy appointment does not affect eligibility. The oral examination chair may be from the same department as any other member(s) of the examination committee. All members of the oral examination committee are normally members of the Academic Council, as the oral examination chair must be. With the prior approval of the program director or school dean, one of the examiners may be a person who is not a member of the Academic Council if that individual contributes expertise not otherwise available. Official responsibility for selecting the oral examination chair rests with the program. Cancer Biology delegates this to the student and dissertation adviser.

CHEMICAL AND SYSTEMS BIOLOGY

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

Chair: James E. Ferrell, Jr.

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

Associate Professors: Karlene A. Cimprich, Thomas J. Wandless
Assistant Professors: James K. Chen, Joshua Elias, Joanna K. Wysocka

Courtesy Professors: Stuart Kim, Beverly S. Mitchell, Paul A. Wender

Courtesy Associate Professors: Calvin J. Kuo, Matthew Bogoy

Courtesy Assistant Professors: Marcus Covert, Jan M. Skotheim

Web Site: <http://casb.stanford.edu>

Courses offered by the Department of Chemical and Systems Biology are listed under the subject code CSB on the *Stanford Bulletin's* ExploreCourses web site.

In Autumn of 2006, the Department of Molecular Pharmacology changed its name to become the Department of Chemical and Systems Biology. The department has established a new Ph.D. program in Chemical and Systems Biology. Molecular Pharmacology Ph.D. students who enrolled prior to Autumn 2007 have the option of receiving their Ph.D. in either Molecular Pharmacology or Chemical and Systems Biology. Ph.D. students matriculating in Autumn 2007 and thereafter are admitted to Chemical and Systems Biology. Further details about degree requirements are available from the department.

MASTER OF SCIENCE IN CHEMICAL AND SYSTEMS BIOLOGY

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 IN CHEMICAL AND SYSTEMS BIOLOGY

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

The Department of Chemical and Systems Biology offers interdisciplinary training to prepare students for independent careers in biomedical science. The main focus of the program is cell signaling, chemical biology, and systems biology.

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

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

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

COMPARATIVE MEDICINE

Chair: Sherril Green

Professors: Donna M. Bouley, Linda C. Cork, Sherril Green

Associate Professors: Paul Buckmaster, Corinna Darian-Smith, Shaul Hestrin

Assistant Professors: Megan Albertelli, Stephen Felt, Claude Nagamine

Department Offices: Edwards Building, Room R321

Mail Code: 94305-5342

Phone: (650) 498-5080

Web Site: <http://med.stanford.edu/compmed>

Courses offered by the Department of Comparative Medicine are listed under the subject code COMPMED on the *Stanford Bulletin's* ExploreCourses web site.

The Department of Comparative Medicine is a clinical department that offers residency training in laboratory animal medicine for veterinarians, although it does not offer degrees. Its faculty offer courses at the undergraduate and graduate levels and participate in teaching in other departments. Both clinical faculty members, who are board-certified specialists in a veterinary medical specialty, and basic science faculty accept students to participate in ongoing research projects within the department and assist students with special research projects.

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

DEVELOPMENTAL BIOLOGY

Emeriti: (Professors) David S. Hogness, A. Dale Kaiser

Chair: Roeland Nusse

Associate Chair: Lucy Shapiro

Professors: Ben Barres, Philip Beachy, Gerald Crabtree, Margaret Fuller, Stuart Kim, David Kingsley, Roeland Nusse, Matthew Scott, Lucy Shapiro, James Spudich, William Talbot, Anne Villeneuve, Irving Weissman

Associate Professor: Seung Kim

Assistant Professors: Gill Bejerano, Joanna Wysocka

Professor (Teaching): Ellen Porzig

Professor (Research): Harley McAdams

Courses offered by the Department of Development Biology are listed under the subject code DBIO on the *Stanford Bulletin's* ExploreCourses web site.

A fundamental problem in biology is how the complex set of multicellular structures that characterize an adult animal is generated from the fertilized egg. Recent 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 develop-

mental biology draws on biochemistry, cell biology, genetics, molecular biology, and genomics. People in the department have a major interest in regenerative medicine and stem cell biology.

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

MASTER OF SCIENCE IN DEVELOPMENTAL BIOLOGY

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

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 IN DEVELOPMENTAL BIOLOGY

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 (MSTP) in which individuals are candidates for both the M.D. and Ph.D. degrees.

Students are required to 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 expected to attend Developmental Biology seminars and journal clubs.

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 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 pass the University oral examination, taken only after the student has substantially completed 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.

GENETICS

Emeritus: (Professor) Leonard Herzenberg

Chair: Michael Snyder

Professors: Russ Altman, Gregory Barsh, Michele Calos, Stanley Cohen, Ronald Davis, Andrew Fire, Uta Francke, Margaret Fuller, Mark Kay, Stuart Kim, Joseph Lipsick, John Pringle, Matthew Scott, Tim Stearns

Associate Professors: Laura Attardi, Julie Baker, James Ford, Arend Sidow, Zijie Sun, Anne Villeneuve, Douglas Vollrath

Assistant Professors: Anne Brunet, Julien Sage, Man-Wah Tan, Hua Tang

Professor (Research): Leonore Herzenberg

Associate Professor (Research): J. Michael Cherry

Associate Professor (Teaching): Kelly Ormond

Assistant Professor (Research): Gavin Sherlock

Courtesy Professor: Hank Greely

Mail Code: 94305-5120

Phone: (650) 723-3335

Email: genetics-info@genome.stanford.edu

Web Site: <http://genetics.stanford.edu>

Courses offered by the Department of Genetics are listed under the subject code GENE on the *Stanford Bulletin's* ExploreCourses web site.

MASTER OF SCIENCE IN HUMAN GENETICS AND GENETIC COUNSELING

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

The Department of Genetics offers an M.S. in Human Genetics and Genetic Counseling, which is accredited by the American Board of Genetic Counseling. This program prepares students to practice in the healthcare profession of genetic counseling. The program is a full time two-year program, and accepts students to begin the program only in Autumn Quarter. Students must be admitted directly into this program, and cannot automatically transfer from the Ph.D. programs within the department, or vice versa. While courses are oriented primarily towards genetic counseling students, they may also be taken by medical students, other graduate students, residents or post-doctoral fellows, and (with permission) undergraduates.

The degree requires the completion of clinical rotations and an approved research project. Students must also complete required course work (GENE 271-286), several additional required courses (MED 250A, MED 255, DBIO 201, and GENE 238), and are encouraged to take 3-4 elective courses of their choice, including a research methods elective. Faculty members include members of the Stanford faculty from Genetics, Pediatrics, Obstetrics, Pathology, Developmental Biology, Biomedical Ethics, Law, and Psychology, and practicing genetic counselors and clinical geneticists in various medical centers across the Bay Area.

Applications are due in December (see web site) for admission in the following Autumn Quarter. Applicants should demonstrate a combination of academic preparation, exposure to genetic counseling, and counseling and/or laboratory experiences. Exposure to persons with disabilities or chronic illness is also helpful. Additional information about the program is available at <http://www.med.stanford.edu/genetic-counseling>.

DOCTOR OF PHILOSOPHY IN GENETICS

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

The Ph.D. program in the Department of Genetics offers graduate students the opportunity to pursue a discipline that encompasses both a set of tools and a coherent way of thinking about biology and medicine. All major areas of genetics are represented in the department, including human genetics (molecular identification of Mendelian traits and the pathophysiology of genetic disease, gene therapy, genetic epidemiology, analysis of complex traits, and human evolution), and application of model organisms such as bacteria, yeast, flies, worms, or mice to basic questions in biomedical research. The department is especially strong in genomic and bioinformatic approaches to genome biology and evolution, and includes several genome-scale databases such as the *Saccharomyces Genome Database* (SGD), the *Stanford Microarray Database* (SMD), and the *Pharmacogenetics and Pharmacogenomics Knowledge Base* (PharmGKB) and, administered through the Department of Biochemistry, the *Stanford Genome Technology Center* (SGTC).

Exposure to the intellectual scope of the department is provided by laboratory rotations, dissertation research, advanced courses in genetics and other areas of biomedical science, seminar series, journal clubs, and an annual three-day retreat of faculty, students, postdoctoral fellows, and staff scientists. Emphasis is placed on interactions and collaborations among students, postdoctoral stu-

dents, and faculty within the department and throughout the campus.

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

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

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

Students who have recently received a bachelor's, master's, M.D., or Ph.D. degree in related fields may apply for graduate study. Prospective students must have a background in 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 and the department's interest in promoting a diverse learning environment. Interviews take place in late February or early March and successful applicants are offered admission by early spring. Students who wish to pursue a combined M.D./Ph.D. degree are considered for admission into the graduate program in the department after they have been admitted to the M.D. program in the School of Medicine.

Students begin graduate studies in Autumn Quarter. Prospective students are encouraged to start the application process early to ensure that they are able to submit a complete application by the December deadline. All students accepted into the Ph.D. program in the Department of Genetics are provided with full tuition and a stipend. Two training grants from the National Institutes of Health provide major support for the graduate training program in the department. Other student support is provided by departmental funds and from research grants, both federal and private, of the faculty. In addition, a number of graduate students are funded by fellowships, including those from the National Science Foundation and the Stanford Graduate Fellows program.

HEALTH RESEARCH AND POLICY

Emeriti (Professors) Dan Bloch, John Farquhar, Victor R. Fuchs

Chair: Phil Lavori

Co-Chair: Robert Tibshirani

Professors: Laurence Baker, Bradley Efron, Trevor Hastie, Victor W. Henderson, Mark Hlatky, Iain M. Johnstone, Abby C. King, Philip W. Lavori, Ying Lu, Richard A. Olshen, Julie Parsonnet, Robert Tibshirani, Alice S. Whittemore, Dee W. West, Wing Wong

Associate Professor: Lorene M. Nelson, Chiara Sabatti

Assistant Professors: M. Kate Bundorf, Marc Coram, Allison Kuriyan, Mei-Chiung Shih, Weiva Sieh, Lu Tian

Assistant Professors (Clinical): Rita Popat, Kristin Sainani

Courtesy Professors: Stephen P. Fortmann, Alan M. Garber, Mary Goldstein, Daniel Kessler, Alex Macario, Yvonne Maldonado, Douglas Owens, Paul Wise

Courtesy Associate Professors: Jay Bhattacharya, Michael K. Gould, Paul Heidenreich, David R. Rogosa

Courtesy Assistant Professors: Grant Miller

Senior Lecturer: Irene Corso

Lecturers: Raymond Balise, Scarlett Gomez, Laurel Habel, De Kun Li, David Lilienfeld, Cynthia O'Malley, Caroline Tanner, Stephen Van Den Eeden

Consulting Professors: Gary Friedman, Elizabeth Holly, Marion Lee, George Lundberg, Peggy Reynolds, Joseph Selby

Consulting Associate Professors: Paul Barnett, Sally Glaser, Pamela Horn-Ross, Esther John, Ciaran Phibbs

Consulting Assistant Professors: Ellen Chang, Christina Clarke-Dur, Theresa Keegan, Bang Nguyen, Ingrid Oakley-Girvan, Rudy Rull, Todd Wagner

Mail Code: 94305-5405

Phone: (650) 723-5456

Web Site: <http://hrp.stanford.edu>

Courses offered by the Department of Health Research and Policy are listed under the subject code HRP on the *Stanford Bulletin's* ExploreCourses web site.

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

1. Biostatistics deals with scientific methodology in the medical sciences, emphasizing the use of statistical techniques.
2. Epidemiology is the study of the distribution and determinants of illness and impairment in human populations. Epidemiology training provides analytic tools for clinical and translational research, including studies of disease etiology, prevention, and therapy.
3. Health Services Research is concerned with many aspects of health policy analysis in the public and private sectors

GRADUATE PROGRAMS IN HEALTH RESEARCH POLICY

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

For additional information, address inquiries to the Educational Coordinator, Department of Health Research and Policy, Stanford University School of Medicine, HRP Redwood Building, Room T138C, Stanford, California 94305-5405.

HEALTH SERVICES RESEARCH

Director: Mark Hlatky (Professor, Health Research and Policy, and Medicine)

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

Participating Faculty and Staff by Department:

Anesthesia: Alex Macario (Professor)

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

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

Law: Henry Greely (Professor)

Management Science and Engineering: Margaret Brandeau (Professor)

Medicine: Jay Bhattacharya (Assistant Professor), Jeremy Goldhaber-Fiebert (Assistant Professor), Alan Garber (Professor), Mary Goldstein (Professor), Michael Gould (Associate Profes-

or), Paul Heidenreich (Associate Professor), Mark Hlatky (Professor), Grant Miller (Assistant Professor), Douglas Owens (Professor)

Pediatrics: Paul Wise (Professor)

Psychiatry: Rudolph Moos (Professor)

Sociology: Richard Scott (Professor, emeritus)

Program Offices: HRP Redwood Building, Room T138C

Mail Code: 94305-5405

Phone: (650) 723-5456

Email: hsr-program@med.stanford.edu

Web Site: <http://med.stanford.edu/hsr>

MASTER OF SCIENCE IN HEALTH SERVICES RESEARCH

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

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

1. At least 8 units from the following group of Health Research and Policy (HRP) core courses: HRP 256, Economics of Health and Medical Care; HRP 391, Health Care Regulation; HRP 392, Analysis of Costs, Risks, and Benefits in Health Care.
2. At least 6 units of graduate-level statistics courses. The sequence of HRP 261, Intermediate Biostatistics: Analysis of Discrete Data; and HRP 262, Intermediate Biostatistics: Regression, Prediction, Survival Analysis, is strongly recommended.
3. At least 3 units of HRP 283, Health Services Research Core Seminar.
4. At least 15 units of HRP research credit from HRP 299, Directed Reading, or HRP 399, Research.
5. An additional set of approved elective courses to complete the program total of at least 45 units.

For additional information, address inquiries to the Educational Coordinator, Department of Health Research and Policy, Stanford University School of Medicine, HRP Redwood Building, Room T138C, Stanford, California 94305-5405.

EPIDEMIOLOGY

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

Core Faculty and Academic Teaching Staff: Raymond R. Balise (Lecturer, Health Research and Policy), Gary D. Friedman (Consulting Professor, Health Research and Policy), Victor W. Henderson (Professor, Health Research and Policy, and Neurology and Neurological Sciences), Abby C. King (Professor, Health Research and Policy, and Medicine), Allison Kurian (Assistant Professor, Medicine, and Health Research and Policy), Philip Lavori (Professor, Health Research and Policy), Yvonne A. Maldonado (Professor, Pediatrics), Lorene M. Nelson (Associate Professor, Health Research and Policy), Julie Parsonnet (Professor, Medicine, and Health Research and Policy), Rita A. Popat (Clinical Assistant Professor, Health Research and Policy), Kristin L. Sainani (Clinical Assistant Pro-

fessor, Health Research and Policy), Weiva Sieh (Assistant Professor, Health Research and Policy), Dee W. West (Professor, Health Research and Policy), Alice S. Whittemore (Professor, Health Research and Policy)

Program Offices: HRP Redwood Building, Room T138C

Mail Code: 94305-5405

Phone: (650) 723-5456

Email: epiprogram@med.stanford.edu

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

MASTER OF SCIENCE IN EPIDEMIOLOGY

The Graduate Program in Epidemiology offers instruction and interdisciplinary research opportunities leading to the M.S. degree in Epidemiology. Epidemiology is the study of the distribution and determinants of illness and impairment in human populations. It is important in its own right, and epidemiologic methods are used by clinical investigators and by other scientists who conduct observational and experimental research on the identification, prevention, and treatment of human disorders.

Core and affiliated faculty come from the Department of Health Research and Policy; other Stanford University departments, and notable Bay Area research facilities. The Program has particular strengths in cancer epidemiology, cardiovascular disease epidemiology, infectious disease epidemiology, musculoskeletal disease epidemiology, neuroepidemiology, and aspects of epidemiologic methods, genetic epidemiology, and reproductive epidemiology and women's health.

The mission of the Stanford University School of Medicine is to be a premier research-intensive medical school that improves health through leadership and collaborative discoveries and innovation in patient care, education and research. With support from a NIH Clinical and Translational Science Award, the graduate program in Epidemiology fosters this mission through the training of physician investigators in techniques of clinical research. We also consider students from other disciplines who would benefit from formal training in epidemiologic methods.

A typical student has the M.D. degree and is in the fellowship stage of his or her postgraduate training, or in an early stage of faculty development. Other students may not have prior clinical training. These may include behavioral, social, and life scientists; law students; and students with the baccalaureate degree. They may wish to bring an epidemiologic orientation to their research or practice, or they may be considering careers in epidemiology or a related discipline.

To receive the M.S. degree, students are expected to obtain a grounding in epidemiologic methods and applied biostatistics and to demonstrate research skills through the completion of a thesis. Students must complete at least 45 units of course work:

1. Epidemiologic methods: HRP 225, Design and Conduct of Clinical and Epidemiologic Studies; HRP 226, Advanced Epidemiologic and Clinical Research Methods; HRP 251, Design and Conduct of Clinical Trials.
2. Biostatistics: HRP 259, Introduction to Probability and Statistics for Epidemiology; HRP 261, Intermediate Biostatistics: Analysis of Discrete Data; HRP 262, Intermediate Biostatistics: Regression, Prediction, Survival Analysis.
3. Research seminars: HRP 236, Epidemiology Research Seminar (at least 3 units).
4. Research: HRP 399, Master thesis (at least 12 units).
5. Research conduct: Students must complete MED 255, Responsible Conduct of Research, and attend a Human Subjects Institutional Review Board meeting.
6. Additional approved selective and elective courses to complete the program total of at least 45 units.

Students are assigned a methodology mentor from the Department of Health Research and Policy, and they also select a research mentor, who may be from another department. For physicians, the research mentor is often an affiliated faculty member from the department of the student's clinical specialty.

University requirements for the M.S. degree are described in the "Graduate Degrees" section of this bulletin. Other programmatic requirements are in *Graduate Program in Epidemiology, Information and Guidelines*, available from the educational coordinator in the Department of Health Research and Policy.

IMMUNOLOGY

Chair, Executive Committee for the Immunology Program: Lawrence Steinman (Professor, Neurology and Neurological Sciences)

Director for Immunology Program: Olivia Martinez (Professor, Research, Surgery, Transplantation)

Director for Clinical Immunology Program: C. Garrison Fathman (Medicine/Immunology and Rheumatology)

Participating Departments and Faculty:

Biology: Patricia P. Jones (Professor)

Chemistry: Harden M. McConnell (Professor, emeritus)*

Developmental Biology: Irving L. Weissman (Professor, Biology)

Genetics: Leonore A. Herzenberg (Professor, Research), Leonard A. Herzenberg (Professor, emeritus), Man-wah Tan (Assistant Professor)

Medical Informatics: Atul Butte (Assistant Professor, Pediatrics and Computer Science)

Medicine/Bone Marrow Transplantation Program: Robert Negrin (Professor), David Miklos (Assistant Professor), Judith Shizuru (Associate Professor)

Medicine/Endocrinology, Gerontology and Metabolism: Ajay Chawla (Assistant Professor)

Medicine/Hematology: Calvin Kuo (Associate Professor), Peter Lee (Associate Professor), Ravi Majeti (Assistant Professor)

Medicine/Immunology and Rheumatology: C. Garrison Fathman (Professor), William Robinson (Assistant Professor), Samuel Strober (Professor), Paul J. Utz (Associate Professor)

Medicine/Oncology: Gilbert Chu (Professor, and Biochemistry), Dean Felsher (Associate Professor, and Pathology), Ronald Levy (Professor), Shoshana Levy (Professor, Research)

Medicine/Pulmonary and Critical Care Medicine: Mark Nicolls (Associate Professor)

Microbiology and Immunology: John Boothroyd (Professor), Chang-Zheng Chen (Assistant Professor), Yueh-Hsiu Chien (Professor), Mark M. Davis (Professor), Hugh McDevitt (Professor), Garry P. Nolan (Professor), David Schneider (Associate Professor)

Molecular and Cellular Physiology: K. Christopher Garcia (Professor, and Structural Biology), Richard S. Lewis (Professor)

Neurology and Neurological Sciences: Lawrence Steinman (Professor, and Pediatrics), Tony Wyss-Coray (Associate Professor, Research)

Neurosurgery: Theo Palmer (Associate Professor)

Pathology: Eugene C. Butcher (Professor), Michael Cleary (Professor), Gerald R. Crabtree (Professor, and Developmental Biology), Edgar G. Engleman (Professor, and Medicine/Immunology and Rheumatology), Magali Fontaine (Assistant Professor), Stephen Galli (Professor), Sara Michie (Professor), Raymond A. Sobel (Professor)

Pediatrics: Ann Arvin (Professor, and Microbiology and Immunology), Christopher Contag (Associate Professor, Research, and Microbiology and Immunology, and Radiology), David B. Lewis (Professor), Elizabeth Mellins (Associate Professor), Kari Nadeau (Assistant Professor), Minnie Sarwal (Professor)

Psychiatry and Behavioral Sciences: Firdaus Dhabhar (Associate Professor), Emmanuel Mignot (Professor)

Structural Biology: Peter Parham (Professor, and Microbiology and Immunology)

Surgery: Sheri Krams (Associate Professor, Research), Olivia Martinez (Professor, Research)

* Recalled to active duty

Mail Code: 94305-5173

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Web Site: <http://immunol.stanford.edu>

Courses offered by the Immunology Program are listed under the subject code IMMUNOL on the *Stanford Bulletin's* Explore-Courses web site.

MASTER OF SCIENCE IN IMMUNOLOGY

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

1. Three full-tuition quarters of residency as a graduate student at Stanford.
2. At least 45 units of academic work, all of which must be in courses at or above the 100 level, 36 units of which must be at or above the 200 level.
3. 2-3 quarters of graduate research (IMMUNOL 399), consisting of rotations in the labs of three faculty members.
4. Course work in Immunology as follows: basic Immunology (for graduate students, BIO 230A, Molecular and Cellular Immunology Literature Review, and for medical students, IMMUNOL 205, Immunology in Human Health and Disease or equivalent), advanced Immunology such as IMMUNOL 201, 202, and 203. In addition, the student may take one elective course. Some possible electives are: MPHA 210, Signal Transduction Pathways and Networks; SBIO 241, Biological Macromolecules; CBIO 241, Molecular, Cellular, and Genetic Basis of Cancer; or DBIO 210, Developmental Biology. Other required core courses are: GENE 203, Advanced Genetics; IMMUNOL 215, Principles of Biological Technologies; BIO 214, Advanced Cell Biology.
5. Graduate-level biochemistry and molecular biology (BIOC 187 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 Immunology seminar series and at the annual Stanford Immunology Scientific Conference.
8. The qualifying examination process in Immunology before admission to Ph.D. candidacy has two parts: a comprehensive written exam on many fields in immunology, (qualifying examination process, Part I), in the third week in June, first year; the thesis proposal (qualifying examination process, Part II), before December 17th, second year. In addition, an oral presentation is required on the research of one rotation, early July in the first year.
9. Students must submit a master's thesis paper on one of their rotations. This requirement may be waived under special circumstances.

DOCTOR OF PHILOSOPHY IN IMMUNOLOGY

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

The Immunology Program offers instruction and research opportunities leading to a Ph.D. in Immunology. The goal of the program is to develop investigators who have a solid foundation in Immunology and related sciences to carry out innovative research. The program features a flexible choice of courses and seminars combined with extensive research training in the laboratories of 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 1st. Applications are evaluated by the Immunology predoctoral committee based upon: GRE scores; grades; evidence of research experience; letters of recommendation, including letters from research sponsor(s); and commitment to a career in bio-

medical research. Subject tests are not required. Interested Stanford medical students are welcome to apply to the program and should submit a formal application by December 1st.

Students admitted to the program are offered financial support covering tuition, a living stipend, insurance coverage, and an allowance for books/travel. Applicants are urged to apply for independent fellowships such as from the National Science Foundation. Fellowship applications are due in November of the year prior to matriculation in the graduate program, but Immunology graduate students may continue to apply for outside fellowships after matriculation. Because of the small number of department-funded slots, students who have been awarded an outside fellowship have an improved chance of acceptance into the program. On matriculation, each student is assisted by a first-year advising committee 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 the dissertation adviser and two additional Immunology faculty, 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 135 units of graduate course work and research. At least 3 units must be taken with each of four different Stanford faculty members.

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

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 (BIO 230A, Molecular and Cellular Immunology Literature Review)
 - b. Advanced Immunology (IMMUNOL 201, 202, 203)
 - c. Chemistry of Biological Processes (BIOC 220 or CSB 220)
 - d. Advanced Genetics (GENE 203)
 - e. Advanced Cell Biology (BIO 214)
 - f. Biostatistics (BIO 141 or STATS 141)
 - g. Principles of Biological Technologies (IMMUNOL 215)
 - h. One elective course; suggested courses include: MPHA 210, Signal Transduction Pathways and Networks; SBIO 241, Biological Macromolecules; CBIO 241, Cancer Biology; DBIO 210, Developmental Biology.
 - i. Responsible Conduct in Science (MED 255)
 - j. Immunology Journal Club (IMMUNOL 305)
3. First-year students are required to take both the IMMUNOL 311, Seminar in Immunology, and the companion course, IMMUNOL 311A, Seminar Discussion in Immunology, and participate in IMMUNOL 305, Immunology Journal Club. Students in their second year and above must participate in the IMMUNOL 311, Seminar in Immunology and may opt to take the companion course, IMMUNOL 311A. Students who have not yet achieved TGR status must register for 1 unit for IMMUNOL 311. Students attend the Immunology Seminar Series (12:00pm, Tuesdays). Students read the papers of visiting seminar speakers and meet to discuss the material in Seminar Discussion, IMMUNOL 311A.
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 comprehensive written examination (part 1 of the qualifying examination process) at the end of June, students, including MSTP and M.D./Ph.D. students, present their lab rotation research projects to the predoctoral committee. Medical students who are accepted into the Ph.D. program must do at least three rotations.
6. Teaching assistantship in two Immunology courses (IMMUNOL 290, Teaching in Immunology). A teaching assistantship requirement may be fulfilled by proposing a graduate student-initiated course: IMMUNOL 315, Topics in Immunology. Be-

fore fulfilling their teaching assistantships, Immunology graduate students are required to attend a teaching assistantship orientation offered at the beginning of every quarter by the Center for Teaching and Learning. MSTP students may submit one of their medical school TAs as partial fulfillment of the TA requirement for the Ph.D. in Immunology.

7. For admission to Ph.D. candidacy, a comprehensive written examination (qualifying examination process, Part I) in Immunology and related biomedical sciences, and a rotation presentation on one of three lab rotations, must be completed satisfactorily by the middle of Summer Quarter of the first year. Students must prepare and defend a research proposal on their dissertation research (qualifying examination process, Part II) by December 17th, the end of Autumn Quarter of their second year, and complete all core course requirements by the end of the second year. Administration and evaluation of these requirements leading to Ph.D. candidacy is the responsibility of the Predoctoral Committee; the student's dissertation committee is responsible for advising the student through the research and other courses as needed towards the completion of the Ph.D. dissertation.
8. Participation (through regular attendance and oral presentation) in the student-run Immunology journal clubs for at least the first three years (IMMUNOL 305), the Tuesday Immunology seminars, and the annual Stanford Immunology Scientific Conference. Students are required to give one poster and one scientific presentation at these annual Stanford Immunology scientific conferences. Fourth year and above students present their current research to fellow students and faculty in a monthly forum.
9. Passing 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.

MICROBIOLOGY AND IMMUNOLOGY

Emeriti: (Professors) Hugh O. McDevitt, Edward S. Mocarski, Sidney Raffel, Leon T. Rosenberg

Chair: Karla Kirkegaard

Associate Chair: Stanley Falkow

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, Garry Nolan, Peter Parham, Phillip Pizzo, Charles Prober, David Relman, Peter Sarnow, Gary K. Schoolnik, Lucy S. Tompkins

Associate Professors: Matthew Bogyo, Christopher Contag, David Schneider, Julie Theriot

Assistant Professors: Manuel Amieva, Chang-Zheng Chen, Denise Monack, Upinder Singh, Justin Sonnenburg, Man-Wah Tan

Associate Professor (Teaching): Robert D. Siegel

Department Offices: D300 Fairchild Building, 299 Campus Drive

Mail Code: 94305-5124

Phone: (650) 725-8541

Email: micro_immuno@lists.stanford.edu

Web Site: <http://microimmuno.stanford.edu>

Courses offered by the Department of Microbiology and Immunology are listed under the subject code MI on the *Stanford Bulletin's* ExploreCourses web site.

GRADUATE PROGRAMS IN MICROBIOLOGY AND IMMUNOLOGY

The Department of Microbiology and Immunology offers a 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. 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.

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 IN MICROBIOLOGY AND IMMUNOLOGY

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 1.

Applicants must file a report of scores on the general subject tests 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 Graduate Fellowship. Successful applicants have been competitive for predoctoral fellowships such as those from the National Science Foundation.

Program for Graduate Study—The Ph.D. degree requires course work and independent research demonstrating an individual's creative, scholastic, and intellectual abilities. On entering the department, students meet an advisory faculty member; 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 are requirements of the department: MI 215, Principles of Biological Techniques; MI 230, Medical Microbiology and Infectious Diseases; and MI 210, Advanced Pathogenesis of Bacteria, Viruses, and Eukaryotic Parasites. Three courses are part of the core curriculum that is required of many graduate students in Stanford Biosciences: BIO 203 /DBIO 203 /GENE 203, Advanced Genetics; BIO 230, Molecular and Cellular Immunology; and BIO 214/BIOC 224, Advanced Cell Biology.

In Autumn Quarter of the second year, a research proposal based on the student's own thesis topic is defended to the thesis committee. In Spring Quarter of the second year, each student defends orally a formal research proposal on a topic outside the intended thesis project. This qualifying examination proposal is due to the graduate program steering committee by May 1. Based on successful performance on this proposal, the student is admitted to candidacy. Teaching experience and training are also part of the graduate curriculum. Graduate students are required to act as

teaching assistants for two courses. In addition, first- and second-year graduate students are required to participate in a bi-weekly journal club.

MOLECULAR AND CELLULAR PHYSIOLOGY

Chair: Brian K. Kobilka

Professors: Axel T. Brunger, Brian K. Kobilka, Richard S. Lewis, W. James Nelson, Stephen J. Smith, Thomas C. Sudhof, Richard W. Tsien, William Weis

Associate Professors: Christopher Garcia, John Huguenard, V. Daniel Madison, Merritt C. Maduke, Miriam B. Goodman

Assistant Professors: Maxence V. Nachury

Courtesy Associate Professors: Stefan Heller, Anthony J. Ricci

Courtesy Assistant Professor: Richard J. Reimer

Department Offices: Beckman Center, B100

Mail Code: 94305-5345

Phone: (650) 725-7554

Email: schantae@stanford.edu

Web Site: <http://mcp.stanford.edu>

Courses offered by the Department of Molecular and Cellular Physiology are listed under the subject code MCP on the *Stanford Bulletin's* ExploreCourses web site.

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 IN MOLECULAR AND CELLULAR PHYSIOLOGY

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 IN MOLECULAR AND CELLULAR PHYSIOLOGY

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.

Study toward the Ph.D. is expected to occupy five years, including summers. A minimum of six quarter-long courses is required. These include four graduate-level courses (200-300 series) and a choice of two out of these three courses: MCP 221, MCP 258, 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. Grades for 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 Madison, 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 such as NIH and NSF.

NEUROBIOLOGY

Emeritus: Denis Baylor, Uel J. McMahan, Eric Shooter, Lubert Stryer

Chair: Ben Barres

Professors: Eric I. Knudsen, William T. Newsome

Associate Professors: Thomas Clandinin, Jennifer Raymond

Assistant Professors: Stephen Baccus, Ricardo Dolmetsch, Tirin Moore

Department Offices: Fairchild Building, Second Floor

Mail Code: 94305-5125

Web Site: <http://neurobiology.stanford.edu>

Courses offered by the Department of Neurobiology are listed under the subject code NBIO on the *Stanford Bulletin's* ExploreCourses web site.

GRADUATE PROGRAM IN NEUROBIOLOGY

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 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 information processing in vertebrate retina; structure, function, and development of auditory and visual systems; development and regenera-

tion in the central and peripheral nervous system; neural mechanisms mediating higher nervous system functions, including perception, learning, attention and decision making.

NEUROSCIENCES

Director: John R. Huguenard (Professor, Neurology and Neurological Sciences)

Committee: Katrin Andreasson, Thomas Clandinin, Luis de Lecea, Craig Garner, Miriam Goodman, John R. Huguenard, Jennifer Raymond, Carla Shatz, Kang Shen, Anthony Wagner

Participating Faculty:

Anesthesia: Rona Giffard (Professor), M. Bruce MacIver (Associate Professor, Research), Sean Mackey (Associate Professor), David Yeomans (Associate Professor)

Applied Physics: Mark Schnitzer (Assistant Professor)

Bioengineering: Kwabena Boahen (Associate Professor), Karl Deisseroth (Associate Professor), Scott Delp (Professor), Matthew Scott (Professor)

Biology: Russell D. Fernald (Professor), William F. Gilly (Professor), H. Craig Heller (Professor), Ron Kopito (Professor), Liqun Luo (Professor), Susan McConnell (Professor), Robert M. Sapolsky (Professor), Mark Schnitzer (Assistant Professor), Carla Shatz (Professor), Kang Shen (Assistant Professor), Stuart Thompson (Professor)

Chemical and Systems Biology: Tobias Meyer (Professor), Daria Mochly-Rosen (Professor)

Comparative Medicine: Paul S. Buckmaster (Associate Professor), Corinna Darian-Smith (Associate Professor), Shaul Hestrin (Associate Professor)

Developmental Biology: Ben Barres (Professor), David Kingsley (Professor), Matthew P. Scott (Professor)

Electrical Engineering: Krishna Shenoy (Associate Professor)

Genetics: Anne Brunet (Assistant Professor), Matthew Scott (Professor)

Microbiology and Immunology: Helen Blau (Professor)

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

Neurobiology: Stephen Baccus (Assistant Professor), Ben Barres (Professor), Tom Clandinin (Associate Professor), Ricardo Dolmetsch (Assistant Professor), Eric I. Knudsen (Professor), U. J. McMahan (Professor), Tirin Moore (Assistant Professor), William T. Newsome (Professor), Jennifer Raymond (Associate Professor), Carla Shatz (Professor)

Neurology and Neurological Sciences: Katrin Andreasson (Associate Professor), Ben Barres (Professor), Helen Bronte-Stewart (Associate Professor), Paul Buckmaster (Associate Professor), Robert S. Fisher (Professor), Michael Greicius (Assistant Professor), May Han (Assistant Professor), Ting-Ting Huang (Assistant Professor, Research), John A. Huguenard (Professor), Frank Longo (Professor), William C. Mobley (Professor), Josef Parvizi (Assistant Professor), David A. Prince (Professor), Thomas A. Rando (Professor), Lawrence Recht (Professor), Richard Reimer (Assistant Professor), Robert M. Sapolsky (Professor), Lawrence Steinman (Professor), Tony Wyss-Coray (Associate Professor, Research), Yanmin Yang (Associate Professor)

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

Ophthalmology: Yaping Joyce Liao (Assistant Professor)

Otolaryngology: Stefan Heller (Associate Professor), Anthony Ricci (Associate Professor)

Pathology: Isabella Graef (Assistant Professor), Bingwei Lu (Assistant Professor), Raymond Sobel (Professor), Marius Wernig (Assistant Professor)

Pediatrics: Heidi Feldman (Professor), Anna Penn (Assistant Professor), Lawrence Steinman (Professor)

Philosophy: Patrick Suppes (Professor, emeritus)

Psychiatry and Behavioral Sciences: Karl Deisseroth (Associate Professor), Luis de Lecea (Associate Professor), Firdaus Dhabhar (Associate Professor), Craig Garner (Professor), Terrence A. Ketter (Professor), Robert C. Malenka (Professor), Vinod Menon (Associate Professor, Research), Emmanuel Mignot (Professor), Karen Parker (Assistant Professor), Natalie Rasgon (Professor), Allan L. Reiss (Professor), Edith Sullivan (Professor, Research), Jamie Zeitzer (Assistant Professor)

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

Radiology: Gary H. Glover (Professor)

Structural Biology: U. J. McMahan (Professor)

Program Offices: CCSR 4235c

Mail Code: 94305-5173

Phone: (650) 723-9855

Web Site: http://neuroscience.stanford.edu/education/phd_program

Courses offered by the Neurosciences Program are listed under the subject code NEPR on the *Stanford Bulletin's* ExploreCourses web site.

DOCTOR OF PHILOSOPHY IN NEUROSCIENCES

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 2 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 on the application.

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

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

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

OBSTETRICS AND GYNECOLOGY

Chair: Jonathan S. Berek

Courses offered by the Department of Obstetrics and Gynecology are listed under the subject code OBGYN on the *Stanford Bulletin's* ExploreCourses web site.

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) Ronald Dorfman, Richard L. Kempson; (*Professor, Clinical*) Lawrence F. Eng, Luis Fajardo, Heinz Furthmayr, F. Carl Grumet, Jon Kosek; (*Associate Professor*) P. Joanne Cornbleet

Chair: Stephen J. Galli

Professors: Daniel Arber, Ellen Jo Baron, Gerald J. Berry, Eugene C. Butcher, Michael L. Cleary, Gerald R. Crabtree, Edgar G. Engleman, Andrew Fire, Steven Foug, Stephen J. Galli, Lawrence Tim Goodnough, Michael R. Hendrickson, Joseph S. Lipsick, Donald P. Regula, Robert V. Rouse, Richard K. Sibley, Raymond Sobel, Howard H. Sussman, Dolly Tyan, Matt van de Rijn, Hannes Vogel, Teresa S. F. Wang, Roger A. Warnke, Irving L. Weissman, James Zehnder

Associate Professors: Jeffrey D. Axelrod, Matt Bogyo, Athena M. Cherry, Andrew Connolly, Tina Cowan, James D. Faix, Dean Felsher, Susan A. Galel, Sharon M. Geaghan, John P. Higgins, Neeraja Kambham, Christina Kong, Teri A. Longacre, Sara A. Michie, Yasodha Natkunam, Bruce Patterson, Jonathan R. Pollack, Iris Schrijver, Arend Sidow

Assistant Professors: Niaz Banaei, Raffick Bowen, Magali Fontaine, Tracy George, Dita Gratzinger, F. Kim Hazard, Kristin Jensen, Bingwei Lu, Jesse McKenney, Erich Schwartz, Uma Sundram, Marius Wernig, Robert West

Courtesy Professors: Donna Bouley, Bertil Glader, Lucy Tompkins

Courtesy Associate Professor: Robert Shafer

Clinician Educators: Susan Atwater, David Bingham, Barbara Egbert, Christopher Gonzales, Terri Haddix, Jinah Kim, Amy McKenney, Melanie Manning, Reetesh Pai, Run Shi, Brent Tan, Maurene Viele

Instructors: Ching-Cheng Chen, Neng Chen, Franklin Mullins, Chris Park, Adrian Piliponsky

Adjunct Clinical Faculty: Robert Archibald, Jerome S. Burke, Glenn Cockerham, Stephen Shi-Hua Chen, Seth Haber, Maie K. Herrick, Paul W. Herrmann, Anthony Le, Steven Long, Charles Lombard, Judy Melinek, Gregory Moes, Joseph O'Hara, Girish Putcha, Mahendra Ranchod, Thomas W. Rogers, Joshua Sickel

Department Offices: Medical Center, Lane Building, L-235

Mail Code: 94305-5324

Phone: (650) 723-5255

Web Site: <http://pathology.stanford.edu>

Courses offered by the Department of Pathology are listed under the subject code PATH on the *Stanford Bulletin's* ExploreCourses web site.

PROGRAMS OF STUDY IN PATHOLOGY

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

Investigation in the department includes basic studies in areas using 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, mechanisms of immune and other responses in the central nervous system, and neurodegenerative diseases. Various studies focus on the development of novel diagnostic and immunotherapeutic treatment modalities and techniques for solid tumors, lymphomas, HIV, and genetic diseases. Research training in all of these areas is available for qualified medical and graduate students by individual arrangement with the appropriate faculty member. A summary of the research interests of the department faculty is available at <http://pathology.stanford.edu>.

RADIATION ONCOLOGY

Emeriti: Malcolm A. Bagshaw, Peter Fessenden, Don R. Goffinet, George M. Hahn, Kendric Smith

Chair: Richard T. Hoppe

Professors: J. Martin Brown, Sarah S. Donaldson, Amato J. Giaccia, Steven L. Hancock, Richard T. Hoppe, Quynh-Thu Le, Daniel S. Kapp, Steven A. Liebel

Associate Professors: Iris C. Gibbs, Paul Keall, Christopher R. King, Susan J. Knox, Gary Luxton, Lei Xing

Assistant Professors: Laura Attardi, Daniel Chang, Nicholas Denko, Edward Graves, Albert C. Koong

Consulting Professor: Robert M. Sutherland

Courses offered by the Department of Radiation Oncology are listed under the subject code RADO on the *Stanford Bulletin's* ExploreCourses web site.

Radiation Oncology focuses on the use of radiation for cancer therapy and research. The department does not offer degrees; however, its faculty teach courses open to medical students, graduate students, and undergraduates. The department accepts students in other curricula as advisees for study and research. Graduate students in Biophysics and Cancer Biology may perform their thesis research in the department. Undergraduates may arrange individual research projects under supervision of faculty.

At this 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.

RADIOLOGY

Emeriti: (Professors) Herbert L. Abrams, Barton Lane, Gerald Friedland, David A. Goodwin, Henry H. Jones, Albert Macovski, I. Ross McDougall, Robert E. Mindelzun, William H. Northway, Lewis Wexler, Leslie M. Zatz

Chair: Gary M. Glazer

Professors: Scott W. Atlas, Richard A. Barth, Christopher F. Beaulieu, Sanjiv Sam Gambhir, Gary M. Glazer, Gary H. Glover, Michael L. Goris, Robert J. Herfkens, Debra M. Ikeda, R. Brooke Jeffrey, Ann Leung, Michael Marks, Michael Moseley, Sandy Napel, Matilde Nino-Murcia, Norbert J. Pelc, Geoffrey Rubin, George Segall, F. Graham Sommer

Associate Professors: Patrick D. Barnes, Francis Blankenberg, Bruce Daniel, Terry Desser, Huy M. Do, Nancy Fischbein, Dominik Fleischmann, Garry E. Gold, Lawrence Hofmann, Beverly Newman, Eric W. Olcott, Daniel M. Spielman, Daniel Y. Sze

Associate Professors (Research): Kim Butts-Pauly, Craig Levin, Sylvia Plevritis

Assistant Professors: Sandip Biswal, Frandics P. Chan, Nishita Kothary, William Kuo, Andrew Quon, Jiaanghong Rao, Justus Roos, Lewis Shin, Kathryn J. Stevens, Shreyas Vasanawala, Joseph Wu, Greg Zaharchuk

Assistant Professors (Research): Roland Bammer, Xiaoyuan Chen, Rebecca Fahrig, Samira Guccione, Brian Hargreaves, David Paik

Web Site: <http://www-radiology.stanford.edu>

Courses offered by the Department of Radiology are listed under the subject code RAD on the *Stanford Bulletin's* ExploreCourses web site.

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

STRUCTURAL BIOLOGY

Chair: Joseph D. Puglisi

Associate Chair: Michael Levitt

Professors: Theodore Jardetzky, Roger D. Kornberg, Michael Levitt, Peter Parham, Joseph D. Puglisi, William I. Weis

Associate Professor: K. Christopher Garcia

Associate Professor (Research): Yahli Lorch

Assistant Professor (Research): Elizabetta Viani Puglisi

Courtesy Professor: Axel Brunger

Courtesy Associate Professor: Vijay Pande

Courtesy Assistant Professor: Zev Bryant

Department Offices: Fairchild Building, D100

Mail Code: 94305-5126

Phone: (650) 723-7576

Email: structuralbio@med.stanford.edu

Web Site: <http://structuralbio.stanford.edu>

Courses offered by the Department of Structural Biology are listed under the subject code SBIO on the *Stanford Bulletin's* ExploreCourses web site.

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

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

DOCTOR OF PHILOSOPHY IN STRUCTURAL BIOLOGY

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

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

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

Applicants to the program should have a bachelor's degree and should have completed at least a year of course work in biology, mathematics, organic chemistry, physical chemistry, and physics. Application forms must be received by the department before December 15 for notification by April 15. Application to the National Science Foundation for fellowship support is also encouraged.

Remission of fees and a personal stipend are available to graduate students in the department. Prospective applicants should contact the Department of Structural Biology for further information.

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

BIOCHEMISTRY (BIOC)

UNDERGRADUATE COURSES IN BIOCHEMISTRY

BIOC 118Q. Genomics and Medicine

(S,Sem) Stanford Introductory Seminar. Preference to sophomores. Knowledge gained from sequencing human, bacterial, and viral genomes and implications for medicine and biomedical research. Novel diagnoses (chips, SNPs and gene expression) and treatment of diseases including gene therapy, stem cell therapy, and rational drug design. Ethical implications of stem cell therapy and uses of genetic information. Use of genome and disease databases to determine gene function in disease, diagnosis, and potential treatments. See <http://biochem118.stanford.edu/>. GER:DB-EngrAppSci
3 units, Aut (Brutlag, D)

BIOC 199. Undergraduate Research

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

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

GRADUATE COURSES IN BIOCHEMISTRY

BIOC 200. Applied Biochemistry

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

1 unit, Aut (Harbury, P; Theriot, J; Cowan, T)

BIOC 201. Advanced Molecular Biology

Literature-based lectures and discussion on rapidly developing frontiers in chromosome structure and function and modern insights into the control of gene expression. Emphasis is on experimental approaches and insights. Topics include chromosome organization, novel modes of transcriptional control, RNA-based mechanisms for controlling gene expression and emerging translational regulatory mechanisms. Prerequisite: undergraduate molecular biology.

5 units, Spr (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.

3 units, Aut (Chu, G; Krasnow, M; Brown, P)

BIOC 210. Advanced Topics in Membrane Trafficking

Structure, function, and biosynthesis of cellular membranes and organelles. Current literature. Prerequisite: consent of instructor.

3 units, Sum (Staff)

BIOC 215. Frontiers in Biological Research

(Same as DBIO 215, GENE 215) Literature discussion in conjunction with the Frontiers in Biological Research seminar series hosted by Biochemistry, Developmental Biology, and Genetics in which distinguished investigators present current work. Students and faculty meet beforehand to discuss papers from the speaker's primary research literature. Students meet with the speaker after the seminar to discuss their research and future direction, commonly used techniques to study problems in biology, and comparison between the genetic and biochemical approaches in biological research.

1 unit, Aut (Harbury, P; Calos, M; Villeneuve, A), Win (Harbury, P; Villeneuve, A; Calos, M)

BIOC 218. Computational Molecular Biology

(Same as BIOMEDIN 231) For molecular biologists and computer scientists. Representation and analysis of genomes, sequences, and proteins. Strengths and limitations of existing methods. Course work performed on web or using downloadable applications. See <http://biochem218.stanford.edu/>. Prerequisites: introductory molecular biology course at level of BIOSCI 41 or consent of instructor. Autumn and spring offerings are via internet only.

3 units, Aut (Brutlag, D), Win (Brutlag, D), Spr (Brutlag, D)

BIOC 220. Chemistry of Biological Processes

(Same as CSB 220) The principles of organic and physical chemistry as applied to biomolecules. Goal is a working knowledge of chemical principles that underlie biological processes, and chemical tools used to study and manipulate biological systems. Prerequisites: organic chemistry and biochemistry, or consent of instructor.

4 units, alternate years, not given this year

BIOC 221. The Teaching of Biochemistry

Required for teaching assistants in Biochemistry. Practical experience in teaching on a one-to-one basis, and problem set design and analysis. Familiarization with current lecture and text materials; evaluations of class papers and examinations. Prerequisite: enrollment in the Biochemistry Ph.D. program or consent of instructor.

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

BIOC 224. Advanced Cell Biology

(Same as BIO 214) For Ph.D. students. Current research on cell structure, function, and dynamics. Topics include complex cell phenomena such as cell division, apoptosis, compartmentalization, transport and trafficking, motility and adhesion, differentiation, and multicellularity. Current papers from the primary literature. Prerequisite for advanced undergraduates: BIO 129A,B, and consent of instructor.

2-5 units, Win (Kopito, R; Theriot, J; Pfeffer, S; Straight, A; Nachury, M)

BIOC 228. Computational Genomic Biology

(Same as BIOMEDIN 228) Application of computational genomics methods to biological problems. Topics include: assembly of genomic sequences; genome databases; comparative genomics; gene discovery; gene expression analyses including gene clustering by expression, transcription factor binding site discovery, metabolic pathway discovery, functional genomics, and gene and genome ontologies; and medical diagnostics using SNPs and gene expression. Recent papers from the literature and hands-on use of the methods. Prerequisites: introductory course in computational molecular biology or genomics such as BIOC 218, BIOMEDIN 214 or GENE 211.

3 units, not given this year

BIOC 230. Molecular Interventions in Human Disease

For M.D. students who intend to declare a concentration in molecular basis of medicine, MSTP students, and Ph.D. students. Advanced medical biochemistry focusing on cases where molecular-level research has led to new medical treatments or changes in the understanding of important diseases. Different topics each week explore the underlying molecular basis of a variety of diseases and the reasons for success and failure in molecular approaches to treatment. Student-led discussions dissect papers from the primary medical and scientific research literature.

2-3 units, not given this year

BIOC 236. Biology by the Numbers

(Same as APPPHYS 136) Skillbuilding in biological quantitative reasoning. Topics include: biological size scales from proteins to ecosystems; biological time scales from enzymatic catalysis and DNA replication to evolution; biological energy, motion, and force from molecular to organismic scales; mechanisms of environmental sensing from bacterial chemotaxis to vision. Prerequisite: Physics 21, 41, or consent of instructor.

3 units, Win (Theriot, J; Fisher, D)

BIOC 241. Biological Macromolecules

(Same as BIOPHYS 241, SBIO 241) The physical and chemical basis of macromolecular function. 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. Prerequisites: introductory biochemistry and physical chemistry or consent of instructor.

3-5 units, Aut (Herschlag, D; Garcia, K; Ferrell, J; Block, S; Weis, W)

BIOC 257. Currents in Biochemistry

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

1 unit, Aut (Spudich, J)

BIOC 278. Systems Biology

(Same as BIOE 310, CS 278, CSB 278) Complex biological behaviors through the integration of computational modeling and molecular biology. Topics: reconstructing biological networks from high-throughput data and knowledge bases. Network properties. Computational modeling of network behaviors at the small and large scale. Using model predictions to guide an experimental program. Robustness, noise, and cellular variation. Prerequisites: background in biology and mathematical analysis.

3 units, not given this year

BIOC 298. Biochemistry Consulting Service

Students are presented with requests for advice from faculty and students in the biological sciences and Medical School encountering experimental and analytical problems in their research. Students work with the instructor and other biochemistry faculty to propose solutions. May be repeated for credit.

3 units, Aut (Brown, P), Win (Brown, P), Spr (Staff), Sum (Brown, P)

BIOC 299. Directed Reading in Biochemistry

Prerequisite: consent of instructor. (Staff)

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

BIOC 370. Medical Scholars Research

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

4-18 units, Aut (Staff), Win (Staff), Spr (Staff), Sum (Staff)

BIOC 399. Graduate Research and Special Advanced Work

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

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

BIOC 459. Frontiers in Interdisciplinary Biosciences

(Same as BIO 459, BIOE 459, CHEMENG 459, CHEM 459, PSYCH 459) Students register through their affiliated department; otherwise register for CHEMENG 459. For specialists and non-specialists. Sponsored by the Stanford BioX Program. Three seminars per quarter address scientific and technical themes related to interdisciplinary approaches in bioengineering, medicine, and the chemical, physical, and biological sciences. Leading investigators from Stanford and the world present breakthroughs and endeavors that cut across core disciplines. Pre-seminars introduce basic concepts and background for non-experts. Registered students attend all pre-seminars; others welcome. See <http://biox.stanford.edu/courses/459.html>. Recommended: basic mathematics, biology, chemistry, and physics.

1 unit, Aut (Robertson, C), Win (Robertson, C), Spr (Robertson)

BIOMEDICAL INFORMATICS (BIOMEDIN)

UNDERGRADUATE COURSES IN BIOMEDICAL INFORMATICS

BIOMEDIN 109Q. Genomics: A Technical and Cultural Revolution

(S,Sem) (Same as GENE 109Q) Stanford Introductory Seminar. Preference to sophomores. Concepts of genomics, high-throughput methods of data collection, and computational approaches to analysis of data. The social, ethical, and economic implications of genomic science. Students may focus on computational or social aspects of genomics.

3 units, Win (Altman, R)

BIOMEDIN 156. Economics of Health and Medical Care

(Same as BIOMEDIN 256, ECON 126, HRP 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. Prerequisites: ECON 50 and ECON 102A or equivalent statistics. Recommended: ECON 51.

5 units, Aut (Bhattacharya, J)

GRADUATE COURSES IN BIOMEDICAL INFORMATICS

BIOMEDIN 200. Biomedical Informatics Colloquium

Series of colloquia offered by program faculty, students, and occasional guest lecturers. May be repeated three times for credit.

1 unit, Aut (Musen, M), Win (Musen, M), Spr (Musen, M)

BIOMEDIN 201. Biomedical Informatics Student Seminar

Participants report on recent articles from the Biomedical Informatics literature or their research projects. Goal is to teach presentation skills. May be repeated three times for credit.

1 unit, Aut (Musen, M), Win (Musen, M), Spr (Musen, M)

BIOMEDIN 204. Pharmacogenomics

Via Internet. Genetically determined responses to drugs; applications focusing on the PharmGKB database, a publicly available Internet tool to aid researchers in understanding how genetic variation among individuals contributes to differences in reactions to drugs. Topics include: introduction to pharmacogenomics and pharmacology; the genome and genetics; human polymorphisms, frequencies, significance, and populations; informatics in pharmacogenomics; genotype to phenotype and phenotype to genotype approaches; drug discovery and validation; genomic variation discovery and genotyping; adverse drug reactions and interactions; pathways of drug metabolism; and cancer pharmacogenomics. Prerequisites: two of BIOSCI 41, 42, 43, and 44X,Y or consent of instructor.

1 unit, Aut (Cheng, B; Fagan, L), Win (Cheng, B; Fagan, L), Spr (Staff), Sum (Cheng, B; Fagan, L)

BIOMEDIN 205. Biomedical Informatics for Medicine

Primarily for M.D. students; open to other graduate students. Emphasis is on practical applications of bioinformatics and medical informatics for medicine, health care, clinicians, and biomedical research, focused on work at Stanford. Topics may include: methods to analyze genetic conditions' integrative methods for microarray, proteomic, and genomic data to understand the etiology of disease, clinical information systems in local healthcare facilities, cellular and radiology imaging, and pharmacogenomics. Enrollment for 2 units includes weekly assignments. Non-MD students may enroll for 1 unit. May be repeated for credit. Prerequisite: background in biomedicine. Recommended: background in programming.

1-2 units, Aut (Butte, A; Liu, L), Spr (Butte, A)

BIOMEDIN 206. Informatics in Industry

Effective management, modeling, acquisition, and mining of biomedical information in healthcare and biotechnology companies and approaches to information management adopted by companies in this ecosystem. Guest speakers from pharmaceutical/biotechnology companies, clinics/hospitals, health communities/portals, instrumentation/software vendors. May be repeated for credit.

1 unit, Spr (Kotecha, N; Shah, N)

BIOMEDIN 207. Digital Medicine: Promise and Peril in the Age of Electronic Health Records

Topical discussions of the use of electronic health records in clinical care and clinical research. Lectures by faculty, students and guest speakers are augmented by site visits to local clinical institutions that have implemented electronic health records systems. Goal is exposure to practical challenges of system implementation and to research opportunities in clinical informatics.

1 unit, Sum (Das, A)

BIOMEDIN 210. Modeling Biomedical Systems: Ontology, Terminology, Problem Solving

(Same as CS 270) Methods for modeling biomedical systems and for making those models explicit in the context of building software systems. Emphasis is on intelligent systems for decision support and Semantic Web applications. Topics: knowledge representation, controlled terminologies, ontologies, reusable problem solvers, and knowledge acquisition. Recommended: exposure to object-oriented systems, basic biology.

3 units, Aut (Musen, M)

BIOMEDIN 211. Effective Design in Clinical Informatics Systems

(Same as CS 271) Methods of designing and engineering software systems in complex clinical environments. Case studies illustrate factors leading to success or failure of systems. Project assignments involve focused team-based design work. Topics: user and organizational requirements, data and knowledge modeling, component-based system design, system prototyping, and human-systems interaction. Prerequisite: BIOMEDIN 210 recommended, or database or object-oriented programming course.

3 units, Win (Das, A)

BIOMEDIN 212. Introduction to Biomedical Informatics Research Methodology

(Same as BIOE 212, CS 272, GENE 212) Hands-on software building. Student teams conceive, design, specify, implement, evaluate, and report on a software project in the domain of biomedicine. Creating written proposals, peer review, providing status reports, and preparing final reports. Guest lectures from professional biomedical informatics systems builders on issues related to the process of project management. Software engineering basics. Prerequisites: BIOMEDIN 210, 211, 214, 217 or consent of instructor.

3 units, Aut (Altman, R; Cheng, B; Klein, T)

BIOMEDIN 214. Representations and Algorithms for Computational Molecular Biology

(Same as BIOE 214, CS 274, GENE 214) Topics: introduction to bioinformatics and computational biology, algorithms for alignment of biological sequences and structures, computing with strings, phylogenetic tree construction, hidden Markov models, Gibbs Sampling, 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, microarray analysis, machine learning (clustering and classification), and natural language text processing. Prerequisites: programming skills; consent of instructor for 3 units.

3-4 units, Spr (Staff)

BIOMEDIN 216. Lectures on Representations and Algorithms for Molecular Biology

Lecture series for BIOMEDIN 214. Via internet. Prerequisite: familiarity with biology recommended:

1 unit, Spr (Altman, R)

BIOMEDIN 217. Translational Bioinformatics

(Same as CS 275) Analytic, storage, and interpretive methods to optimize the transformation of genetic, genomic, and biological data into diagnostics and therapeutics for medicine. Topics: access and utility of publicly available data sources; types of genome-scale measurements in molecular biology and genomic medicine; analysis of microarray data; analysis of polymorphisms, proteomics, and protein interactions; linking genome-scale data to clinical data and phenotypes; and new questions in biomedicine using bioinformatics. Case studies. Prerequisites: programming ability at the level of CS 106A and familiarity with statistics and biology.

4 units, Win (Butte, A)

BIOMEDIN 218. Translational Bioinformatics

Same content as 217; for medical and graduate students who attend lectures and participate in limited assignments and final project. Analytic, storage, and interpretive methods to optimize the transformation of genetic, genomic, and biological data into diagnostics and therapeutics for medicine. Topics: access and utility of publicly available data sources; types of genome-scale measurements in molecular biology and genomic medicine; analysis of microarray data; analysis of polymorphisms, proteomics, and protein interactions; linking genome-scale data to clinical data and phenotypes; and new questions in biomedicine using bioinformatics. Case studies. Prerequisites: programming at the level of CS 106A; familiarity with statistics and biology.

2 units, Win (Butte, A)

BIOMEDIN 219. Mathematical Models and Medical Decisions

Analytic methods for determining the optimal diagnostic and therapeutic decisions for the care of individual patients and for the design of policies affecting the care of patient populations. Topics: utility theory and probability modeling, empirical methods for estimating disease prevalence, probability models for periodic processes, binary decision-making techniques, Markov models of dynamic disease state problems, utility assessment techniques, parametric utility models, utility models for multidimensional outcomes, analysis of time-varying clinical outcomes, and the design of cost-constrained clinical policies. 2 units requires completion of a case study project. Prerequisites: introduction to calculus and basic statistics.

1-2 units, Win (Staff)

BIOMEDIN 228. Computational Genomic Biology

(Same as BIOE 228) Application of computational genomics methods to biological problems. Topics include: assembly of genomic sequences; genome databases; comparative genomics; gene discovery; gene expression analyses including gene clustering by expression, transcription factor binding site discovery, metabolic pathway discovery, functional genomics, and gene and genome ontologies; and medical diagnostics using SNPs and gene expression. Recent papers from the literature and hands-on use of the methods. Prerequisites: introductory course in computational molecular biology or genomics such as BIOE 218, BIOMEDIN 214 or GENE 211.

3 units, not given this year

BIOMEDIN 231. Computational Molecular Biology

(Same as BIOE 218) For molecular biologists and computer scientists. Representation and analysis of genomes, sequences, and proteins. Strengths and limitations of existing methods. Course work performed on web or using downloadable applications. See <http://biochem218.stanford.edu/>. Prerequisites: introductory molecular biology course at level of BIOSCI 41 or consent of instructor. Autumn and spring offerings are via internet only.

3 units, Aut (Brutlag, D), Win (Brutlag, D), Spr (Brutlag, D)

BIOMEDIN 233. Intermediate Biostatistics: Analysis of Discrete Data

(Same as HRP 261, STATS 261) Methods for analyzing data from case-control and cross-sectional studies: the 2x2 table, chi-square test, Fisher's exact test, odds ratios, Mantel-Haenzel methods, stratification, tests for matched data, logistic regression, conditional logistic regression. Emphasis is on data analysis in SAS. Special topics: cross-fold validation and bootstrap inference.

3 units, Win (Sainani, K)

BIOMEDIN 251. Outcomes Analysis

(Same as HRP 252) 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, J)

BIOMEDIN 256. Economics of Health and Medical Care

(Same as BIOMEDIN 156, ECON 126, HRP 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. Prerequisites: ECON 50 and ECON 102A or equivalent statistics. Recommended: ECON 51.

5 units, Aut (Bhattacharya, J)

BIOMEDIN 262. Computational Genomics

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

3 units, Win (Batzoglou, S)

BIOMEDIN 273A. A Computational Tour of the Human Genome

(Same as CS 273A, DBIO 273A) Biology through an exploration of Human Genome. Key genomic and genetic concepts from an informatics perspective. Biomedical advances resulting from the Genomics revolution. Topics: genome sequencing: technologies, assembly, personalized sequencing. Functional landscape: genes, gene regulation, repeats, RNA genes. Genome evolution: comparative genomics, ultraconservation, co-option. Additional topics: population genetics, personalized genomics, and ancient DNA. Course starts with primer in Biology and text processing languages. Ends with guest lectures from forefront of genomic research.

3 units, Aut (Batzoglou, S; Bejerano, G)

BIOMEDIN 299. Directed Reading and Research

For students wishing to receive credit for directed reading or research time. Prerequisite: consent of instructor. (Staff)

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

BIOMEDIN 366. Computational Biology

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

2-3 units, Spr (Zhang, N)

BIOMEDIN 370. Medical Scholars Research

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

4-18 units, Aut (Staff), Win (Staff), Spr (Staff), Sum (Staff)

BIOMEDIN 374. Algorithms in Biology (same as CS 374)

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

2-3 units, Spr (Batzoglou, S)

BIOMEDIN 390A. Curricular Practical Training

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

1 unit, Aut (Musen, M), Win (Staff), Spr (Musen, M), Sum (Musen, M)

BIOMEDIN 390B. Curricular Practical Training

BIOMEDIN 390A, B, and C may each be taken only once.

1 unit, Aut (Musen, M), Win (Staff), Spr (Musen, M), Sum (Musen, M)

BIOMEDIN 390C. Curricular Practical Training

BIOMEDIN 390A, B, and C may each be taken only once.

1 unit, Aut (Musen, M), Win (Staff), Spr (Musen, M), Sum (Musen, M)

BIOMEDIN 432. Analysis of Costs, Risks, and Benefits of Health Care

(Same as HRP 392) (Same as MGTECON 332) For graduate students. How to do cost/benefit analysis when the output is difficult or impossible to measure. How do M.B.A. analytic tools apply in health services? Literature on the principles of cost/benefit analysis applied to health care. Critical review of actual studies. Emphasis is on the art of practical application.

4 units, Aut (Garber, A; Owens, D)

CANCER BIOLOGY (CBIO)

UNDERGRADUATE COURSES IN CANCER BIOLOGY

CBIO 101. Cancer Biology

(Same as PATH 101) Experimental approaches to understanding the origins, diagnosis, and treatment of cancer. Focus on key experiments and discoveries with emphasis on genetics, molecular biology, and cell biology. Topics include carcinogens, tumor virology, oncogenes, tumor suppressor genes, cell cycle regulation, angiogenesis, invasion and metastasis, cancer genomics, cancer epidemiology, and cancer therapies. Discussion sections based on primary research articles that describe key experiments in the field. Prerequisite: Biology or Human Biology core or equivalent, or consent of instructor.

4 units, Win (Staff)

GRADUATE COURSES IN CANCER BIOLOGY

CBIO 241. Molecular, Cellular, and Genetic Basis of Cancer

Core course required of 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 (Giaccia, A; Pech, M; Graves, E)

CBIO 242. Scientific Basis of Clinical Cancer Therapy

Required for first- and second-year medical students who wish to join the Cancer Biology Scholarly Concentration Program. The curriculum includes a sampling of recent biomedical research discoveries that led to the current cancer diagnosis and therapeutic treatments.

3 units, Spr (Giaccia, A)

CBIO 260. Teaching in Cancer Biology

Practical experience in teaching by serving as a teaching assistant in a cancer biology course. Unit values are allotted individually to reflect the level of teaching responsibility assigned to the student.

1-10 units, Aut (Giaccia, A), Win (Giaccia, A), Spr (Lipsick, J)

CBIO 275. Tumor Immunology

(Same as IMMUNOL 275) Focuses on the ability of innate and adaptive immune responses to recognize and control tumor growth. Topics include: tumor antigens, tumor immunosurveillance and immunoediting, tumor immunotherapy, cancer vaccines and dendritic cell therapy. Tracks the historical developments of our understanding of modulating tumor immune response and discusses their relative significance in the light of current research findings. Prerequisite: for undergraduates, human biology or biology core.

3 units, Aut (Engleman, E; Rothbard, J)

CBIO 280. Cancer Biology Journal Club

Required of and limited to first- and second-year graduate students in Cancer Biology. Recent papers in the literature presented by graduate students. When possible, discussion relates to and precedes cancer-related seminars at Stanford. Attendance at the relevant seminar required.

1 unit, Aut (Giaccia, A), Win (Giaccia, A), Spr (Giaccia, A)

CBIO 299. Directed Reading in Cancer Biology

Prerequisite: consent of instructor.

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

CBIO 399. Graduate Research

Students undertake investigations sponsored by individual faculty members. Cancer Biology Ph.D. students must register as soon as they begin dissertation-related research work.

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

CHEMICAL SYSTEMS BIOLOGY (CSB)

UNDERGRADUATE COURSES IN CHEMICAL SYSTEMS BIOLOGY

CSB 199. Undergraduate Research

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

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

GRADUATE COURSES IN CHEMICAL SYSTEMS BIOLOGY

CSB 210. Signal Transduction Pathways and Networks

The molecular mechanisms through which cells receive and respond to external signals. Emphasis is on principles of cell signaling, the systems-level properties of signal transduction modules, and experimental strategies through which cell signaling pathways are being studied. Prerequisite: biochemistry and genetics.

4 units, Win (Ferrell, J; Meyer, T)

CSB 220. Chemistry of Biological Processes

(Same as BIOC 220) The principles of organic and physical chemistry as applied to biomolecules. Goal is knowledge of chemical principles that underlie biological processes, and chemical tools used to study and manipulate biological systems. Prerequisites: organic chemistry and biochemistry, or consent of instructor.

4 units, alternate years, not given this year

CSB 240A. A Practical Approach to Drug Discovery and Development

Advancing a drug from discovery of a therapeutic target to human trials and commercialization. Topics include: high throughput assay development, compound screening, lead optimization, protecting intellectual property, toxicology testing, regulatory issues, assessment of clinical need, defining the market, conducting clinical trials, project management, and commercialization issues, including approach to licensing and raising capital.

3 units, alternate years, not given this year

CSB 240B. A Practical Approach to Drug Discover and Development

(Continuation of 240A) Advancing a drug from discovery of a therapeutic target to human trials and commercialization. Topics include: high throughput assay development, compound screening, lead optimization, protecting intellectual property, toxicology testing, regulatory issues, assessment of clinical need, defining the market, conducting clinical trials, project management, and commercialization issues, including approach to licensing and raising capital. Prerequisite: 240A.

3 units, alternate years, not given this year

CSB 250. The Biology of Chromatin Templated Processes

Topics include mechanisms of DNA replication; gene expressions regulation; DNA damage sensing and DNA repair; chromatin structure and function; and epigenetics and nuclear reprogramming. Prerequisite: working knowledge of molecular biology, biochemistry and genetics, or instructor consent.

4 units, not given this year

CSB 260. Quantitative Chemical Biology

Current topics including protein and small molecule engineering, cell signaling sensors and modulators, molecular imaging, chemical genetics, combinatorial chemistry, in vitro evolution, and signaling network modeling. Prerequisites: undergraduate organic chemistry, and biochemistry or cell biology.

4 units, Spr (Staff), alternate years, not given next year

CSB 270. Research Seminar

Guest speakers on current research in pharmacology.

1-2 units, Aut (Cimprich, K; Wysocka, J), Win (Staff), Spr (Staff)

CSB 278. Systems Biology

(Same as BIOC 278, BIOE 310, CS 278) Complex biological behaviors through the integration of computational modeling and molecular biology. Topics: reconstructing biological networks from high-throughput data and knowledge bases. Network properties. Computational modeling of network behaviors at the small and large scale. Using model predictions to guide an experimental program. Robustness, noise, and cellular variation. Prerequisites: background in biology and mathematical analysis.

3 units, not given this year

CSB 299. Directed Reading in Chemical and Systems Biology

Prerequisite: consent of instructor.

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

CSB 370. Medical Scholars Research

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

4-18 units, Aut (Staff), Win (Staff), Spr (Staff), Sum (Staff)

CSB 399. Graduate Research

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

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

COMPARATIVE MEDICINE (COMPMD)

UNDERGRADUATE COURSES IN COMPARATIVE MEDICINE

COMPMD 81N. Comparative Anatomy and Physiology of Mammals

(F,Sem) Stanford Introductory Seminar. Preference to freshmen. Comparative approach to common mammals, laboratory, and domestic species. The unique adaptations of each species in terms of its morphological, anatomical, and behavioral characteristics. How these species interact with human beings and other animals. GER: DB-NatSci

3 units, Win (Bouley, D)

COMP MED 84Q. Globally Emerging Zoonotic Diseases

(S,Sem) Stanford Introductory Seminar. Preference to sophomores. Infectious diseases impacting veterinary and human health around the world today. Mechanisms of disease, epidemiology, and underlying diagnostic, treatment and control principles associated with these pathogens.

3 units, Spr (Felt, S)

COMP MED 87Q. Introduction to the Mouse in Biomedical Research

(S,Sem) Stanford Introductory Seminar. Preference to sophomores. The laboratory mouse, one of the most widely used models for biomedical research. The natural history and origin of the laboratory mouse, its relationship to its wild cousins, the history and uses of some common laboratory mice, widely used research models (transgenic mice, knock-out and knock-in mice, cloning, immunodeficient mice) and their uses in the understanding and treatment of human diseases. Reading and discussion of scientific papers; presentation of a paper that uses the mouse as a model for the study of a human disease.

3 units, Aut (Nagamine, C)

COMP MED 103. Horse Medicine

The most common equine diseases, ranging from colic to lameness. Equine anatomy and physiology relevant to topics in equine medicine. Equine infectious diseases, care of the newborn foal, medical emergencies, and neurological disorders. Laboratory sessions involve physical examination of the horse and review the basics of the neurological and lameness exam.

2 units, Win (Green, S)

COMP MED 107. Comparative Neuroanatomy

(Same as COMP MED 207) Functional organization and evolution of the vertebrate nervous system. Topics include paleoneurology, cladistic analysis, allometry, mosaic versus concerted evolution, and evolution of brain region structure, connectivity, and neurons. Comparisons between structure and function of vertebrate forebrains including hippocampi. Evolution of the primate visual and sensorimotor central nervous system as related to vocalization, socialization, and intelligence.

4 units, not given this year

COMP MED 110. Pre-Vet Advisory

For students interested in a career in veterinary medicine. Guest speakers present career options in veterinary medicine. Networking with other pre-vet students. How to meet the academic and practical experience prerequisites for admission to veterinary school. Prerequisite: consent of instructor.

1 unit, Aut (Bouley, D), Win (Bouley, D), Spr (Bouley, D)

COMP MED 198. Undergraduate Directed Reading in Comparative Medicine

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 (Staff), Win (Staff), Spr (Staff), Sum (Staff)

COMP MED 199. Undergraduate Research

Investigations sponsored by individual faculty members. Prerequisite: consent of instructor.

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

GRADUATE COURSES IN COMPARATIVE MEDICINE**COMP MED 207. Comparative Neuroanatomy**

(Same as COMP MED 107) Functional organization and evolution of the vertebrate nervous system. Topics include paleoneurology, cladistic analysis, allometry, mosaic versus concerted evolution, and evolution of brain region structure, connectivity, and neurons. Comparisons between structure and function of vertebrate forebrains including hippocampi. Evolution of the primate visual and sensorimotor central nervous system as related to vocalization, socialization, and intelligence.

4 units, not given this year

COMP MED 299. Directed Reading in Comparative Medicine

Prerequisite: consent of instructor. (Staff)

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

COMP MED 370. Medical Scholars Research

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

4-18 units, Aut (Staff), Win (Staff), Spr (Staff), Sum (Staff)

COMP MED 399. Graduate Research

Investigations sponsored by individual faculty members. 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. Prerequisite: consent of instructor.

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

DEVELOPMENTAL BIOLOGY (DBIO)**UNDERGRADUATE COURSES IN DEVELOPMENTAL BIOLOGY****DBIO 156. Human Developmental Biology and Medicine**

(Same as HUMBIO 141) The biological, medical, and social aspects of normal and abnormal human development. Topics: in vitro fertilization and embryo transfer; gene and cell therapy; gametogenesis; pattern formation in the nervous system and limb development; gene and grand multiple pregnancies; prematurity, in utero effects of teratogens; sex determination and differentiation; growth control; gigantism and dwarfism; neural tube defects; cardiac morphogenesis; progress in the developmental biology of humans. Limited enrollment. Prerequisites: Human Biology or Biology core, or consent of instructor.

4 units, not given this year

DBIO 199. Undergraduate Research

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

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

GRADUATE COURSES IN DEVELOPMENTAL BIOLOGY**DBIO 201. Development and Disease Mechanisms**

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

4 units, Aut (Porzig, E; Kingsley, D; Kim, S)

DBIO 202. Assisted Reproductive Technologies

(Same as OBGYN 202) Primary and current literature in basic and clinical science aspects of assisted reproductive technologies (ART), and demonstrations of current ART techniques including in vitro fertilization and embryo culture, and micromanipulation procedures such as intracytoplasmic sperm injection and embryo biopsy and cryopreservation. Class only may be taken for 1 unit. 2 units includes papers and attendance at clinical demonstrations. 3 units includes a term paper. Recommended: DBIO 201, or consent of instructors.

1-3 units, Win (Porzig, E; Behr, B)

DBIO 203. Advanced Genetics

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

4 units, Aut (Stearns, T; Sidow, A; Barsh, G)

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 (Beachy, P; Fuller, M)

DBIO 215. Frontiers in Biological Research

(Same as BIOC 215, GENE 215) Literature discussion in conjunction with the Frontiers in Biological Research seminar series in which investigators present current work. Students and faculty meet beforehand to discuss papers from the speaker's primary research literature. Students meet with the speaker after the seminar to discuss their research and future direction, commonly used techniques to study problems in biology, and comparison between the genetic and biochemical approaches in biological research.

1 unit, Aut (Harbury, P; Calos, M; Villeneuve, A), Win (Harbury, P; Villeneuve, A; Calos, M)

DBIO 221. Current Issues in Aging

(Same as GENE 221, NENS 221) Current research literature on genetic mechanisms of aging in animals and human beings. Topics include: mitochondria mutations, insulin-like signaling, sirtuins, aging in flies and worms, stem cells, human progeria, and centenarian studies. Prerequisite: GENE 203.

2 units, Spr (Staff)

DBIO 257. The Biology of Stem Cells

(Same as HUMBIO 157) The role of stem cells in human development and potential for treating disease. Guest lectures by biologists, ethicists, and legal scholars. Prerequisites: 2A,B, or consent of instructor.

3 units, not given this year

DBIO 273A. A Computational Tour of the Human Genome

(Same as BIOMEDIN 273A, CS 273A) Biology through an exploration of Human Genome. Key genomic and genetic concepts from an informatics perspective. Biomedical advances resulting from the Genomics revolution. Topics: genome sequencing: technologies, assembly, personalized sequencing. Functional landscape: genes, gene regulation, repeats, RNA genes. Genome evolution: comparative genomics, ultraconservation, co-option. Additional topics: population genetics, personalized genomics, and ancient DNA. Course starts with primer in Biology and text processing languages. Ends with guest lectures from forefront of genomic research.

3 units, Aut (Batzoglou, S; Bejerano, G)

DBIO 296. Stem Cell Biology and Regenerative Medicine

(Same as PATH 296) For graduate and medical students. Embryonic and adult stem cells, including origin, regulation, self-renewal, differentiation, fate, and relationship to cancer; biological mechanisms and methods to translate findings to therapeutic applications. Medical students must enroll for 5 units; graduate students may choose to take only the basic science part for 3 units. Prerequisites: DBIO 201 and 210, or consent of instructor.

3-5 units, Win (Weissman, I; Nusse, R; Fuller, M)

DBIO 299. Directed Reading in Developmental Biology

Prerequisite: consent of instructor.

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

DBIO 370. Medical Scholars Research

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

4-18 units, Aut (Staff), Win (Staff), Spr (Staff), Sum (Staff)

DBIO 399. Graduate Research

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

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

GENETICS (GENE)

UNDERGRADUATE COURSES IN GENETICS

GENE 109Q. Genomics: A Technical and Cultural Revolution (S,Sem) (Same as BIOMEDIN 109Q) Stanford Introductory Seminar. Preference to sophomores. Concepts of genomics, high-throughput methods of data collection, and computational approaches to analysis of data. The social, ethical, and economic implications of genomic science. Students may focus on computational or social aspects of genomics.

3 units, Win (Altman, R)

GENE 199. Undergraduate Research

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

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

GRADUATE COURSES IN GENETICS

GENE 202. Human Genetics

Theoretical and experimental basis for the genetics of human health and disease. Molecular, chromosomal, biochemical, developmental, cancer, and medical genetics, emphasizing the last. Clinical cases. Prerequisites: biochemistry; basic genetics.

4 units, Aut (Ormond, K; Hudgins, L)

GENE 203. Advanced Genetics

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

4 units, Aut (Stearns, T; Sidow, A; Barsh, G)

GENE 206. Epigenetics

(Same as PATH 206) For graduate students; undergraduates by consent of instructor. Mechanisms by which phenotypes not determined by the DNA sequence are stably inherited in successive cell divisions. From the discovery of position-effect variegation in *Drosophila* in the 1920s to present-day studies of covalent modifications of histones and DNA methylation. Topics include: position effect, gene silencing, heterochromatin, centromere identity, genomic imprinting, histone code, variant histones, and the role of epigenetics in cancer. Prerequisite: BIO41 and BIO42, or GENE 203, or consent of instructor.

2 units, Spr (Lipsick, J; Gozani, O), alternate years, not given next year

GENE 211. Genomics

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

3 units, Win (Cherry, J; Sherlock, G)

GENE 212. Introduction to Biomedical Informatics Research Methodology

(Same as BIOE 212, BIOMEDIN 212, CS 272) Hands-on software building. Student teams conceive, design, specify, implement, evaluate, and report on a software project in the domain of biomedicine. Creating written proposals, peer review, providing status reports, and preparing final reports. Guest lectures from professional biomedical informatics systems builders on issues related to the process of project management. Software engineering basics. Prerequisites: BIOMEDIN 210, 211, 214, 217 or consent of instructor.

3 units, Aut (Altman, R; Cheng, B; Klein, T)

GENE 214. Representations and Algorithms for Computational Molecular Biology

(Same as BIOE 214, BIOMEDIN 214, CS 274) Topics: introduction to bioinformatics and computational biology, algorithms for alignment of biological sequences and structures, computing with strings, phylogenetic tree construction, hidden Markov models, Gibbs Sampling, 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, microarray analysis, machine learning (clustering and classification), and natural language text processing. Prerequisites: programming skills; consent of instructor for 3 units.

3-4 units, Spr (Staff)

GENE 215. Frontiers in Biological Research

(Same as BIOC 215, DBIO 215) Literature discussion in conjunction with the Frontiers in Biological Research seminar series in which investigators present current work. Students and faculty meet beforehand to discuss papers from the speaker's primary research literature. Students meet with the speaker after the seminar to discuss their research and future direction, commonly used techniques to study problems in biology, and comparison between the genetic and biochemical approaches in biological research.

1 unit, Aut (Harbury, P; Calos, M; Villeneuve, A), Win (Harbury, P; Villeneuve, A; Calos, M)

GENE 218. Computational Analysis of Biological Images

(Same as PATH 218) Physical and computational tools for acquisition, processing, interpretation, and archiving of biological images. Emphasis is on digital microscopy.

2 units, alternate years, not given this year

GENE 221. Current Issues in Aging

(Same as DBIO 221, NENS 221) Current research literature on genetic mechanisms of aging in animals and human beings. Topics include: mitochondria mutations, insulin-like signaling, sirtuins, aging in flies and worms, stem cells, human progeria, and centenarian studies. Prerequisite: GENE 203.

2 units, Spr (Staff)

GENE 222. Method and Logic in Experimental Genetics

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

3 units, Win (Baker, J; Calos, M)

GENE 233. The Biology of Small Modulatory RNAs

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

2 units, Aut (Fire, A; Chen, C), alternate years, not given this year

GENE 234. Fundamentals of RNA Biology

(Same as MI 234, PATH 234) For graduate or medical students and (if space allows) to active participants from other segments of the Stanford Community (e.g., TGR students); undergraduates by instructor consent. Fundamental issues of RNA biology, with the goal of setting a foundation for students to explore the expanding world of RNA-based regulation. Each week a topic is covered by a faculty lecture and journal club presentations by students.

2 units, Aut (Chen, C; Fire, A; Sarnow, P)

GENE 235. C. Elegans Genetics

Genetic approaches to *C. elegans*, practice in designing experiments and demonstrations of its growth and anatomy. Probable topics include: growth and genetics, genome map and sequence, mutant screens that start with a desired phenotype, reverse genetics and RNAi screens, genetic duplications, uses of null phenotype non-null alleles, genetic interactions and pathway analysis, and embryogenesis and cell lineage. Focus of action, mosaic analysis, and interface with embryological and evolutionary approaches.

2 units, Win (Staff), alternate years, not given next year

GENE 238. Current Concepts and Dilemmas in Genetic Testing

(Same as INDE 238) For M.D., biomedical graduate, and genetic counseling students. Issues arising from the translational process from research to commercialization. Diagnostic inventions and applications, community implications, newborn screening, cancer genetics, and pharmacogenomics. Guest experts.

2 units, Spr (Tobin, S; Schrijver, I; Cowan, T; Magnus, D)

GENE 243. Scientific Evidence and Expert Testimony: Patent Litigation

Open to clinical MD and graduate students. How to explain science to judge and jury; how litigators determine which legal issues to argue. Patent and expert testimony law. Student teams choose patents for final simulation projects, prepare claim charts, devise a design-around, and present oral arguments. Prerequisite: Graduate students must have completed all coursework in their departments for the PhD degree.

3 units, Aut (Morris, R)

GENE 244. Introduction to Statistical Genetics

Statistical methods for analyzing human genetics studies of Mendelian disorders and common complex traits. Probable topics include: principles of population genetics; epidemiologic designs; familial aggregation; segregation analysis; linkage analysis; linkage-disequilibrium-based association mapping approaches; and genome-wide analysis based on high-throughput genotyping platforms. Prerequisite: STATS 116 or equivalent or consent of instructor.

3 units, alternate years, not given this year

GENE 245. Computational Algorithms for Statistical Genetics

(Same as STATS 345) Computational algorithms for human genetics research. Topics include: permutation, bootstrap, expectation maximization, hidden Markov model, and Markov chain Monte Carlo. Rationales and techniques illustrated with existing implementations commonly used in population genetics research, disease association studies, and genomics analysis. Prerequisite: GENE 244 or consent of instructor.

2-3 units, alternate years, not given this year

GENE 260. Supervised Study

Genetics graduate student lab research from first quarter to filing of candidacy. Prerequisite: consent of instructor.

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

GENE 271. Human Molecular Genetics

For genetic counseling students, graduate students in genetics, medical students, residents, and postdoctoral fellows interested in the practice of medical genetics. Gene structure and function; the impact of mutation and polymorphism as they relate to developmental pathways and health and human disease; population based genetics; approaches to the study of complex genetic conditions, and gene therapy, proteomics, stem cell biology, and pharmacogenetics. Undergraduates require consent of instructor and a basic genetics course.

4 units, Aut (Ormond, K; Francke, U)

GENE 272. Introduction to Medical Genetics

For genetic counseling students, graduate students in human genetics, medical students, residents, and fellows; undergraduates with consent of instructor. Principles of medical genetics including taking a family history, modes of inheritance, and mathematical principles of medical genetics (Bayes theorem, population genetics). An additional paper is required for 3 units.

2-3 units, Aut (Hudgins, L; Ormond, K)

GENE 273. Introduction to Clinical Genetics Testing

For genetic counseling students, graduate students in genetics, medical students, residents, and postdoctoral fellows; undergraduates with consent of instructor. Principles of cytogenetic, molecular, and biochemical laboratory analysis. How to select the appropriate laboratory for testing and laboratory quality assurance, including the CLIA process. An additional paper is required for 3 units.

2-3 units, Aut (Ormond, K; Cowan, T; Cherry, J; Schrijver, I)

GENE 274A. A Case Based Approach to Clinical Genetics

For genetic counseling students, graduate students in genetics, medical students, residents, and post-doctoral fellows. Case-based scenarios and guest expert lectures. Skills in case preparation, management, and presentation.

2 units, Win (Hudgins, L; Ormond, K)

GENE 274B. A Case Based Approach to Clinical Genetics

For genetic counseling students, graduate students in genetics, medical students, residents, and post-doctoral fellows. Case-based scenarios and guest expert lectures. Skills in case preparation, management, and presentation.

2 units, Spr (Hudgins, L; Ormond, K)

GENE 275. Role Play and Genetic Counseling Observations

Observation includes genetic counseling sessions in prenatal, pediatric, and cancer settings, and medical genetics procedures and testing settings.

2 units, Aut (Ormond, K)

GENE 276. Genetic Counseling Clinical Rotations

For genetic counseling students only. Supervised clinical experiences. May be repeated for credit. Prerequisite: GENE 275.

4-7 units, Aut (Staff), Win (Ormond, K), Spr (Ormond, K), Sum (Ormond, K)

GENE 278. Prenatal Genetic Counseling

Internet-based course for genetic counseling students, graduate students in genetics, medical students, residents, and postdoctoral fellows; genetic counseling students should take this course in conjunction with their initial prenatal genetics rotation. Topics include prenatal genetic screening and diagnosis in the first and second trimesters, ultrasound, teratology, and genetic carrier screening.

1 unit, Aut (Ormond, K), Win (Ormond, K), Spr (Ormond, K), Sum (Ormond, K)

GENE 279. Pediatric and Adult Genetic Counseling

Internet-based course for genetic counseling students, graduate students in genetics, medical students, residents, and postdoctoral fellows; genetic counseling students should take this course in conjunction with their initial general genetics rotation. Topics include: common genetic conditions; assessment of child development and medical history in the context of a genetic workup; dysmorphology; development of a differential diagnosis; and resources for case management and family support.

1 unit, Aut (Ormond, K), Win (Ormond, K), Spr (Ormond, K), Sum (Ormond, K)

GENE 280. Metabolic Genetic Counseling

Internet-based course for genetic counseling students, graduate students in genetics, medical students, residents, and postdoctoral fellows; genetic counseling students should take this course in conjunction with their metabolic genetics rotation. Topics include: overview of metabolic diseases; common pathways; diagnosis, management, and treatment of metabolic disorders; and newborn screening.

1 unit, Aut (Ormond, K), Win (Ormond, K), Spr (Ormond, K), Sum (Ormond, K)

GENE 281. Cancer Genetic Counseling

Internet-based course for genetic counseling students, graduate students in genetics, medical students, residents, and postdoctoral fellows; genetic counseling students should take this course in conjunction with their initial cancer genetics rotation. Topics include: cancer cytogenetics and genetic principles; diagnosis and management of common cancer genetic syndromes; predictive testing; psychology of cancer genetic counseling; and topics recommended by ASCO guidelines.

1 unit, Aut (Ormond, K), Win (Ormond, K), Spr (Ormond, K), Sum (Ormond, K)

GENE 282. Genetic Counseling Research Seminar

For genetic counseling students only. Facilitated discussions on identifying a topic and mentor for genetic counseling departmental research projects. Corequisite: GENE 299.

2 units, Win (Staff)

GENE 282. Genetic Counseling Research Seminar

For genetic counseling students only. Facilitated discussions on identifying a topic and mentor for genetic counseling departmental research projects. Corequisite: GENE 299.

2 units, Win (Ormond, K)

GENE 283. Genetic Counseling Research

Investigations sponsored by individual faculty members. Students complete an approved research project. May be repeated for credit. Prerequisite: GENE 282.

1-8 units, Aut (Staff), Win (Ormond, K), Spr (Ormond, K), Sum (Staff)

GENE 284. Medical Genetics Seminar

Presentation of research and cases. Students enrolling for 2 units also attend and report on external seminars. May be repeated for credit.

1-2 units, Aut (Ormond, K), Win (Ormond, K), Spr (Ormond, K)

GENE 285A. Genetic Counseling Seminar

Year-long seminar primarily for genetic counseling students. Autumn: basics of medical communication; crosscultural and disability sensitive communication about genetics, and principles of providing genetic counseling. Winter: the impact of chronic illness and genetic disease in a developmental manner. Spring: applying therapeutic counseling approaches to the practice of genetic counseling. Undergraduates may enroll in Autumn Quarter with consent of instructor.

2-3 units, Aut (Ormond, K)

GENE 285B. Genetics Counseling Seminar

Year-long seminar primarily for genetic counseling students. Autumn: basics of medical communication; crosscultural and disability sensitive communication about genetics, and principles of providing genetic counseling. Winter: the impact of chronic illness and genetic disease in a developmental manner. Spring: applying therapeutic counseling approaches to the practice of genetic counseling. Prerequisite: GENE 285A.

2-3 units, Win (Ormond, K)

GENE 285C. Genetic Counseling Seminar

Year-long seminar primarily for genetic counseling students. Autumn: basics of medical communication; crosscultural and disability sensitive communication about genetics, and principles of providing genetic counseling. Winter: the impact of chronic illness and genetic disease in a developmental manner. Spring: applying therapeutic counseling approaches to the practice of genetic counseling. Prerequisite: 285 A/B.

2-3 units, Spr (Ormond, K)

GENE 286A. Advanced Genetic Counseling Seminar

For genetic counseling students only. Psychosocial issues associated with genetic counseling cases through cases that students have seen throughout their training. Professional development topics including: the expanding roles of genetic counselors; billing, reimbursement, and licensing; the role of genetic counseling in the changing healthcare system; the incorporation of genetics into all areas of medicine and public health; and implications of direct-to-consumer genetic testing. Prerequisites: GENE 285 A,B,C and 276.

2 units, Aut (Ormond, K)

GENE 286B. Advanced Genetic Counseling Seminar

Continuation of GENE 286A. For genetic counseling students only. Psychosocial issues associated with genetic counseling cases through cases that students have seen throughout their training. Professional development topics including: the expanding roles of genetic counselors; billing, reimbursement, and licensing; the role of genetic counseling in the changing healthcare system; the incorporation of genetics into all areas of medicine and public health; and implications of direct-to-consumer genetic testing. Prerequisites: GENE 285 A,B,C and 276.

2 units, Win (Staff)

GENE 286C. Advanced Genetic Counseling Seminar

Continuation of 286A/B. For genetic counseling students only. Psychosocial issues associated with genetic counseling cases through cases that students have seen throughout their training. Professional development topics including: the expanding roles of genetic counselors; billing, reimbursement, and licensing; the role of genetic counseling in the changing healthcare system; the incorporation of genetics into all areas of medicine and public health; and implications of direct-to-consumer genetic testing. Prerequisites: GENE 285 A,B,C and 276.

2 units, Spr (Ormond, K)

GENE 299. Directed Reading in Genetics

Prerequisite: consent of instructor.

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

GENE 399. Graduate Research

Investigations sponsored by individual faculty members. Prerequisite: consent of instructor.

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

GENE 801. TGR Project

0 units, Aut (Staff), Win (Staff), Spr (Staff), Sum (Staff)

GENE 802. TGR Dissertation

0 units, Aut (Staff), Win (Staff), Spr (Staff), Sum (Staff)

HEALTH RESEARCH AND POLICY (HRP)

UNDERGRADUATE COURSES IN HEALTH RESEARCH AND POLICY

HRP 89Q. Introduction to Cross Cultural Issues in Medicine

(S,Sem) Stanford Introductory Seminar. Preference to sophomores. Introduction to social factors that impact health care delivery, such as ethnicity, immigration, language barriers, and patient service expectations. Focus is on developing a framework to understand culturally unique and non-English speaking populations in the health care system. GER:EC-AmerCul

3 units, Win (Corso, I)

HRP 199. Undergraduate Research

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

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

GRADUATE COURSES IN HEALTH RESEARCH AND POLICY

HRP 207. Introduction to Concepts and Methods in Health Services and Policy Research I

Primarily for medical students in the Health Services and Policy Research scholarly concentration. Topics include health economics, statistics, decision analysis, study design, quality measurement, cost benefit and effectiveness analysis, and evidence based guidelines.

2 units, Aut (Haberland, C)

HRP 208. Introduction to Concepts and Methods in Health Services and Policy Research II

Primarily for medical students in the Health Services and Policy Research scholarly concentration; continuation of 207. Topics include health economics, statistics, decision analysis, study design, quality measurement, cost benefit and effectiveness analysis, and evidence based guidelines. Recommended: 207.

2 units, Win (Haberland, C)

HRP 209. FDA's Regulation of Health Care

(Same as LAW 458) Open to law and medical students; other graduate students by consent of instructor. The FDA's regulatory authority over drugs, biologics, medical devices, and dietary supplements. The nature of the pharmaceutical, biotech, medical device, and nutritional supplement industries.

2-3 units, not given this year

HRP 210. Health Law and Policy

(Same as Law 313) Open to law or medical students; other graduate students by consent of instructor. Focus this term is on the American health care financing system and its reform, how the present system works, diagnosing where it does not work, and exploring how it might be improved.

3 units, Aut (Greely, H)

HRP 211. Law and the Biosciences

(Same as LAW 368) Legal, social, and ethical issues arising from advances in neuroscience, including effects upon law and society through improvements in predicting illnesses and behaviors, reading minds through neuroimaging, understanding responsibility and consciousness, treating criminal behavior, cognitive enhancement.

3 units, not given this year

HRP 212. Crosscultural Medicine

Developing interviewing and behavioral skills needed to facilitate culturally relevant health care across all population groups. Discussions focus on explicit and implicit cultural influences operating in formal and informal medical contexts.

3 units, Spr (Corso, I)

HRP 214. Scientific Writing

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

2-3 units, Win (Sainani, K)

HRP 215. Scientific Writing for Basic and Translational Scientists

How to write clearly, concisely, and effectively. Focus is on the process of writing and publishing a scientific manuscript. Not intended for Epidemiology graduate students.

2-3 units, Sum (Sainani, K)

HRP 216. Analytical and Practical Issues in the Conduct of Clinical and Epidemiologic Research

Topics include: advanced aspects of study design and data analyses; development of health measurement instruments; methods of summarizing literature and quantifying effect sizes; and multivariable nature of health events in human populations. 3 units requires a term paper. Prerequisites: 225, and 258 or 261, or consent of instructor.

2-3 units, Spr (Staff)

HRP 220. Biotechnology Law and Policy

(Same as LAW 440) Open to law or medical students; other graduate students by consent of the instructor. Focus is on the biotechnology industry, with some discussion of the med tech or medical device industry and the pharmaceutical industry. The life cycle of a biotech firm, from a good idea to a start-up company to FDA approval and beyond. Guest speakers. Group project making law and business recommendations about a biotech firm.

3 units, Spr (Greely, H)

HRP 221. Law and the Biosciences: Genetics

(Same as LAW 480) Open to all law or medical students; other graduate students by consent of the instructor. Ethical, legal, and social issues arising primarily from advances in knowledge of human genetics. May also include a section on stem cell research.

3 units, Spr (Greely, H)

HRP 223. Epidemiologic Analysis: 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, R)

HRP 225. Design and Conduct of Clinical and Epidemiologic Studies

Intermediate-level. The skills to design, carry out, and interpret epidemiologic studies, particularly of chronic diseases. Topics: epidemiologic concepts, sources of data, cohort studies, case-control studies, cross-sectional studies, sampling, estimating sample size, questionnaire design, and the effects of measurement error. Prerequisite: A basic/introductory course in statistics or consent of instructor.

3-4 units, Aut (Popat, R)

HRP 226. Advanced Epidemiologic and Clinical Research Methods

Principles of measurement, measures of effect, confounding, effect modification, and strategies for minimizing bias in clinical and epidemiologic studies. Prerequisite: 225 or consent of instructor.

3-4 units, Win (Nelson, L)

HRP 228. Genetic Epidemiology

Reading of seminal papers in genetic epidemiology. Topics include human genetic variation, genetics of complex diseases, genome-wide association studies, and new genomic technologies. Provides a background for clinicians, epidemiologists, and other scientists to incorporate the study of genetic factors into human disease research. Prerequisite: HRP 225 or consent of instructor.

2 units, Spr (Staff)

HRP 229. Methods in Chronic Disease Epidemiology

Descriptive epidemiology and sources of incidence and mortality data; biological bases of neurological, musculoskeletal, cardiovascular, and other chronic diseases except cancer; methodological and analytic issues relevant to chronic epidemiologic research; causal inference; major environmental risk factors; genetic susceptibility; and examples of current research and critiques of literature. Prerequisite: 225 or consent of instructor.

2-3 units, alternate years, not given this year

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. 3 units requires paper or project. Prerequisite: 225, or consent of instructor.

2-3 units, Win (Staff)

HRP 231. Epidemiology of Infectious Diseases

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, Win (Staff)

HRP 236. Epidemiology Research Seminar

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

1 unit, Aut (Henderson, V), Win (West, D), Spr (Whitmore, A)

HRP 238. Genes and Environment in Disease Causation: Implications for Medicine and Public Health

(Same as HUMBIO 159) The historical, contemporary, and future research and practice among genetics, epidemiology, clinical medicine, and public health as a source of insight for medicine and public health. Genetic and environmental contributions to multifactorial diseases; multidisciplinary approach to enhancing detection and diagnosis. The impact of the Human Genome Project on

analysis of cardiovascular and neurological diseases, and cancer. Ethical and social issues in the use of genetic information. Prerequisite: basic course in genetics; for undergraduates, Human Biology core or equivalent or consent of instructor.

2-3 units, Win (Popat, R)

HRP 239. Understanding Statistical Models and their Social Science Applications

(Same as EDUC 260X, STATS 209) Critical examination of statistical methods in social science applications, especially for cause and effect determinations. Topics: path analysis, multilevel models, matching and propensity score methods, analysis of covariance, instrumental variables, compliance, longitudinal data, mediating and moderating variables. See <http://www-stat.stanford.edu/~rag/stat209>. Prerequisite: intermediate-level statistical methods

3 units, Win (Rogosa, D)

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 (Henderson, V; Lavori, P)

HRP 252. Outcomes Analysis

(Same as BIOMEDIN 251) 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, J)

HRP 256. Economics of Health and Medical Care

(Same as BIOMEDIN 156, BIOMEDIN 256, ECON 126) 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. Prerequisites: ECON 50 and ECON 102A or equivalent statistics. Recommended: ECON 51.

5 units, Aut (Bhattacharya, J)

HRP 258. Introduction to Probability and Statistics for Clinical Research

Open to medical and graduate students; required of medical students in the Clinical Research Scholarly Concentration. Tools to evaluate medical literature. Topics include random variables, expectation, variance, probability distributions, the central limit theorem, sampling theory, hypothesis testing, confidence intervals, correlation, regression, analysis of variance, and survival analysis.

3 units, Spr (Sainani, K)

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 (Sainani, K)

HRP 260A. Workshop in Biostatistics

(Same as STATS 260A) Applications of statistical techniques to current problems in medical science.

1-2 units, Aut (Olshen, R)

HRP 260B. Workshop in Biostatistics

(Same as STATS 260B) Applications of statistical techniques to current problems in medical science.

1-2 units, Win (Olshen, R)

HRP 260C. Workshop in Biostatistics

(Same as STATS 260C) Applications of statistical techniques to current problems in medical science.

1-2 units, Spr (Olshen, R)

HRP 261. Intermediate Biostatistics: Analysis of Discrete Data

(Same as BIOMEDIN 233, STATS 261) Methods for analyzing data from case-control and cross-sectional studies: the 2x2 table, chi-square test, Fisher's exact test, odds ratios, Mantel-Haenzel methods, stratification, tests for matched data, logistic regression, conditional logistic regression. Emphasis is on data analysis in SAS. Special topics: cross-fold validation and bootstrap inference.

3 units, Win (Sainani, K)

HRP 262. Intermediate Biostatistics: Regression, Prediction, Survival Analysis

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

3 units, Spr (Staff)

HRP 280. Spanish for Medical Students

(Same as SPANLANG 121M) Goal is a practical and culturally appropriate command of spoken Spanish. Emphasis is on taking the medical history. Topics include the human body, hospital procedures, diagnostics, food, and essential doctor-patient phrases when dealing with Spanish-speaking patients. Series can be taken independently, depending on the level of prior knowledge.

3 units, Aut (Corso, I)

HRP 281. Spanish for Medical Students

(Same as SPANLANG 122M) Goal is a practical and culturally appropriate command of spoken Spanish. Emphasis is on performing a physical examination. Topics include the human body, hospital procedures, diagnostics, food, and essential doctor-patient phrases when dealing with Spanish-speaking patients. Series can be taken independently, depending on the level of prior knowledge.

3 units, Win (Corso, I)

HRP 282. Spanish for Medical Students

(Same as SPANLANG 123M) Goal is a practical and culturally appropriate command of spoken Spanish. Emphasis is on different specialties and medical conditions. Topics include the human body, hospital procedures, diagnostics, food, and essential doctor-patient phrases when dealing with Spanish-speaking patients. Series can be taken independently, depending on the level of prior knowledge.

3 units, Spr (Corso, I)

HRP 283. Health Services Research Core Seminar

Presentation of research in progress and tutorials in the field of health services research.

1 unit, Aut (Haberland, C), Win (Haberland, C), Spr (Haberland, C)

HRP 290. Advanced Medical Spanish Oral Communication

Enrollment limited to medical students. Designed to further develop linguistic skills, covering all medical specialties according to student needs. Sessions also include topics on patient education and diseases, such as diabetes, asthma, TB, and CVDs.

3 units, Aut (Corso, I), Win (Corso, I), Spr (Corso, I)

HRP 299. Directed Reading in Health Research and Policy

Epidemiology, health services research, preventive medicine, medical genetics, public health, economics of medical care, occupational or environmental medicine, international health, or related fields. May be repeated for credit. Prerequisite: consent of instructor.

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

HRP 351. Health Care Technology: From Innovators to Providers to Patients

(Same as GSBGEN 351) How health care businesses use biotechnology, medical technology and information technology to improve patient outcomes and manage costs. New technologies commercialized by innovator biotech and pharmaceutical companies, device manufacturers, diagnostics developers, and health IT

companies, and adopted by hospitals and physicians in patient care and paid for by third-party payers. Case studies: how innovators finance and manage new product development; clinical trial management and gaining regulatory approval; strategies to drive product adoption; business models to drive innovation; clinical and business models for adopting new technology; organizational change; criteria for reimbursement and coverage decisions; selective provider network design to manage added costs; and IT-intensive business models. Guest speakers and panelists.

4 units, not given this year

HRP 370. Medical Scholars Research

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

4-18 units, Aut (Staff), Win (Staff), Spr (Staff), Sum (Staff)

HRP 391. Health Care Regulation, Finance and Policy

(Same as PUBLPOL 231) (SAME AS LAW 348) Provides the legal, institutional, and economic background necessary to understand the financing and production of health services in the U.S. Potential topics include: health reform, health insurance (Medicare and Medicaid, employer-sponsored insurance, the uninsured), medical malpractice and quality regulation, pharmaceuticals, the corporate practice of medicine, regulation of fraud and abuse, and international comparisons.

3 units, Win (Kessler, D)

HRP 392. Analysis of Costs, Risks, and Benefits of Health Care

(Same as BIOMEDIN 432) (Same as MGTECON 332) For graduate students. How to do cost/benefit analysis when the output is difficult or impossible to measure. How do M.B.A. analytic tools apply in health services? Literature on the principles of cost/benefit analysis applied to health care. Critical review of actual studies. Emphasis is on the art of practical application.

4 units, Aut (Garber, A; Owens, D)

HRP 399. Graduate Research

Investigations sponsored by individual faculty members. Prerequisite: consent of instructor.

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

IMMUNOLOGY (IMMUNOL)**UNDERGRADUATE COURSES IN IMMUNOLOGY****IMMUNOL 185. Brain and the Immune System**

(Same as IMMUNOL 285) For advanced undergraduates, co-terminal students, and graduate students. Molecular and cellular interactions between the nervous and immune systems. Focus is on the role of immune molecules in neural development, the bidirectional mechanisms by which the brain and immune system communicate with each other, and the role of the immune system in the diseased and infected brain. Topics include: molecular basis of fever, stress and inflammation, gender differences in autoimmune diseases, inflammation in neurodegenerative diseases, central nervous system infections, and the immune system in psychiatric disorders. Expert guest lectures, weekly discussion sections, and student presentations. Prerequisite: Biology or Human Biology core.

3 units, Win (Steinman, L; Brownell, S; Price, J)

GRADUATE COURSES IN IMMUNOLOGY**IMMUNOL 201. Advanced Immunology I**

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

3 units, Win (Chien, Y)

IMMUNOL 202. Advanced Immunology II

(Same as MCP 202) Readings of immunological literature. Classic problems and emerging areas based on primary literature. Student and faculty presentations. Prerequisite: IMMUNOL 201/MI 211.

3 units, Spr (Garcia, K)

IMMUNOL 203. Advanced Immunology III

Key experiments and papers in immunology. Student presentations and faculty participation; faculty describe their experimental process and scientific papers. Prerequisite: IMMUNOL 201/MI 211 or IMMUNOL 202/MCP 202.

3 units, Sum (Staff)

IMMUNOL 204. Innate Immunology

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

3 units, Spr (Schneider, D)

IMMUNOL 205. Immunology in Health and Disease

Concepts and application of adaptive and innate immunology and the role of the immune system in human diseases. Case presentations of diseases including autoimmune diseases, infectious disease and vaccination, hematopoietic and solid organ transplantation, genetic and acquired immunodeficiencies, hypersensitivity reactions, and allergic diseases. Problem sets based on lectures and current clinical literature. Laboratory in acute and chronic inflammation.

2-4 units, Win (Lewis, D)

IMMUNOL 215. Principles of Biological Technologies

(Same as MI 215) 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. Required of first-year graduate students in Microbiology and Immunology, and the Immunology program.

3 units, Spr (Kirkegaard, K)

IMMUNOL 231. Medicine for Innovators and Entrepreneurs

(Same as PEDS 231) Interdisciplinary, project-based course in which bioscience, bioinformatics, biodesign, bioengineering students learn concepts and principles to understand human disease and work together to propose solutions to medical problems. Diabetes mellitus is used as a paradigm for understanding human disease. Guest medical school and outside faculty. Field trips to Stanford clinics and biotechnology companies. Prerequisite: college level biology.

3-4 units, Spr (Aye, T; Mellins, E)

IMMUNOL 275. Tumor Immunology

(Same as CBI 275) Focuses on the ability of innate and adaptive immune responses to recognize and control tumor growth. Topics include: tumor antigens, tumor immunosurveillance and immunoeediting, tumor immunotherapy, cancer vaccines and dendritic cell therapy. Tracks the historical developments of our understanding of modulating tumor immune response and discusses their relative significance in the light of current research findings. Prerequisite: for undergraduates, human biology or biology core.

3 units, Aut (Engleman, E; Rothbard, J)

IMMUNOL 285. Brain and the Immune System

(Same as IMMUNOL 185) For advanced undergraduates, coterminal students, and graduate students. Molecular and cellular interactions between the nervous and immune systems. Focus is on the role of immune molecules in neural development, the bi-directional mechanisms by which the brain and immune system communicate with each other, and the role of the immune system in the diseased and infected brain. Topics include: molecular basis of fever, stress and inflammation, gender differences in autoimmune diseases, inflammation in neurodegenerative diseases, central nervous system infections, and the immune system in psychiatric disorders. Expert guest lectures, weekly discussion sections, and student presentations. Prerequisite: Biology or Human Biology core.

3 units, Win (Steinman, L; Brownell, S; Price, J)

IMMUNOL 290. Teaching in Immunology

Practical experience in teaching by serving as a teaching assistant in an immunology course. Unit values are allotted individually to reflect the level of teaching responsibility assigned to the student. May be repeated for credit.

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

IMMUNOL 299. Directed Reading in Immunology

Prerequisite: consent of instructor.

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

IMMUNOL 305. Immunology Journal Club

Required of first- to fourth-year graduate students. Graduate students present and discuss recent papers in the literature. May be repeated for credit.

1 unit, Aut (Steinman, L; Martinez, O), Win (Steinman, L), Spr (Steinman, L)

IMMUNOL 311. Seminar in Immunology

Enrollment limited to Ph.D., M.D./Ph.D., and medical students whose scholarly concentrations are in Immunology.

1 unit, Aut (Steinman, L; Fathman, C), Win (Steinman, L; Fathman, C), Spr (Steinman, L; Fathman, C)

IMMUNOL 311A. Discussions in Immunology

Students discuss papers of speakers in 311, and meet with the speakers. Corequisite: 311.

1 unit, Aut (Steinman, L; Fathman, C), Win (Steinman, L; Fathman, C), Spr (Steinman, L; Fathman, C)

IMMUNOL 399. Graduate Research

For Ph.D., M.D./Ph.D. students, and medical students whose scholarly concentrations are in Immunology.

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

MEDICINE (MED)

UNDERGRADUATE COURSES IN MEDICINE

MED 1A. Leadership in Multicultural Health

Year-long course. Models of instruction for undergraduates serving as Stanford Medical Youth Science Summer Residential Program (SMYSP) staff. Observation, participation, and evaluation of leadership development and multicultural health theories and practices; school and community engagement and advocacy. 1 unit: class attendance and oral presentation; 2 units: class attendance and project portfolio; 3 units: class attendance, poster and oral presentation; 4 units: class attendance and reflective term paper. Applications for this year-long course must be submitted during autumn quarter. Contact Judith Ned: jned@stanford.edu, 650-498-4514. Current or past SMYSP Summer Residential Program staff.

1-4 units, Win (Winkleby, M; Ned, J)

MED 1B. Leadership in Multicultural Health

Models of instruction for undergraduates serving as Stanford Medical Youth Science Summer Residential Program (SMYSP) staff. Application of leadership development skills, multicultural health theories and practices, and school and community engagement and advocacy to creating and implementing activities for low-income high school students participating in the Summer Residential Program. 1 unit: class attendance and oral presentation; 2 units: class attendance and project portfolio; 3 units: class attendance, poster and oral presentation; 4 units: class attendance and reflective term paper. Prerequisite: MED 1A.

1-4 units, Spr (Winkleby, M; Ned, J)

MED 1C. Leadership in Multicultural Health

Students submit a written reflective term paper based on their experience as staff for the SMYSP Summer Residential Program. Prerequisite: MED 1A/B.

1 unit, Aut (Winkleby, M; Ned, J)

MED 70Q. Cancer and the Immune System

(S,Sem) Stanford Introductory Seminar. Preference to sophomores. Myths and facts surrounding the idea that the immune system is capable of recognizing malignant cells. The biological basis and function of effector arms of the immune system; how these mechanisms may be used to investigate the biological basis and potential therapy of cancer. How the immune system functions.

3 units, Spr (Negrin, R)

MED 83Q. Ethical, Legal, and Social Dimensions of Stem Cell Research

(S,Sem) Stanford Introductory Seminar. Preference to sophomores. Ethical, legal, social, and economic dimensions of stem cell research such as the discovery of human embryonic stem cells and the international landscape of public policy. How stem cells work, their role in the upkeep of the human body, and current and future uses in medicine. Issues at the intersection of science and society such as human-animal hybrids, notions of justice in intellectual property law, distribution of health care, and the major ethical frameworks defining the debate.

3 units, Spr (Scott, C)

MED 86Q. Seeing the Heart

(F,Dial) Stanford Introductory Dialogue. Introduction to biomedical technology, science, clinical medicine, and public policy through cardiovascular imaging. Invasive and noninvasive techniques to detect early stage heart disease and to see inside the heart and blood vessels. Topics include: common forms of heart disease, how they develop, and why they affect so many people; imaging technologies such as ultrasound, CT, MRI, PET, and optical; a cost-effective public screening program. Field trips to Stanford Medical Center imaging centers.

2 units, Win (McConnell, M)

MED 87Q. Women and Aging

(S,Sem) (Same as HUMBIO 87Q) Stanford Introductory Seminar. Preference to sophomores. Biology, clinical issues, social and health policies of aging; relationships, lifestyles, and sexuality; wise women and grandmothers. Sources include scientific articles, essays, poetry, art, and film. Service-learning experience with older women. GER:EC-Gender

5 units, Win (Winograd, C)

MED 88Q. Dilemmas in Current Medical Practice

(S,Sem) Stanford Introductory Seminar. Preference to sophomores. Social, political, scientific, and economic forces influencing medical practice. Spiraling costs, impaired access to health care, and disillusionment toward the health care system. Attempts by government and medical insurers to control costs through managed care and health maintenance organizations. Medical education and how it has affected the practice of medicine. Alternative health care, preventive medicine, and the doctor-patient relationship. The paradox of health in America: why do so many people who are healthy feel unhealthy? Mandatory observation of instructors in their medical practices.

3 units, Aut (Croke, J; Jones, H)

MED 93Q. The AIDS Epidemic: Biology, Behavior, and Global Responses

(S,Sem) Stanford Introductory Seminar. Preference to sophomores. How the discovery of the causative agent and the modes of transmission of HIV fueled a quest for prevention, treatments, and a vaccine. Discoveries in biology, biotechnology, epidemiology, and medicine during the last 20 years. Hypotheses about the origins of HIV as a human disease; the spread of AIDS and HIV; social, political, and economic consequences of the epidemic; and national and global responses.

3 units, Aut (Katzenstein, D)

MED 108Q. Human Rights and Health

(S,Sem) Stanford Introductory Seminar. Preference to sophomores. History of human-rights law. International conventions and treaties on human rights as background for social and political changes that could improve the health of groups and individuals. Topics such as: regional conflict and health, the health status of refugees and internally displaced persons; child labor; trafficking in women and children; HIV/AIDS; torture; poverty, the environment and health; access to clean water; domestic violence and sexual assault; and international availability of drugs. Possible optional opportunities to observe at community sites where human rights and health

are issues. Guest speakers from national and international NGOs including Doctors Without Borders; McMaster University Institute for Peace Studies; UC Berkeley Human Rights Center; Kiva. Powerpoint presentation on topic of choice required.

3 units, Win (Laws, A)

MED 143. Patient Health Education in Community Clinics

(Same as MED 243) (Open to undergraduate, graduate, and medical students) Principles of health education, theories of behavior change, methods for risk reduction. Presentations of health education modules, focusing on topics prevalent among underserved populations. Students apply theoretical frameworks to health education activities in the Cardinal Free Clinics.

2 units, Aut (Kao, P; Ho, E)

MED 147. Methods in Community Assessment, Evaluation, and Research

(Same as MED 247) Development of pragmatic skills for design, implementation, and analysis of structured interviews, focus groups, survey questionnaires, and field observations. Topics include: principles of community-based participatory research, including importance of dissemination; strengths and limitations of different study designs; validity and reliability; construction of interview and focus group questions; techniques for moderating focus groups; content analysis of qualitative data; survey questionnaire design; and interpretation of commonly-used statistical analyses.

3 units, Spr (Kiernan, M; Fortmann, S)

MED 149. Medical Interpreting: Skills and Etiquette

(Same as MED 249) Open to medical students, graduate and undergraduate students. The skills and etiquette of medical interpreting from a cross-cultural perspective. Includes an overview of the U.S. healthcare system and guest lectures on humanistic medicine. Requires two volunteer shifts at the Arbor Free Clinic. Successful completion qualifies students to become volunteer interpreters at the Stanford University Medical Center and the Arbor Free Clinic. Prerequisite: Fluency in a language other than English.

2 units, Win (Osterberg, L; Chen, Y)

MED 160. Physician Shadowing: Stanford Immersion in Medicine Series (SIMS)

Undergraduates are paired with a physician mentor at Stanford Hospital and Clinics, Lucile Packard Children's Hospital, or the Veteran's Administration Hospital. May be repeated for credit. Prerequisite: Application and acceptance to the SIMS program.

1 unit, Aut (Gesundheit, N; Fox, E), Win (Gesundheit, N; Fox, E), Spr (Gesundheit, N; Lewis, P)

MED 199. Undergraduate Research

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

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

GRADUATE COURSES IN MEDICINE

MED 201. Introduction to Internal Medicine

Introduction to the different roles internists play in health care. Weekly lectures augmented with opportunities for mentorship, shadowing, and clinical skills-building. Lecture topics include primary care, subspecialties, and non-clinical careers.

1 unit, Aut (Verghese, A)

MED 207. History of Medicine

Weekly lectures that trace the development of Western medical tradition from Babylonian, Egyptian, and Greek ancient cultures to the present.

1 unit, Win (Camargo, C)

MED 217. Technological Frontiers in Digestive Diseases

Focused on introducing engineering, bioengineering, and physical sciences students to technologies used in the clinical setting. Topics include: endoscopes to detect and remove cancer; minimally invasive surgery to treat obesity; measurements of propulsion through the intestine; and technologies to detect and stop internal bleeding. Observations in the clinical setting; visits to laboratories engaged in the development of new technologies.

2 units, Spr (Lowe, A; Milroy, J)

MED 227. Bedside Ultrasound

For pre-clinical or clinical medical students, and others with permission. Uses of ultrasound (US) at the bedside. Portable US machines (now the size of laptop computers) are used. How to identify the normal anatomy of the heart, abdomen, and pelvis using US. As proficiency increases, patients with abnormal physical findings are examined at the bedside, enabling students to compare the traditional physical examination with information obtained during US. The syllabus, *Introduction to the Physical Examination with Diagnostic Ultrasound* (2001), written by Drs. Wolfe and Thompson is used as the students' guide.

1 unit, Aut (Liang, D; Thompson, N), Win (Liang, D; Thompson, N), Spr (Liang, D; Thompson, N)

MED 228. Physicians and Social Responsibility

Social and political context of the roles of physicians and health professionals in social change; policy, advocacy, and shaping public attitudes. How physicians have influenced governmental policy on nuclear arms proliferation; environmental health concerns; physicians in government; activism through research; the effects of poverty on health; homelessness; and gun violence. Guest speakers from national and international NGOs.

1 unit, Aut (Laws, A)

MED 230. Rethinking International Health

Issues and players that shape international health today. How to develop a road map for thoughtful, responsible action. Topics include: the role of the physician and health care worker; health as a human right; successful interventions; children's and women's health; issues in immunization; economic development; and NGOs. Online interviews with influential leaders in international health.

2-3 units, Spr (Goldhaber-Fiebert, J)

MED 236. Psychosocial and Behavioral Health Interventions

For medical students, graduate students and undergraduates with senior standing in Human Biology or Psychology. Contemporary theory and conceptual frameworks for psychosocial and behavioral change interventions as applied in the context of contemporary models of community medicine. The trans-theoretical model of behavioral change, contemporary behavioral, cognitive behavioral, social cognitive and acceptance-based models of behavioral change. Current models of emotion regulation, goal setting and attainment, and the impact of personality and characterological features on behavior and behavioral change. Application of theory in practicum based community clinic settings. Prerequisite: Stanford HIPAA training.

1 unit, not given this year

MED 240. Sex Differences in Human Physiology and Disease

(Same as OBGYN 240, HUMBIO 140) Chromosomal and hormonal influences on cells, tissues, and organs that underlie the development of reproductive organs and sexual dimorphism of the neuroendocrine system. Consequences of sex hormones and environmental factors that differ between men and women in systems including the musculoskeletal, neurological, cardiovascular, and immunological. Guest lecturers. Prerequisite: Human Biology core or equivalent, or consent of instructor.

2-3 units, Win (Stefanick, M)

MED 242. Physicians and Human Rights

Weekly lectures on how human rights violations affect health. Topics include: regional conflict and health, the health status of refugees and internally displaced persons; child labor; trafficking in women and children; HIV/AIDS; torture; poverty, the environment and health; access to clean water; domestic violence and sexual assault; and international availability of drugs. Guest speakers from national and international NGOs including Doctors Without Borders; McMaster University Institute for Peace Studies; UC Berkeley Human Rights Center; Kiva.

1 unit, Win (Laws, A)

MED 243. Patient Health Education in Community Clinics

(Same as MED 143) (Open to undergraduate, graduate, and medical students) Principles of health education, theories of behavior change, methods for risk reduction. Presentations of health education modules, focusing on topics prevalent among underserved populations. Students apply theoretical frameworks to health education activities in the Cardinal Free Clinics.

2 units, Aut (Kao, P; Ho, E)

MED 244. Health Screening in the Community

Practicum in the basics of health care screening and counseling with minor lecture component. Includes, but is not limited to, blood pressure, diabetes, cholesterol, obesity, safe sex, tuberculosis, diet and smoking. Students organize and participate in one community health screening even each month during the quarter. Adjunct to Stanford free clinics courses (Arbor and Pacific), but with consent of instructor may be taken by students not volunteering at these clinics.

1 unit, Aut (Osterberg, L), Win (Osterberg, L), Spr (Staff), Sum (Osterberg, L)

MED 247. Methods in Community Assessment, Evaluation, and Research

(Same as MED 147) Development of pragmatic skills for design, implementation, and analysis of structured interviews, focus groups, survey questionnaires, and field observations. Topics include: principles of community-based participatory research, including importance of dissemination; strengths and limitations of different study designs; validity and reliability; construction of interview and focus group questions; techniques for moderating focus groups; content analysis of qualitative data; survey questionnaire design; and interpretation of commonly-used statistical analyses.

3 units, Spr (Kiernan, M; Fortmann, S)

MED 248. Student Rounds

Teams of preclinical students meet weekly with a clinical student to hear the history and physical of a recent case the clinical student encountered on the wards. Following the presentation, the preclinical students work together under the guidance of the clinical student to develop a problem list and plan, which are then compared with the problem list, plan, and orders made by the actual admitting team. In the course of presenting the cases, the clinical student describes personal experiences and practical components of ward work and daily clinical routine.

1 unit, Aut (Kenny, K), Win (Kenny, K), Spr (Kenny, K), Sum (Kenny, K)

MED 249. Medical Interpreting: Skills and Etiquette

(Same as MED 149) Open to medical students, graduate and undergraduate students. The skills and etiquette of medical interpreting from a cross-cultural perspective. Includes an overview of the U.S. healthcare system and guest lectures on humanistic medicine. Requires two volunteer shifts at the Arbor Free Clinic. Successful completion qualifies students to become volunteer interpreters at the Stanford University Medical Center and the Arbor Free Clinic. Prerequisite: Fluency in a language other than English.

2 units, Win (Osterberg, L; Chen, Y)

MED 250A. Medical Ethics I

Required for Scholarly Concentration in Biomedical Ethics and Medical Humanities. The field of bioethics, including theoretical approaches to bioethical problems. Contemporary controversies and clinical cases. Values that arise in different situations and clinical encounters. Issues include: genetics and stem cell research, rationing, ethical issues in care at the end of life, organ transplantation issues.

2 units, Win (Magnus, D)

MED 250B. Medical Ethics II

The integration of ethical theory with applications of theory or conceptual issues in medicine, health care, and the life and social sciences. Topic varies by year. Possible topics include: ethical issues in stem cell research; death and dying; genetics and ethics; concepts of health and disease; the ethics of international research; and ethical implications of new reproductive technology.

2 units, not given this year

MED 255. The Responsible Conduct of Research

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

1 unit, Aut (Karkazis, K), Win (Karkazis, K), Spr (Karkazis, K)

MED 255C. The Responsible Conduct of Research for Clinical Researchers

Engages clinical researchers in discussions about ethical issues commonly encountered during their clinical research careers and addresses contemporary debates at the interface of biomedical science and society. Medical and graduate students required to take RCR who are or will be conducting clinical research are encouraged to enroll in this version of the course. Prerequisites: research experience recommended, instructor consent required.

1 unit, Aut (Karkazis, K)

MED 256. Global HIV/AIDS

(Same as HUMBIOL 156) Public health, policy, and research issues. Resources at Stanford and institutions such as government, NGOs, and pharmaceutical, advocacy, and international organizations. Sources include biomedical, social, and behavioral sciences. Student projects. Guest lectures. Prerequisite: Human Biology core or equivalent, or consent of instructor.

3 units, Spr (Katzenstein, D)

MED 257A. Patient Advocacy in Community Clinics

Early clinical experience for pre-medical and medical students. Structured training and shadowing in preparation for a clinical role working with patients in community health clinics; the context of the work, populations served, and social role of physicians. Regular shifts at one of the course-affiliated clinic sites throughout the academic year. 1-2 units for students attending class meetings and performing clinic shifts. 3-4 units for a year-long, clinic-based project. Prerequisite: application.

1-4 units, Aut (Garcia, G; Banchoff, A)

MED 257B. Patient Advocacy in Community Clinics

Early clinical experience for pre-medical and medical students. Structured training and shadowing in preparation for a clinical role working with patients in community health clinics; the context of the work, populations served, and social role of physicians. Regular shifts at one of the course-affiliated clinic sites throughout the academic year. 1-2 units for students attending class meetings and performing clinic shifts. 3-4 units for a year-long, clinic-based project. Prerequisite: MED 257A

1-4 units, Win (Garcia, G; Banchoff, A)

MED 257C. Patient Advocacy in Community Clinics

Early clinical experience for pre-medical and medical students. Structured training and shadowing in preparation for a clinical role working with patients in community health clinics; the context of the work, populations served, and social role of physicians. Regular shifts at one of the course-affiliated clinic sites throughout the academic year. 1-2 units for students attending class meetings and performing clinic shifts. 3-4 units for a year-long, clinic-based project. Prerequisite: 257A,B

1-4 units, Spr (Garcia, G; Banchoff, A)

MED 258. Advanced Patient Advocacy in Community Clinics

Continuation of 257A,B,C for second-year students in Patient Advocacy Program; open to students who have worked in a clinical capacity in a community clinic setting. Skills training in areas such as health education counseling and group facilitation. Regular shifts at partner clinics. Students partner with clinic staff in developing and carrying out a service-learning or research project designed to meet the clinic's needs. May be repeated for credit. Prerequisites: 257A,B,C or consent of instructor.

1-3 units, alternate years, not given this year

MED 258A. Advanced Patient Advocacy in Community Clinics

Continuation of 257A,B,C for second-year students in Patient Advocacy Program; open to students who have worked in a clinical capacity in a community clinic setting. Skills training in areas such as health education counseling and group facilitation. Regular shifts at partner clinics. Students partner with clinic staff in developing and carrying out a service-learning or research project designed to meet the clinic's needs. Prerequisites: 257A,B,C or consent of instructor.

1-3 units, Aut (Garcia, G; Banchoff, A)

MED 258B. Advanced Patient Advocacy in Community Clinics

Continuation of 258A for second-year students in Patient Advocacy Program; open to students who have worked in a clinical capacity in a community clinic setting. Skills training in areas such as health education counseling and group facilitation. Regular shifts at partner clinics. Students partner with clinic staff in developing

and carrying out a service-learning or research project designed to meet the clinic's needs. Prerequisites: 257A,B,C and 258A, or consent of instructor.

1-3 units, Win (Garcia, G; Banchoff, A)

MED 258C. Advanced Patient Advocacy in Community Clinics

Continuation of 258A/B for second-year students in Patient Advocacy Program; open to students who have worked in a clinical capacity in a community clinic setting. Skills training in areas such as health education counseling and group facilitation. Regular shifts at partner clinics. Students partner with clinic staff in developing and carrying out a service-learning or research project designed to meet the clinic's needs. Prerequisites: 257A,B,C and 258A, B, or consent of instructor.

1-3 units, Spr (Garcia, G; Banchoff, A)

MED 259. Oaxacan Health on Both Sides of the Border

Required for students participating in the Community Health in Oaxaca summer program. Introduction to the health literacy and health-seeking behaviors of Oaxacan and other Mexican migrants; examines the health challenges these groups face. Through discussion and reflection, students prepare for clinical work and community engagement in Oaxaca, while also gaining knowledge and insight to make connections between their experiences in Mexico and their health-related work with Mexican immigrants in the Bay Area. Prerequisite: application and acceptance into the Community Health in Oaxaca Summer Program (<http://och.stanford.edu/oaxaca.html>).

2 units, Spr (Garcia, G; Banchoff, A)

MED 262. Economics of Health Improvement in Developing Countries

(Same as ECON 127) Application of economic paradigms and empirical methods to health improvement in developing countries. Emphasis is on unifying analytic frameworks and evaluation of empirical evidence. How economic views differ from public health, medicine, and epidemiology; analytic paradigms for health and population change; the demand for health; the role of health in international development. Prerequisites: ECON 50 and 102B, and consent of instructor.

5 units, not given this year

MED 272A. Biodesign Innovation Core: Needs Finding and Concept Creation

(Same as BIOE 374A, ME 368A) Two quarter sequence. Inventing new medical devices and instrumentation, including: methods of validating medical needs; techniques for analyzing intellectual property; basics of regulatory (FDA) and reimbursement planning; brainstorming and early prototyping. Guest lecturers and practical demonstrations. May be taken alone (2 units) or in combination with the project component (4 units).

2-4 units, Win (Yock, P; Zenios, S; Milroy, J; Brinton, T)

MED 272B. Biodesign Innovation Core: Concept Development and Implementation

(Same as BIOE 374B, ME 368B) Two quarter sequence. How to take a medical device invention forward from early concept to technology translation and development. Topics include prototyping; patent strategies; advanced planning for reimbursement and FDA approval; choosing translation route (licensing versus start-up); ethical issues including conflict of interest; fundraising approaches and cash requirements; essentials of writing a business or research plan; strategies for assembling a development team. May be taken alone (2 units) or in combination with the project component (4 units). Prerequisite: MED 272A, ME368A, or BIOE 374A.

2-4 units, Spr (Staff)

MED 275. Introduction Biopharmaceutical Innovation

Open to all students. Biotechnology and the pharmaceutical industry. Topics include the biopharmaceutical industry, historical trends, and experiences; research and development; intellectual property; drug approval: regulatory issues and agencies; business development; marketing; manufacturing; capital structure and financing; careers in biopharmaceutical industry. 2-unit option, lectures and weekly assignments, MED or S/NC grading only. 3-unit option, including a group project and final presentation, may be taken for a letter grade. May be repeated for credit.

2-3 units, Win (Gardner, P; Seam, A)

MED 276. Careers in Medical Technology

Career tracks in biomedical technology for medical, life science, engineering, business, and law students of all levels. Industry professionals describe career tracks, current roles, and industry perspectives. 2-unit option, lectures and weekly assignments, MED or S/NC grading only. 3-unit option, including a group project and final presentation, may be taken for a letter grade. May be repeated for credit.

2-3 units, Spr (Gardner, P; Seam, A)

MED 282. Early Clinical Experience at the Arbor Free Clinic

Students provide health care in a student-run clinic for the homeless and uninsured. Student volunteers are guided in the practice of medical interviews, history-taking and physical examinations as appropriate. Clinical students and attending physicians provide support and guidance as the team arrives at a diagnosis and management plan. Two units of credit is intended for Steering Committee members or for students who work at the clinic every other Sunday.

1-2 units, Aut (Osterberg, L), Win (Osterberg, L), Spr (Osterberg, L), Sum (Osterberg, L)

MED 283. Early Clinical Experience at Pacific Free Clinic

Hands-on experience at a student-run free clinic targeting immigrants in the San Jose area. Opportunity to work with an interpreter and learn about unique health care issues faced by immigrants. Students are expected to conduct history and physicals, present to the attending physician, help arrive at a diagnosis and plan and participate in basic procedures. 1 unit for limited commitment. 2 units for volunteers in training and students who volunteer a minimum of once a month. 3 units for Steering Committee members and students who volunteer a minimum of twice a month.

1-3 units, Aut (Staff), Win (Kao, P; Martin, M), Spr (Kao, P)

MED 289. Introduction to Bioengineering Research

(Same as BIOE 390) Preference to medical and bioengineering graduate students. Bioengineering is an interdisciplinary field that leverages the disciplines of biology, medicine, and engineering to understand living systems, and engineer biological systems and improve engineering designs and human and environmental health. Topics include: imaging; molecular, cell, and tissue engineering; biomechanics; biomedical computation; biochemical engineering; biosensors; and medical devices. Limited enrollment.

1-2 units, Aut (Taylor, C), Win (Taylor, C)

MED 295. Advanced Cardiac Life Support

(For clinical MD students only) Prepares students to manage the victim of a cardiac arrest. Knowledge and skills necessary for resuscitation of critically-ill patients. Clinical scenarios and small group discussions address cardiovascular pharmacology, arrhythmia recognition and therapy, acute coronary syndrome including myocardial infarction, ventricular dysrhythmias and defibrillation, and acute ischemic stroke. Requires pre-course preparation and an intensive two-day session on a Friday and Saturday. Students should get the approval of their Clerkship Coordinator before registering for the course. Recommended prerequisites: Medicine 300A, Pediatrics 300A, or Surgery 300A.

2 units, Aut (Giacomini, J), Win (Giacomini, J), Spr (Giacomini)

MED 299. Directed Reading in Medicine

Prerequisite: consent of instructor.

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

MED 370. Medical Scholars Research

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

4-18 units, Aut (Staff), Win (Staff), Spr (Staff), Sum (Staff)

MED 399. Graduate Research

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

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

MEDICINE INTERDISCIPLINARY (INDE)

UNDERGRADUATE COURSES IN MEDICINE INTERDISCIPLINARY

INDE 183I. Early Clinical Experience in International Family and Community Medicine

(Same as INDE 283I) (Graduate students register for 283I.) For preclinical medical students; undergraduates by special arrangement. Interactive early clinical experience with physicians, community leaders, health care workers, and patients in Mexico, India, China, or Tibet. Emphasis is on community health from local and global perspectives. Social, political, historical, and economic backgrounds of the country and local region. Non-western attitudes, beliefs and practices regarding health care, including herbal and other complementary medicine; local institutions and infrastructure including schools, social services, and the public health care system; and policies that impact health and the provision of care. Prerequisites: conversational Spanish for Mexico; for medical students, completion of first year; for undergraduates, junior standing or higher. Undergraduates apply through International Alliance in Service and Education (IASE) for Mexico; Volunteers in Asia (VIA) for Asian sites. Medical students a

6-12 units, Aut (LeBaron, S), Win (LeBaron, S), Spr (LeBaron, S), Sum (LeBaron, S)

INDE 199. Undergraduate Directed Reading and Research in Family and Community Medicine

Interested students should contact the Center for Education in Family and Community Medicine administration. Prerequisite: consent of instructor.

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

GRADUATE COURSES IN MEDICINE INTERDISCIPLINARY

INDE 200. The Future of Academic Medicine

Required for first-year MSTP students; limited to MSTP. Presentations of research directions and opportunities by chairs of basic science, clinical departments, and PhD programs. Prerequisite: instructor consent.

1 unit, Aut (Kim, S)

INDE 207A. Medical Mandarin I: Beginning

Develops essential medical vocabularies and conversational communication skills. Teaches the pinyin pronunciation system, which provides an accessible method of learning basic phrases. The foundations of taking a comprehensive patient history in Mandarin and doing medical interviews at individual hospital divisions, including making introductions, soliciting symptoms, explaining health concepts (e.g. diseases and prescriptions). Main goals are to improve rapport with Chinese patients through Mandarin fluency in the medical setting and to promote understanding of Chinese culture in the context of health care. Students participating in classroom instruction only register for 1 unit. Students registering for 2 units participate in field activities as well.

1-2 units, Aut (Wang, X; So, S)

INDE 207B. Medical Mandarin II: Intermediate

For students who already have a basic command of spoken Chinese. Conversational communication skills practiced in a more advanced setting, including more sophisticated assessment of patient history and cultural components that influence diseases found in Chinese-speaking patients. Builds working vocabulary for organ system disease processes to conduct a full physical exam, and to describe treatment modalities for Chinese-speaking patients (diagnostic and therapeutic). Students participating in classroom instruction only register for 1 unit. Students registering for 2 units participate in field activities as well. Prerequisite: one semester of college-level Chinese or instructor assessment of fluency.

1-2 units, Aut (Wang, X; So, S)

INDE 207C. Medical Mandarin III: Advanced

Access advanced professional medical vocabulary, conduct medical research, and engage in discussions in Chinese. Aims at a proficiency level of medical interpreting or doing other independent work in Chinese. Students are also assisted in doing a project or projects related to a specific field of medicine. Students participating in classroom instruction only register for 1 unit. Students registering for 2 units participate in project activities as well. Prerequisite: Completion of Medical Mandarin II, or advanced Chinese proficiency.

1-2 units, Aut (Wang, X; So, S)

INDE 208C. Medical Mandarin III: Advanced

Access advanced professional medical vocabulary, conduct medical research, and engage in discussions in Chinese. Aims at a proficiency level of medical interpreting or doing other independent work in Chinese. Students are also assisted in doing a project or projects related to a specific field of medicine. Students participating in classroom instruction only register for 1 unit. Students registering for 2 units participate in project activities as well. Prerequisite: Completion of 207C, or advanced Chinese proficiency.

1-2 units, Win (Wang, X; So, S)

INDE 209C. Medical Mandarin III: Advanced

Access advanced professional medical vocabulary, conduct medical research, and engage in discussions in Chinese. Aims at a proficiency level of medical interpreting or doing other independent work in Chinese. Students are also assisted in doing a project or projects related to a specific field of medicine. Students participating in classroom instruction only register for 1 unit. Students registering for 2 units participate in project activities as well. Prerequisite: Completion of 208C or advanced Chinese proficiency.

1-2 units, Spr (Wang, X; So, S)

INDE 210. The Healer's Art

For pre-clinical and clinical medical students. Explores core dimensions of meaning, service and healing exemplified by the outstanding physician. Goals are to develop and preserve personal values such as service, harmlessness, compassion, altruism, self care, integrity, equality, justice, respect, and nurturing wholeness; to develop the compassionate listening skill that is foundational for clinical practice and for finding personal meaning and satisfaction; and to clarify a commitment to medicine as one's life's work. Clinical faculty facilitate small group sessions and participate in the discovery model process on an equal footing with students. The Healer's Art was originally developed by Dr. Rachel Naomi Remen, Clinical Professor at UCSF.

1 unit, Aut (Feldstein, B; LeBaron, S)

INDE 211. Creative Writing

For medical students - all levels of writing skill. Examines uses of creative writing, including understanding the experience of medical training.

1 unit, Win (Charlton, B; Shafer, A)

INDE 212. The Human Condition: Medicine, Arts, and Humanities

The interdisciplinary field of medical humanities: the use of the arts and humanities to examine medicine in personal, social, and cultural contexts. Topics include the doctor/patient relationship, the patient perspective, the meaning of doctoring, and the meaning of illness. Sources include visual and performing arts, film, and literary genres such as poetry, fiction, and scholarly writing. Designed for medical students in the Biomedical Ethics and Medical Humanities Scholarly Concentration, but all students are welcome.

2 units, Spr (Zaroff, L; Shafer, A)

INDE 213. Medical Tai Chi

Tai chi as a recognized form of complimentary and alternative medicine. Intended to promote student health and well-being and to decrease stress, depression, and anxiety through the practice of tai chi. Weekly practices under the instruction of world-renowned 20th generation tai chi expert, Master Shu Dong Li. Analysis of the literature regarding health benefits of tai chi.

2 units, Aut (Sundberg, M; LeBaron, S), Win (Andrews, J; LeBaron, S), Spr (Andrews, J; LeBaron, S)

INDE 214. Stanford Medical Student Clinical Journal

Provides an opportunity for editors of all levels to cultivate their skills and assist in preparing pieces submitted by colleagues for publication in the Stanford Medical Student Clinical Journal (SMSCJ). Students enrolled in the course work closely with student authors as well as other editors. Editors examine multiple categories of writing, including opinion pieces, poetry, memoirs, book reviews, case reports and investigative reports. The SMSCJ is published two to three times per year and highlights the diverse talents of Stanford medical students in both scientific writing and the humanities.

1 unit, Aut (Shafer, A; Connolly, A), Win (Shafer, A; Cross, P), Spr (Shafer, A; Cross, P)

INDE 216. Cells to Tissues

Focuses on the cell biology and structural organization of human tissues as self-renewing systems. Topics include identification and differentiation of stem cells, regulation of the cell cycle and apoptosis in normal and cancerous cells, cell adhesion and polarity in epithelial tissues, intracellular transport, and cell migration. Histology laboratory sessions examine normal and abnormal samples of blood, epithelia, skin, connective tissue, muscle, bone and cartilage. Patient presentations and small group discussions of current medical literature illustrate how cell biology influences medical practice.

3 units, Aut (Theriot, J; Connolly, A)

INDE 219. Mind-Body Medicine

Exploration of the interconnections among human capacities such as thought, emotion, belief, attitudes, and physical health. Reviews literature relevant to mind-body medicine. Discusses and practices specific skills (including mindfulness exercises, meditation, imagery, visualization, body awareness, autogenics, and biofeedback) to enhance self-awareness, self-expression, and stress management. Anticipated benefits to class participants include discovering and mobilizing their capacity to participate in valuable and proven methods of stress reduction, while dealing with the frustrations and alienation that many students experience in medical school and beyond. Prerequisite: Interest in PsychoNeuroimmunology.

1 unit, not given this year

INDE 220. Human Health and Disease I

Establishes the foundation for the Human Health and Disease block which spans Q3 (Spring quarter Year One) through Q5 (Winter quarter Year Two). The Human Health and Disease block presents organ system-based histology, pathology, physiology, pharmacology, and infectious disease in a sequence of interdisciplinary courses. Each organ-specific integrated course includes a review of the anatomy and related histology, normal function of that organ system, how the organ system is affected by and responds to disease including infection, and how diseases of that organ system are treated (therapeutics).

3 units, Win (Siegel, R; Whitlock, J; Regula, D)

INDE 221. Human Health and Disease II

Structure, function, disease, and therapeutics of the respiratory system and the cardiovascular system. See INDE 220 for a description of the Human Health and Disease block.

12 units, Spr (Regula, D; Kobilka, B; Kao, P; Cross, P; Whitlock, J)

INDE 222. Human Health and Disease III

Structure, function, disease, and therapeutics of the renal/genitourinary system, the gastrointestinal system, the endocrine system, male and female reproductive systems, and women's health. See INDE 220 for a description of the Human Health and Disease block.

15 units, Aut (Regula, D; Meyer, T; Lowe, A; Gesundheit, N; Hillard, P; Connolly, A; Siegel, R)

INDE 223. Human Health and Disease IV

Structure, function, disease, and therapeutics of the central nervous system, hematologic system and multi-systemic diseases. See INDE 220 for a description of the Human Health and Disease block.

11 units, Win (Regula, D; Cross, P; Siegel, R; Glader, B; Ferrell, J; Fisher, R)

INDE 226. History of Medicine Online

Via Internet. Topics include: ancient medicine, Egypt and Babylonia, ancient Greece and Rome, Europe in the Middle Ages and the Renaissance, 18th-century schools of thought, and technological medicine. Sources include Kleinman's core clinical functions, and text, pictures, hypertext links, and sound clips. For assistance accessing the course, email: cwpsupport@lists.stanford.edu.

1 unit, Aut (Shafer, A), Win (Shafer, A), Spr (Shafer, A)

INDE 227. Careers in Medicine: Pathways in the Medical Sciences

Open to medical students, graduate and undergraduate students. Interactive, seminar-style sessions expose students to diverse career opportunities and the challenges of developing work-life balance in medicine. Recognized experts in clinical medicine and biomedical research who have been innovators in their careers discuss their work, decision-points in their career pathways, and lifestyle aspects of their choices.

1 unit, Spr (Gesundheit, N)

INDE 228. Career Transition Planning: Taking Action Today for a Successful Tomorrow

Open to School of Medicine MD and graduate students; post-docs and clinical fellows may audit by consent of instructor. How to prioritize career goals and develop an effective job search campaign. Topics: translating scientific and clinical training into a variety of workplace environments, professional network development, professional interest assessment, recruiters' perspectives, credentials development, and creating a marketing plan. Guest speakers from myriad career fields. May be repeated for credit.

1 unit, Spr (Eberle, S)

INDE 229. Managing Difficult Conversations

(Same as GSBGEN 568) Dealing effectively with difficult interpersonal situations in medical contexts. Focus is on improving students' judgment as to how to prepare for and confront difficult discussions in medical situations. Relevant principles of professionalism, leadership, and psychology underlie the course pedagogy. Case-based; student-to-student and student-to-instructor role-playing in actual medical situations. Patient and physician-expert participation as class guests.

1 unit, Aut (Grousbeck, I; Prober, C)

INDE 231. Future Faculty Seminar

(Same as CTL 231) For graduate students from all disciplines who are considering faculty careers. Postdoctoral fellows, TGR students, and research/clinical trainees may audit by consent of instructor. Explores the broad spectrum of duties and opportunities presented through faculty positions beyond the research-related aspects. Develops awareness of resources and skills that lead to faculty success; answers field-specific and related faculty job questions through discussions with representatives of a variety of academic institutions and fellow course participants. Topics include: finding and obtaining faculty positions, negotiating and navigating the first year, and working toward tenure. May be repeated for credit.

1 unit, Aut (Eberle, S; Wright-Dunbar, R)

INDE 238. Current Concepts and Dilemmas in Genetic Testing

(Same as GENE 238) For M.D., biomedical graduate, and genetic counseling students. Issues arising from the translational process from research to commercialization. Diagnostic inventions and applications, community implications, newborn screening, cancer genetics, and pharmacogenomics. Guest experts.

2 units, Spr (Tobin, S; Schrijver, I; Cowan, T; Magnus, D)

INDE 241. Assistantship in Family and Community Medicine

Limited to MD students. In-depth experience with a family physician preceptor following the first or second year of the pre-clinical curriculum. Placements with family physicians' practices throughout California.

6-12 units, Aut (Grudzen, M; LeBaron, S), Sum (LeBaron, S; Grudzen, M)

INDE 244. Ethnicity and Medicine

Weekly lecture series introduces basic information about ethnic and cultural factors that impact patient care. Presents information about culturally sensitive health care services and addresses contemporary research issues involving minority and underserved populations. Topics include health care issues and indigenous medical practices of African Americans, Asians, Latinos, Native Americans, immigrants and refugees in both urban and rural settings. One unit for weekly lectures only; two units require additional discussions facilitated by course director; three units (non-medical graduate students and undergraduates) require weekly response papers and a research paper.

1-3 units, Spr (Garcia, R)

INDE 245. Women and Health Care

Lecture and seminar series. Topics of interest to women as health care consumers and providers. The historical role of women in health care; current and future changes.

1-2 units, Aut (Grudzen, M; LeBaron, S; Massion, C)

INDE 253. Rural Health with a Global Perspective

Health status of the population, availability of health services and institutions, personal and environmental factors affecting health and medical care, and present and future models for change. Three-day field trip to San Joaquin Valley and mountain sites.

3-5 units, not given this year

INDE 262A. Providing and Evaluating Health Education for Underserved Children

A service learning experience in community health. Students participate in developing health education materials for underserved middle school students based on principles of human biology and health science; become knowledgeable about logic modes and other evaluation tools available for evaluating health education modules and community interventions; develop an implementation and evaluation plan. Prerequisite for undergraduates: Human Biology core or equivalent or consent of instructor.

3 units, Win (Staff), Spr (Staff)

INDE 283I. Early Clinical Experience in International Family and Community Medicine

(Same as INDE 183I) (Graduate students register for 283I.) For preclinical medical students; undergraduates by special arrangement. Interactive early clinical experience with physicians, community leaders, health care workers, and patients in Mexico, India, China, or Tibet. Emphasis is on community health from local and global perspectives. Social, political, historical, and economic backgrounds of the country and local region. Non-western attitudes, beliefs and practices regarding health care, including herbal and other complementary medicine; local institutions and infrastructure including schools, social services, and the public health care system; and policies that impact health and the provision of care. Prerequisites: conversational Spanish for Mexico; for medical students, completion of first year; for undergraduates, junior standing or higher. Undergraduates apply through International Alliance in Service and Education (IASE) for Mexico; Volunteers in Asia (VIA) for Asian sites. Medical students a

6-12 units, Aut (LeBaron, S), Win (LeBaron, S), Spr (LeBaron, S), Sum (LeBaron, S)

MICROBIOLOGY AND IMMUNOLOGY (MI)

UNDERGRADUATE COURSES IN MICROBIOLOGY AND IMMUNOLOGY

MI 104. Innate Immunology

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

3 units, Spr (Schneider, D)

MI 115B. The Vaccine Revolution

(Same as HUMBIO 155B) Advanced seminar. Human aspects of viral disease, focusing on recent discoveries in vaccine development and emerging infections. Journal club format: students choose articles from primary scientific literature, write formal summaries, and synthesize them into a literature review. Emphasis is on analysis, experimental design, and interpretation of data. Oral presentations. Enrollment limited to 10. Prerequisites: HUMBIO 155H, MI 155V.

6 units, alternate years, not given this year

MI 115C. Human Virology Inquiry Project I

Intensive group tutorial in human virology including classification, clinical features, molecular virology, pathogenesis, immune response, epidemiology, prevention, drug development, and vaccinology. Pertinent examples from all human virus families. Student presentations and discussion in a small group setting. Research and writing intensive. First quarter of a two quarter sequence. Limited enrollment. Prerequisites: Consent of instructor and written application required for enrollment.

6 units, Aut (Siegel, R)

MI 115D. Human Virology Inquiry Project II

Intensive group tutorial in human virology including classification, clinical features, molecular virology, pathogenesis, immune response, epidemiology, prevention, drug development, and vaccinology. Pertinent examples from all human virus families. Student presentations and discussion in a small group setting. Research and writing intensive. Second quarter of a two quarter sequence. Limited enrollment. Prerequisites: MI 115C, consent of instructor and written application required for enrollment.

6 units, Win (Siegel, R)

MI 130. Medical Microbiology and Infectious Diseases

(Same as MI 230) For graduate students and undergraduates. Required of first-year graduate students in Microbiology and Immunology. Biological properties of microbes associated with diseases of humans; identification and laboratory diagnosis; principles of prevention and treatment; introduction to microbial genetics and evolution as it pertains to pathogenicity. Prerequisite: background in molecular biology.

3 units, not given this year

MI 155H. Humans and Viruses I

(Same as HUMBIO 155H) Introduction to human virology integrating epidemiology, molecular biology, clinical sciences, social sciences, history, and the arts. Emphasis is on host pathogen interactions and policy issues. Topics: polio and vaccination, smallpox and eradication, yellow fever and history, influenza and genomic diversity, rubella and childhood infections, adenovirus and viral morphology, ebola and emerging infection, lassa fever and immune response.

6 units, not given this year

MI 155V. Humans and Viruses II

Introduction to human virology integrating epidemiology, molecular biology, clinical sciences, social sciences, history, and the arts. Emphasis on host pathogen interactions and policy issues. Topics: measles and viral epidemiology, rotavirus and world health, rabies and infections of the brain, HPV and cancer-causing viruses, herpes simplex and viral latency, CMV and viral teratogenesis,

retrovirology and endogenous viral sequences, HIV and viral treatment, viral hepatitis and chronic infections, prions and diseases of life style. Prerequisite: MI155H.

6 units, not given this year

MI 185. Topics in Microbiology

For advanced undergraduates. Topics include diversity, molecular regulation, growth, bioenergetics, and unique metabolic processes. Presentation of student papers on current topic selected with student input. Prerequisites: CHEM 31X, Biology core.

3 units, not given this year

MI 198. Directed Reading in Microbiology and Immunology

Fields of study are decided in consultation with sponsoring professor. Prerequisite: consent of instructor.

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

MI 199. Undergraduate Research

Investigations sponsored by individual faculty members. Possible fields: microbial molecular biology and physiology, microbial pathogenicity, immunology, virology, and molecular parasitology. Prerequisite: consent of instructor.

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

GRADUATE COURSES IN MICROBIOLOGY AND IMMUNOLOGY

MI 204. Innate Immunology

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

3 units, Spr (Schneider, D)

MI 209. Advanced Pathogenesis of Bacteria, Viruses, and Eukaryotic Parasites: Part I

For graduate students and advanced undergraduates; required of first-year graduate students in Microbiology and Immunology. Emphasis is on mechanisms to establish infection in the host and responses of the host to infection. Current literature. Prerequisite: background in biochemistry and molecular biology.

4 units, not given this year

MI 210. Advanced Pathogenesis of Bacteria, Viruses, and Eukaryotic Parasites

For graduate and medical students, and advanced undergraduates; required of 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. Current literature.

4 units, Win (Sarnow, P)

MI 211. Advanced Immunology I

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

3 units, Win (Chien, Y)

MI 215. Principles of Biological Technologies

(Same as IMMUNOL 215) 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. Required of first-year graduate students in Microbiology and Immunology, and the Immunology program.

3 units, Spr (Kirkegaard, K)

MI 230. Medical Microbiology and Infectious Diseases

(Same as MI 130) For graduate students and undergraduates. Required of first-year graduate students in Microbiology and Immunology. Biological properties of microbes associated with diseases of humans; identification and laboratory diagnosis; principles of prevention and treatment; introduction to microbial genetics and evolution as it pertains to pathogenicity. Prerequisite: background in molecular biology.

3 units, not given this year

MI 233. The Biology of Small Modulatory RNAs

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

2 units, Aut (Fire, A; Chen, C), alternate years, not given this year

MI 234. Fundamentals of RNA Biology

(Same as GENE 234, PATH 234) For graduate or medical students and (if space allows) to active participants from other segments of the Stanford Community (e.g., TGR students); undergraduates by instructor consent. Fundamental issues of RNA biology, with the goal of setting a foundation for students to explore the expanding world of RNA-based regulation. Each week a topic is covered by a faculty lecture and journal club presentations by students.

2 units, Aut (Chen, C; Fire, A; Sarnow, P)

MI 240. Professional and Leadership Development

Foundational skills; how to communicate, resolve conflict, negotiate, and present. Workshop format integrating theory and practice. Application required; see <http://www.stanford.edu/class/immunol240>.

2 units, Spr (Radermacher, A; Finan, D; Allen, J)

MI 250. Frontiers in Microbiology and Immunology

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

1 unit, Aut (Schneider, D), Win (Schneider, D), Spr (Schneider, D)

MI 299. Directed Reading in Microbiology and Immunology

Prerequisite: consent of instructor.

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

MI 370. Medical Scholars Research

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

4-18 units, Aut (Staff), Win (Staff), Spr (Staff), Sum (Staff)

MI 399. Graduate Research

Students who have completed the necessary foundation courses undertake investigations in general bacteriology, bacterial physiology and ecology, bacterial genetics, microbial pathogenicity, immunology, parasitology, or virology sponsored by individual faculty members. Prerequisite: consent of instructor.

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

MOLECULAR AND CELLULAR PHYSIOLOGY (MCP)

UNDERGRADUATE COURSES IN MOLECULAR AND CELLULAR PHYSIOLOGY

MCP 100Q. The Hippocampus as a Window to the Mind

Preference to sophomores. Electrical physiology of the brain using the hippocampus as a model system. The seminar builds from basic anatomical and electrical principles of brain structure and function, through the electrical properties of individual neurons and simple neuronal circuits, to the nature of behaviors that emerge from these more basic properties. Also discusses other brain regions where the hippocampal model provides insight into specific neuronal functions. Culminates in a discussion of neuronal disorders such as epilepsy, drug addiction, and obsessive-compulsive disorder that can be better understood on a basis of knowledge of the hippocampal model.

3 units, not given this year

MCP 199. Undergraduate Research

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

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

GRADUATE COURSES IN MOLECULAR AND CELLULAR PHYSIOLOGY

MCP 200. Cardiovascular Physiology

Offered jointly with the Department of Medicine. Lectures, small group instruction, clinical presentations, and lab demonstrations of normal and disordered human cardiovascular physiology. Prerequisite: understanding of general biochemistry.

5 units, Spr (Kobilka, B)

MCP 202. Advanced Immunology II

(Same as IMMUNOL 202) Readings of immunological literature. Classic problems and emerging areas based on primary literature. Student and faculty presentations. Prerequisite: IMMUNOL 201/MI 211.

3 units, Spr (Garcia, K)

MCP 216. Genetic Analysis of Behavior

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

4 units, alternate years, not given this year

MCP 222. Imaging: Biological Light Microscopy

(Same as BIO 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, Biology core.

3 units, Spr (Smith, S), alternate years, not given next year

MCP 232. Advanced Imaging Lab in Biophysics

(Same as APPPHYS 232, BIO 132, BIO 232, BIOPHYS 232) Laboratory and lectures. Advanced microscopy and imaging, emphasizing hands-on experience with state-of-the-art techniques. Students construct and operate working apparatus. Topics include microscope optics, Koehler illumination, contrast-generating mechanisms (bright/dark field, fluorescence, phase contrast, differential interference contrast), and resolution limits. Laboratory topics vary by year, but include single-molecule fluorescence, fluorescence resonance energy transfer, confocal microscopy, two-photon microscopy, and optical trapping. Limited enrollment. Recommended: basic physics, Biology core or equivalent, and consent of instructor.

4 units, Spr (Block, S; Schnitzer, M; Smith, S; Stearns, T)

MCP 256. How Cells Work: Energetics, Compartments, and Coupling in Cell Biology

Open to graduate and medical students, and advanced undergraduates. Dynamic aspects of cell behavior and function, including cellular energetics, homeostasis, heterogeneity of membranes, structure and function of organelles, solute and water transport, signaling and motility. Emphasis is on the principles of how coupling of molecular processes gives rise to essential functions at the cellular level. Mathematical models of cell function. Student presentations.

4 units, Spr (Maduke, M; Lewis, R)

MCP 258. Information and Signaling Mechanisms in Neurons and Circuits

(Same as NBIO 258) How synapses, cells, and neural circuits process information relevant to a behaving organism. How phenomena of information processing emerge at several levels of complexity in the nervous system, including sensory transduction in molecular cascades, information transmission through axons and synapses, plasticity and feedback in recurrent circuits, and encoding of sensory stimuli in neural circuits.

5 units, Aut (Baccus, S; Tsien, R)

MCP 299. Directed Reading in Molecular and Cellular Physiology

Prerequisite: consent of instructor.

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

MCP 370. Medical Scholars Research

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

4-18 units, Aut (Staff), Win (Staff), Spr (Staff), Sum (Staff)

MCP 399. Graduate Research

Students undertake investigations sponsored by individual faculty members. Research fields include endocrinology, neuroendocrinology, and topics in molecular and cellular physiology. Prerequisite: consent of instructor. (Staff)

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

NEUROBIOLOGY (NBIO)**UNDERGRADUATE COURSES IN NEUROBIOLOGY****NBIO 101. Social and Ethical Issues in the Neurosciences**

(Same as NBIO 201) Influences on public debate and policy of scientific advances in the study of the brain and behavior: theories of brain function; philosophical and scientific approaches; advances in the neurosciences, possible uses in medical therapy, and interventions involving genetic screening, genetic selection, enhancement of neurological functioning, and manipulation of behavior; questions related to medical therapy, social policy, and broader considerations of human nature such as consciousness, free will, personal identity, and moral responsibility. May be taken for 2 units without a research paper. Prerequisite: Neuroscience, Biology, or Symbolic Systems major; or Human Biology core; or consent of instructor.

2-4 units, Spr (Hurlbut, W; Newsome, W)

NBIO 198. Directed Reading in Neurobiology

Prerequisite: consent of instructor. (Staff)

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

NBIO 199. Undergraduate Research

Investigations sponsored by individual faculty members. Prerequisite: consent of instructor.

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

GRADUATE COURSES IN NEUROBIOLOGY**NBIO 201. Social and Ethical Issues in the Neurosciences**

(Same as NBIO 101) Influences on public debate and policy of scientific advances in the study of the brain and behavior: theories of brain function; philosophical and scientific approaches; advances in the neurosciences, possible uses in medical therapy, and interventions involving genetic screening, genetic selection, enhancement of neurological functioning, and manipulation of behavior; questions related to medical therapy, social policy, and broader considerations of human nature such as consciousness, free will, personal identity, and moral responsibility. May be taken for 2 units without a research paper. Prerequisite: Neuroscience, Biology, or Symbolic Systems major; or Human Biology core; or consent of instructor.

2-4 units, Spr (Hurlbut, W; Newsome, W)

NBIO 206. The Nervous System

Structure and function, 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.

7-8 units, Win (Dolmetsch, R)

NBIO 216. Genetic Analysis of Behavior

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

4 units, alternate years, not given this year

NBIO 218. Neural Basis of Behavior

Advanced seminar. The principles of information processing in the nervous system and the relationship of functional properties of neural systems with perception, behavior, and learning. Original papers; student presentations. Prerequisite: NBIO 206 or consent of instructor.

4 units, Spr (Staff), alternate years, not given next year

NBIO 220. Central Mechanisms in Vision-based Cognition

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, alternate years, not given this year

NBIO 221. Frontiers in Translational Medicine

Small group course for first year MSTP and Master's in Medicine students only. Focus is on pathways for combining science and medicine during graduate and postdoctoral training and in one's career, and practical aspects of translational medicine. Guest lecturers are physician-scientists who have advanced the frontiers of translational medicine. Previous lecturers have included Drs. Gilbert Chu, Jamie Topper, Irv Weissman, Beverly Mitchell, Geoff Duyk, William Mobley, Judy Shizuru, and David Cox. Prerequisite: consent of instructor.

1 unit, Spr (Barres, B)

NBIO 227. Understanding Techniques in Neuroscience

Techniques commonly used in the field of neuroscience, including molecular/genetic, electrophysiological, and whole brain imaging. Presentations by senior graduate students and examples from the literature. Optional laboratory demonstrations.

2 units, Aut (Pradhan, S; Villeda, S; Clark, K; Newsome, W)

NBIO 228. Mathematical Tools for Neuroscience

Student-instructed. For students with no math background beyond basic calculus, or as a review for more advanced students. Techniques useful for analysis of neural data including linear algebra, Fourier transforms, probability and statistics, signal detection, Bayesian inference, and information theory.

1-3 units, not given this year

NBIO 254. Molecular and Cellular Neurobiology

(Same as BIO 154, BIO 254) For advanced undergraduates and graduate students. Cellular and molecular mechanisms in the organization and functions of the nervous system. Topics: wiring of the neuronal circuit, synapse structure and synaptic transmission, signal transduction in the nervous system, sensory systems, molecular basis of behavior including learning and memory, molecular pathogenesis of neurological diseases. Prerequisite for undergraduates: Biology core or equivalent, or consent of instructors.

4-5 units, alternate years, not given this year

NBIO 258. Information and Signaling Mechanisms in Neurons and Circuits

(Same as MCP 258) How synapses, cells, and neural circuits process information relevant to a behaving organism. How phenomena of information processing emerge at several levels of complexity in the nervous system, including sensory transduction in molecular cascades, information transmission through axons and synapses, plasticity and feedback in recurrent circuits, and encoding of sensory stimuli in neural circuits.

5 units, Aut (Baccus, S; Tsien, R)

NBIO 299. Directed Reading in Neurobiology

Prerequisite: consent of instructor.

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

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 (Moore, T), Win (Moore, T), Spr (Moore, T)

NBIO 370. Medical Scholars Research

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

4-18 units, Aut (Staff), Win (Staff), Spr (Staff), Sum (Staff)

NBIO 399. Graduate Research

Investigations sponsored by individual faculty members. Prerequisite: consent of instructor.

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

NEUROLOGY AND NEUROLOGICAL SCIENCES (NENS)

UNDERGRADUATE COURSES IN NEUROLOGY AND NEUROLOGICAL SCIENCES

NENS 67N. Intracellular Trafficking and Neurodegeneration

(F,Sem) Stanford Introductory Seminar. Preference to freshmen. Cell structures and functions, the intracellular trafficking system that maintains exchanges of materials and information inside cells, and clinical features and pathologies of neurodegenerative diseases. Techniques for examining cellular and subcellular structures, especially cytoskeletons; functional insights generated from structural explorations. Prerequisite: high school biology.

3 units, Spr (Yang, Y)

NENS 199. Undergraduate Research

Students undertake research sponsored by an individual faculty member. Prerequisite: consent of instructor.

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

GRADUATE COURSES IN NEUROLOGY AND NEUROLOGICAL SCIENCES

NENS 202. Longevity

(Same as HUMBIO 149L, PSYCH 102) Interdisciplinary. Challenges to and solutions for the young from increased human life expectancy: health care, financial markets, families, work, and politics. Guest lectures from engineers, economists, geneticists, and physiologists.

4 units, Win (Carstensen, L; Rando, T)

NENS 205. Neurobiology of Disease Seminar

Case demonstrations of selected disorders, discussion of the pathophysiological basis of the disorder, presentation of the basic principles underlying modern diagnostic and therapeutic management, and a discussion of recent research advances for each disease entity. Prerequisite: Neurobiology 206 or consent of instructor.

2 units, Win (Yang, Y; Mobley, W; Reimer, R), alternate years, not given next year

NENS 206. Introduction to Neurology Seminar

Exploration of aspects of neurology, including subspecialties. Current issues, clinical cases, and opportunities in the field.

1 unit, Spr (Barreto-Chang, O; Reimer, R)

NENS 220. Computational Neuroscience

Computational approaches to neuroscience applied at levels ranging from neurons to networks. Addresses two central questions of neural computation: 1) How do neurons compute? and 2) How do networks of neurons encode/decode and store information? Focus on biophysical (Hodgkin-Huxley) models of neurons and circuits, with emphasis on application of commonly available modeling tools (NEURON, MATLAB) to issues of neuronal and network excitability. Addresses issues relevant to neural encoding & decoding, information theory, plasticity and learning. Lectures introduce fundamental concepts of neuronal computation; discussion groups focus on relevant literature examples of proper application of these techniques. Final project. Recommended for Neuroscience Program graduate students; open to graduate, medical, and advanced undergraduate students (with consent of instructor). Prerequisite: Neurobiology 206 and facility with linear algebra and calculus recommended.

4 units, Win (Huguenard, J)

NENS 221. Current Issues in Aging

(Same as DBIO 221, GENE 221) Current research literature on genetic mechanisms of aging in animals and human beings. Topics include: mitochondria mutations, insulin-like signaling, sirtuins, aging in flies and worms, stem cells, human progeria, and centenarian studies. Prerequisite: GENE 203.

2 units, Spr (Staff)

NENS 267. Molecular Mechanisms of Neurodegenerative Disease

(Same as BIO 267) The epidemic of neurodegenerative disorders such as Alzheimer's and Parkinson's disease occasioned by an aging human population. Genetic, molecular, and cellular mechanisms. Clinical aspects through case presentations.

4 units, Win (Kopito, R; Wyss-Coray, A; Reimer, R), alternate years, not given next year

NENS 299. Directed Reading in Neurology and Neurological Science

Prerequisite: consent of instructor.

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

NENS 370. Medical Scholars Research

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

4-18 units, Aut (Staff), Win (Staff), Spr (Staff), Sum (Staff)

NENS 399. Graduate Research

Students undertake research sponsored by individual faculty members. Includes laboratory work in neurophysiology and neurochemistry.

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

NEUROSCIENCES PROGRAM (NEPR)

GRADUATE COURSES IN NEUROSCIENCES PROGRAM

NEPR 299. Directed Reading in Neurosciences

Prerequisite: consent of instructor.

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

NEPR 399. Graduate Research

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

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

NEUROSURGERY (NSUR)

UNDERGRADUATE COURSES IN NEUROSURGERY

NSUR 70Q. Experimental Stroke

(F,Dial) Stanford Introductory Dialogue. Preference to sophomores. How stroke is studied in the laboratory; advances in stroke research over the last two decades; and future directions. Topics include: cellular and molecular mechanisms of neuronal death and survival in the brain after stroke, including necrosis, apoptosis, inflammation, and cell signaling pathways; experimental tools for stroke treatment, such as gene therapy, cell therapy, hypothermia, preconditioning, postconditioning, and other pharmacological treatments; the gap and barrier between laboratory research and clinical translation.

2 units, Spr (Staff)

NSUR 199. Undergraduate Research

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

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

GRADUATE COURSES IN NEUROSURGERY

NSUR 261. Principles and Practice of Stem Cell Engineering

(Same as BIOE 261) Quantitative models used to characterize incorporation of new cells into existing tissues emphasizing pluripotent cells such as embryonic and neural stem cells. Molecular methods to control stem cell decisions to self-renew, differentiate, die, or become quiescent. Practical, industrial, and ethical aspects of stem cell technology application. Final projects: team-reviewed grants and business proposals.

3 units, alternate years, not given this year

NSUR 278A. From Science to Business: Innovation in Neurologic Disease Beyond Neurosurgery

For medical, business, and engineering students. The process of innovation and company building in the medical field, emphasizing the neurosciences. Overview of neurological diseases; business and regulatory aspects of device and biotech product development. Guest speakers on healthcare entrepreneurship. Venture capital and entrepreneurial mentors guide interdisciplinary student teams in evaluating a solution to an unmet clinical need or a project within a biotech company. May be taken for 2 units without the team project.

2-4 units, alternate years, not given this year

NSUR 278B. Independent Study on Healthcare Innovation and Entrepreneurship

Continuation of NSUR 278A for students wishing to work on actual strategy and implementation of their idea developed in 278A or, more generally, for students who wish to develop a strategic plan for a specific healthcare (drug or device) venture.

2-4 units, Aut (Kallmeyer, V; Steinberg, G), Win (Kallmeyer, V; Steinberg, G), Spr (Staff), Sum (Kallmeyer, V)

NSUR 279. Concepts in Drug Delivery and Drug Device Combinations

Open to all graduate students. Issues relating to drug-device combination products, including review of recently approved products such as cardiac stent), and development, regulatory, and reimbursement issues. Emphasis is on market evaluation, product development, and regulatory strategies. Lecture only for 2 units; project for 4 units.

2-4 units, Win (Kallmeyer, V), alternate years, not given next year

NSUR 299. Directed Reading in Neurosurgery

Prerequisite: consent of instructor.

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

NSUR 370. Medical Scholars Research

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

4-18 units, Aut (Staff), Win (Staff), Spr (Staff), Sum (Staff)

OBSTETRICS AND GYNECOLOGY (OBYN)

UNDERGRADUATE COURSES IN OBSTETRICS AND GYNECOLOGY

OBYN 199. Undergraduate Research in Reproductive Biology

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

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

GRADUATE COURSES IN OBSTETRICS AND GYNECOLOGY

OBYN 202. Assisted Reproductive Technologies

(Same as DBIO 202) Primary and current literature in basic and clinical science aspects of assisted reproductive technologies (ART), and demonstrations of current ART techniques including in vitro fertilization and embryo culture, and micromanipulation procedures such as intracytoplasmic sperm injection and embryo biopsy and cryopreservation. Class only may be taken for 1 unit. 2 units includes papers and attendance at clinical demonstrations. 3 units includes a term paper. Recommended: DBIO 201, or consent of instructors.

1-3 units, Win (Porzig, E; Behr, B)

OBYN 240. Sex Differences in Human Physiology and Disease

(Same as HUMBIO 140, MED 240) Chromosomal and hormonal influences on cells, tissues, and organs that underlie the development of reproductive organs and sexual dimorphism of the neuroendocrine system. Consequences of sex hormones and environmental factors that differ between men and women in systems including the musculoskeletal, neurological, cardiovascular, and immunological. Guest lecturers. Prerequisite: Human Biology core or equivalent, or consent of instructor.

2-3 units, Win (Stefanick, M)

OBYN 256. Current Controversies in Women's Health

(Same as HUMBIO 125) Interdisciplinary. Focus is on the U.S. Topics include: health research; bioethical, legal, and policy issues; scientific and cultural perspectives; social influences; environmental and lifestyle effects on health; and issues related to special populations. Guest lecturers; student debates. Prerequisite: Human Biology core or equivalent, or consent of instructor.

3 units, Spr (Jacobson, M; Stefanick, M)

OBYN 370. Medical Scholars Research

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

4-18 units, Aut (Staff), Win (Staff), Spr (Staff), Sum (Staff)

OBGYN 399. Graduate Research in Reproductive Biology
Students undertake investigations sponsored by individual faculty members. Prerequisite: consent of instructor.

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

OPHTHALMOLOGY (OPHT)

UNDERGRADUATE COURSES IN OPHTHALMOLOGY

OPHT 199. Undergraduate Research

Allows for qualified students to undertake investigations sponsored by individual faculty members. Prerequisite: consent of instructor.

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

GRADUATE COURSES IN OPHTHALMOLOGY

OPHT 201. Clinical Topics in Ophthalmology

Introduction to the professional opportunities available to the ophthalmologist in the areas of clinical research, community health, biotech and pharmaceutical development, international blindness prevention, graduate and post-graduate education.

1 unit, not given this year

OPHT 203. Introduction to Ophthalmology

(Continuation of 202) Introduction to the practical skills used within the field of ophthalmology. Diagnostic tools and instruments; applications of these tools; practice using instruments under the guidance of faculty and residents; practice in microsurgical techniques with one-on-one guidance.

1 unit, Spr (Staff)

OPHT 299. Directed Reading in Ophthalmology

Prerequisite: consent of instructor.

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

OPHT 370. Medical Scholars Research

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

4-18 units, Aut (Staff), Win (Staff), Spr (Staff), Sum (Staff)

OPHT 399. Graduate Research

Students to undertake investigations sponsored by individual faculty members. Opportunities are available at both predoctoral and postdoctoral levels. Prerequisite: consent of instructor.

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

ORTHOPEDIC SURGERY (ORTHO)

UNDERGRADUATE COURSES IN ORTHOPEDIC SURGERY

ORTHO 97Q. Sport, Exercise, and Health: Exploring Sports Medicine

(S,Sem) (Same as HUMBIO 97Q) Stanford Introductory Seminar. Preference to sophomores. Sports medicine is the practice of clinical medicine at the interface between health and performance, competition and well-being. While sports medicine had its origins in providing care to athletes, medical advances developed in care of athletes exerted a great effect on the nature and quality of care to the broader community. Topics include sports injuries, medical conditions associated with sport and exercise, ethics, coaching, women's issues, fitness and health, and sports science. Case studies.

3 units, Win (Matheson, G)

ORTHO 102. Orthopaedic Surgical Anatomy

(Same as ORTHO 202) Open to medical and undergraduate students. Opportunity to enhance knowledge of anatomy as it pertains to the practice of Orthopaedic Surgery and to improve dissection skills. Follows the operative anatomy syllabus used by the Stanford Orthopaedic Surgery Residency Program. Sessions led by Stanford Orthopaedic Surgery attendings and residents. Didactic sessions, prosection review, dissection.

2 units, Sum (Staff)

ORTHO 199. Undergraduate Research

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

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

GRADUATE COURSES IN ORTHOPEDIC SURGERY

ORTHO 202. Orthopaedic Surgical Anatomy

(Same as ORTHO 102) Open to medical and undergraduate students. Opportunity to enhance knowledge of anatomy as it pertains to the practice of Orthopaedic Surgery and to improve dissection skills. Follows the operative anatomy syllabus used by the Stanford Orthopaedic Surgery Residency Program. Sessions led by Stanford Orthopaedic Surgery attendings and residents. Didactic sessions, prosection review, dissection.

2 units, Sum (Staff)

ORTHO 222. Anatomy of Movement

Perspectives include orthopedic surgery, neurology, mechanical engineering, computer science, anthropology, and art. Anatomy and pathology affecting the human locomotor system. Normal function and functional deficit from disease or injury. Engineering dilemmas that assist or emulate human movement, such as design of an artificial joint or simulation of tendon transfers for nerve palsy. The expression of human movement in art masterpieces and photography. The evolution of the hand as it became an instrument of purpose. Student team projects. Lecture only for 2 units; project for 4 units.

2-4 units, Win (Ladd, A; Rose, J)

ORTHO 260. Tissue Engineering

Biological principles underlying the use of engineering strategies and biocompatible materials for tissue repair and regeneration. Structure, physiology, and mechanics of articular cartilage, bone, and dense soft connective tissues. Current ideas, approaches, and applications being implemented as therapeutic regimens for arthritis, spinal deformities, and limb salvage. Multidisciplinary constraints on the design and creation of tissue constructs. Prerequisite: familiarity with basic cell and molecular mechanisms underlying tissue differentiation.

3 units, Win (Smith, R)

ORTHO 370. Medical Scholars Research

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

4-18 units, Aut (Staff), Win (Staff), Spr (Staff), Sum (Staff)

PATHOLOGY (PATH)

UNDERGRADUATE COURSES IN PATHOLOGY

PATH 101. Cancer Biology

(Same as C BIO 101) Experimental approaches to understanding the origins, diagnosis, and treatment of cancer. Focus on key experiments and discoveries with emphasis on genetics, molecular biology, and cell biology. Topics include carcinogens, tumor virology, oncogenes, tumor suppressor genes, cell cycle regulation, angiogenesis, invasion and metastasis, cancer genomics, cancer epidemiology, and cancer therapies. Discussion sections based on primary research articles that describe key experiments in the field. Prerequisite: Biology or Human Biology core or equivalent, or consent of instructor.

4 units, Win (Staff)

PATH 103Q. Lymphocyte Migration

(F,Dial) Stanford Introductory Dialogue. Preference to sophomores. How lymphocytes leave the blood stream and enter tissues to participate in immune surveillance and the development of inflammation. Known as lymphocyte migration, this process involves a complex series of adhesion, activation and diapedesis events. The cellular mechanisms involved in lymphocyte migration, including lymphocyte adhesion molecules that interact with their counter-receptors on endothelial cells, and molecules, including cytokines and chemokines, that attract or activate lymphocytes. The roles of these molecules in the development of human diseases such as asthma, type 1 diabetes, and multiple sclerosis.

1 unit, Aut (Michie, S)

PATH 105Q. Final Analysis: The Autopsy as a Tool of Medical Inquiry

(S,Sem) Stanford Introductory Seminar. Preference to sophomores. Based on review of patient medical histories and examination of formalin-fixed and unfixed tissues from autopsy. Student-directed problem-solving; students develop learning objectives for each case, and present findings. The effect of disease on normal structure and function, ethics of patient care, allocation of medical resources, efficiency of therapy, and medical error. Prerequisite: hepatitis-B vaccination; free vaccinations during the winter for accepted students.

3 units, Spr (Regula, D)

PATH 199. Undergraduate Research

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

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

GRADUATE COURSES IN PATHOLOGY**PATH 206. Epigenetics**

(Same as GENE 206) For graduate students; undergraduates by consent of instructor. Mechanisms by which phenotypes not determined by the DNA sequence are stably inherited in successive cell divisions. From the discovery of position-effect variegation in *Drosophila* in the 1920s to present-day studies of covalent modifications of histones and DNA methylation. Topics include: position effect, gene silencing, heterochromatin, centromere identity, genomic imprinting, histone code, variant histones, and the role of epigenetics in cancer. Prerequisite: BIO41 and BIO42, or GENE 203, or consent of instructor.

2 units, Spr (Lipsick, J; Gozani, O), alternate years, not given next year

PATH 210. Stem Cells in Development and Disease

Molecular and cellular mechanisms underlying the basic self-renewal and differentiation properties of stem cells in multiple tissues and organisms. How abnormal stem cell behavior may contribute to diseases such as cancer. How to manipulate stem cell behavior in vitro or in vivo for therapeutic purposes. Classical papers and recent literatures in the field of stem cell biology. Open to graduate, medical, and advanced undergraduate students. Prerequisite: consent of instructor.

1-2 units, Aut (Lu, B)

PATH 213. Gross Autopsy Pathology Laboratory

Examine/discuss unfixed dissected organs from current autopsies and correlate morphologic findings with the clinical history. Students view postmortem examinations and may participate (in a small group) in one postmortem examination with the assistance of residents and staff, and present the case to the class. Class scheduling is flexible. Additional unit for participation in a postmortem examination. Pre- or corequisite: HHD.

2-3 units, Aut (Regula, D), Win (Regula, D)

PATH 218. Computational Analysis of Biological Images

(Same as GENE 218) Physical and computational tools for acquisition, processing, interpretation, and archiving of biological images. Emphasis is on digital microscopy.

2 units, alternate years, not given this year

PATH 233. The Biology of Small Modulatory RNAs

(Same as GENE 233, MI 233) Open to graduate and medical students. How recent discoveries of miRNA, RNA interference, and short interfering RNAs reveal potentially widespread gene regulatory mechanisms mediated by small modulatory RNAs during

animal and plant development. Required paper proposing novel research.

2 units, Aut (Fire, A; Chen, C), alternate years, not given this year

PATH 234. Fundamentals of RNA Biology

(Same as GENE 234, MI 234) For graduate or medical students and (if space allows) to active participants from other segments of the Stanford Community (e.g., TGR students); undergraduates by instructor consent. Fundamental issues of RNA biology, with the goal of setting a foundation for students to explore the expanding world of RNA-based regulation. Each week a topic is covered by a faculty lecture and journal club presentations by students.

2 units, Aut (Chen, C; Fire, A; Sarnow, P)

PATH 240. Clinical Studies in Pathology I

Broad exposure to the practice of pathology in an academic medical center. Students are assigned a faculty mentor and work closely with pathology residents, fellows and faculty. Two months are spent in surgical pathology where students help examine surgical resection specimens and biopsies and participate in making a final diagnosis. One month is spent in autopsy pathology where students perform autopsy prosections and formulate final anatomic diagnoses under the supervision of faculty. May be combined with Clinical Studies in Pathology II, and two additional quarters of PATH 399, Directed Research, to fulfill a 12 month Post-Sophomore year Fellowship in Pathology. Prerequisite: MD candidate; instructor consent.

3-9 units, Aut (Natkunam, Y; Higgins, J), Win (Natkunam, Y; Higgins, J), Spr (Higgins, J; Natkunam, Y), Sum (Natkunam, Y; Higgins, J)

PATH 241. Clinical Studies in Pathology II

In-depth exposure to the practice of pathology for students who have completed Clinical Studies in Pathology I. Students are assigned a faculty mentor and work closely with pathology residents, fellows and faculty. Two months are spent in surgical pathology where students help examine surgical resection specimens and biopsies and participate in making a final diagnosis. One month is spent in autopsy pathology where students perform autopsy prosections and formulate final anatomic diagnoses under the supervision of faculty. Additional time may be spent observing in subspecialty areas of pathology that include dermatopathology, neuropathology, renal pathology, lymph node pathology or cytology. May be combined with Clinical Studies in Pathology I and two additional quarters of PATH 399, Directed Research, to fulfill a 12-month Post-Sophomore year Fellowship in Pathology. Prerequisite: consent of instructor and successful completion of Clinical Studies in Pathology I (PATH 240).

3-9 units, Aut (Natkunam, Y; Higgins, J), Win (Natkunam, Y; Higgins, J), Spr (Staff), Sum (Higgins, J; Natkunam, Y)

PATH 296. Stem Cell Biology and Regenerative Medicine

(Same as DBIO 296) For graduate and medical students. Embryonic and adult stem cells, including origin, regulation, self-renewal, differentiation, fate, and relationship to cancer; biological mechanisms and methods to translate findings to therapeutic applications. Medical students must enroll for 5 units; graduate students may choose to take only the basic science part for 3 units. Prerequisites: DBIO 201 and 210, or consent of instructor.

3-5 units, Win (Weissman, I; Nusse, R; Fuller, M)

PATH 299. Directed Reading in Pathology

Prerequisite: consent of instructor.

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

PATH 370. Medical Scholars Research

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

4-18 units, Aut (Staff), Win (Staff), Spr (Staff), Sum (Staff)

PATH 399. Graduate Research

Students undertake investigations sponsored by individual faculty members. Opportunities at the molecular, cellular, and clinicopathologic levels. Prerequisite: consent of instructor.

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

RADIATION ONCOLOGY (RADO)

UNDERGRADUATE COURSES IN RADIATION ONCOLOGY

RADO 101. Readings in Radiation Biology

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

RADO 199. Undergraduate Research

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

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

GRADUATE COURSES IN RADIATION ONCOLOGY

RADO 299. Directed Reading in Radiation Oncology

Prerequisite: consent of instructor.

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

RADO 370. Medical Scholars Research

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

4-18 units, Aut (Staff), Win (Staff), Spr (Staff), Sum (Staff)

RADO 399. Graduate Research

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

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

RADIOLOGY (RAD)

UNDERGRADUATE COURSES IN RADIOLOGY

RAD 72Q. Fluorescence Imaging in Living Cells

(S,Sem) Stanford Introductory Seminar. Preference to sophomores. Basic principles of fluorescent probes and their applications for live-cell imaging. Topics include: general classes of fluorescent probes together with their fluorescence mechanisms; strategies and methods for live cell labeling and imaging of specific proteins. Examples of applications of fluorescence imaging are presented. Provides students first-hand experience in fluorescence imaging research, and exploration of cutting edge techniques. Readings include current reviews and key original articles.

2 units, Win (Staff)

RAD 101. Readings in Radiology Research

Prerequisite: consent of instructor.

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

RAD 199. Undergraduate Research

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

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

GRADUATE COURSES IN RADIOLOGY

RAD 200. Imaging Anatomy and Pathology

Supplements traditional dissection anatomy with modern cross-sectional imaging, and traditional examination of the cadaver with study of live subjects. Chest-abdominal and pelvic anatomy; congenital, traumatic, and neoplastic processes that affect these structures. Preparation for encounters with imaging tests in clinical medicine and surgery. Also open to graduate students in fields related to imaging sciences.

2 units, Win (Staff), Spr (Federle, M; Penner, R)

RAD 203. Introduction to Interventional Radiology

Designed to expose pre-clinical and clinical MD students to minimally-invasive procedures using image guidance through a combination of didactics, simulation, and cathlab observation. Weekly organ-based and/or disease-based lectures are followed by simulation and faculty shadowing. Daily case-based presentations by faculty, technical demonstrations, and informal discussions reinforce the learning experience.

1 unit, Aut (Kothary, N; Hwang, G; Louie, J), Spr (Hwang, G; Louie, J; Kothary, N)

RAD 220. Imaging Anatomy

(Same as BIOE 220) The physics of medical imaging and human anatomy through medical images. Emphasis is on normal anatomy, contrast mechanisms, and the relative strengths of each imaging modality. Labs reinforce imaging techniques and anatomy. Prerequisites: basic biology, physics.

3 units, Win (Pauly, K; Gold, G)

RAD 222A. Multimodality Molecular Imaging in Living Subjects

(Same as BIOE 222A) Focuses on instruments and chemistries for imaging of cellular and molecular processes in vivo. Basics of instrumentation physics, chemistry of molecular imaging probes, and an introduction to preclinical and clinical molecular imaging modalities.

4 units, Aut (Contag, C; Xing, L; Rao, J)

RAD 222B. Chemistry of Molecular Probes for Imaging in Living Subjects

(Same as BIOE 222B) Focuses on molecular probes that target specific disease mechanisms. The ideal characteristics of molecular probes; how to optimize their design for use as effective imaging reagents that target specific steps in biological pathways and reveal the nature of disease through noninvasive assays.

4 units, Win (Contag, C; Rao, J; Xing, L)

RAD 222C. Topics in Multimodality Imaging in Living Subjects

(Same as BIOE 222C) Focuses on emerging chemistries and instruments that address unmet needs for improved diagnosis and disease management in cancer, neurological disease, cardiovascular medicine and musculoskeletal disorders. Objective is to identify problems or controversies in the field, and to resolve them through understanding the relevant primary literature.

4 units, Spr (Contag, C; Xing, L; Rao, J)

RAD 226. In Vivo Magnetic Resonance Spectroscopy and Imaging

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

3 units, Win (Spielman, D)

RAD 227. Functional MRI Methods

(Same as BIOPHYS 227) Basics of functional magnetic resonance neuroimaging, including data acquisition, analysis, and experimental design. Journal club sections. Cognitive neuroscience and clinical applications. Prerequisites: basic physics, mathematics; neuroscience recommended.

3 units, Aut (Glover, G)

RAD 228. Magnetic Resonance Imaging Programming Topics

Primarily for students working on research projects involving MRI pulse sequence programming. Introductory and student-initiated topics in seminars and hands-on labs. Image contrast mechanisms achieved by pulse sequences that control radiofrequency and gradient magnetic fields in real time, while acquiring data in an organized manner for image reconstruction. Prerequisites: EE 369B and consent of instructor.

3 units, Sum (Staff)

RAD 299. Directed Reading in Radiology

Prerequisite: consent of instructor.

*1-18 units, Aut (Staff), Win (Staff), Spr (Staff), Sum (Staff)***RAD 370. Medical Scholars Research**

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

*4-18 units, Aut (Staff), Win (Staff), Spr (Staff), Sum (Staff)***RAD 399. Graduate Research**

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

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

STRUCTURAL BIOLOGY (SBIO)

UNDERGRADUATE COURSES IN STRUCTURAL BIOLOGY

SBIO 199. Undergraduate Research

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

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

GRADUATE COURSES IN STRUCTURAL BIOLOGY

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 proteins via their amino acid sequences and their three-dimensional structures. Structure prediction via simple comparative modeling. How to detect and model remote homologues. Predicting the structure of a protein from knowledge of its amino acid sequence. Via Internet.

*3 units, not given this year***SBIO 241. Biological Macromolecules**

(Same as BIOC 241, BIOPHYS 241) The physical and chemical basis of macromolecular function. 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. Prerequisites: introductory biochemistry and physical chemistry or consent of instructor.

*3-5 units, Aut (Herschlag, D; Garcia, K; Ferrell, J; Block, S; Weis, W)***SBIO 242. Methods in Molecular Biophysics**

(Same as BIOPHYS 242) Experimental methods in molecular biophysics from theoretical and practical standpoints. Emphasis is on X-ray diffraction, nuclear magnetic resonance, and fluorescence spectroscopy. Prerequisite: physical chemistry or consent of instructor.

*3 units, alternate years, not given this year***SBIO 274. Topics in Nucleic Acid Structure and Function**

Principles of nucleic acid structure and function. Methods for investigating nucleic acid structure. Limited to graduate students and postdoctoral fellows in structural biology. Prerequisite: consent of instructor.

*2 units, not given this year***SBIO 299. Directed Reading in Structural Biology**

Prerequisite: consent of instructor.

*1-18 units, Aut (Staff), Win (Staff), Spr (Staff), Sum (Staff)***SBIO 370. Medical Scholars Research**

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

approved projects.

*4-18 units, Aut (Staff), Win (Staff), Spr (Staff), Sum (Staff)***SBIO 399. Graduate Research**

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

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

SURGERY (SURG)

UNDERGRADUATE COURSES IN SURGERY

SURG 68Q. Current Concepts in Transplantation

(S,Sem) Stanford Introductory Seminar. Preference to sophomores. Biological aspects of cell and organ transplantation, including issues that arise in the media. Diseases for which transplantation is a treatment, the state of the art in human transplantation, transplantation of animal tissue into humans (xenotransplantation), development of new tissue and organs in the laboratory (tissue engineering and cloning), and development of drugs and biological strategies to promote long-term survival of the tissue or organ (tolerance). How to write a scientific abstract, critique scientific literature, and research and present topics in contemporary transplantation.

*3 units, Spr (Martinez, O; Krams, S)***SURG 69Q. It's All in the Head: Understanding Diversity, Development, and Deformities of the Face**

(S,Sem) Stanford Introductory Seminar. Preference to sophomores. How the face conveys moods and emotions, and elicits reactions when disease or genetic disorders leave behind disfigurement. New work by evolutionary and molecular biologists concerning how variations in facial form are elicited; how tissues and molecules interact to form the face. How differences in facial anatomy affect an individual's self-perception and their acceptance in our beauty-conscious society.

*3-4 units, Win (Helms, J; Brugmann, S)***SURG 70Q. Surgical Anatomy of the Hand: From Rodin to Reconstruction**

(F,Dial) Stanford Introductory Dialogue. The surgical anatomy of the hand is extremely complex in terms of structure and function. Exploration of the anatomy of the hand in different contexts: its representation in art forms, the historical development of the study of hand anatomy, current operative techniques for reconstruction, advances in tissue engineering, and the future of hand transplantation.

*2 units, Win (Chang, J)***SURG 101. Regional Study of Human Structure**

Preference to seniors. Lectures in regional anatomy and dissection of the human cadaver; the anatomy of the trunk and limbs through the dissection process, excluding the head and neck.

*5 units, Win (Gosling, J; Whitmore, J)***SURG 102. Theory of International Humanitarian Surgery**

(Same as SURG 202) Open to undergraduate, graduate, and medical students. Focus is on understanding the ethics of international surgical aid, the role of surgery in international health, humanitarian theory, the role of students in the international health setting, and business and medicine in the social sector. Opportunities for international health service. Guest speakers include world-renowned physicians, CEOs, and public health workers.

*4 units, Win (Samagh, S; Samagh, S; Laub, D; Chang, J)***SURG 111A. Emergency Medical Technician (EMT-1): Training and Application**(Same as SURG 211A) (Graduate students register for 211A.) Basics of life support outside the hospital setting; readiness training for emergencies on- or off-campus. Topics include emergency patient assessments, and cardiac, respiratory, and neurological emergencies. Lectures, practicals, and applications. Upon completion of SURG 111A,B,C or 211A,B,C, students are eligible to sit for the National Registry EMT licensure exam. Prerequisites: CPR certification; application (see <http://surg211.stanford.edu>), and consent of instructor.*3 units, Aut (Gilbert, G; D'Souza, P; Espinoza, N)*

SURG 111B. Emergency Medical Technician (EMT-1): Training and Application

(Same as SURG 211B) (Graduate students register for 211B.) Continuation of 111A/211A. Approach to traumatic injuries. Topics include head, neck, and trunk injuries, bleeding and shock, burn emergencies, and environmental emergencies. Lectures, practicals, and applications. Upon completion of SURG 111A,B,C or 211A,B,C, students are eligible to sit for the National Registry EMT licensure exam. Prerequisite: 111A/211A and consent of instructor.

3 units, Win (Gilbert, G; D'Souza, P; Espinoza, N)

SURG 111C. Emergency Medical Technician (EMT-1): Training and Application

(Same as SURG 211C) (Graduate students register for 211C.) Continuation of 111B/211B. Special topics in EMS; topics include pediatric, obstetric, and gynecologic emergencies, EMS operations, mass casualty incidents, and assault. Lectures, practicals, and applications. Upon completion of SURG 111A,B,C or 211A,B,C, students are eligible to sit for the National Registry EMT certification exam. Prerequisite: 111B/211B, CPR-PR certification, and consent of instructor.

3 units, Spr (Gilbert, G; D'Souza, P; Espinoza, N)

SURG 112A. Advanced Reading and Teaching for the EMT-1

(Same as SURG 212A) Advanced Topics in EMS and training in teaching BLS skills (Graduate students register for 212A.) Topics include advanced airway and stroke management, abdominal emergencies, and prehospital pharmacology. Prerequisites: SURG 111/211 A-C (or equivalent EMT-Basic certification), CPR for the Professional Rescuer certification, and consent of instructor. May be repeated for credit.

2-3 units, Aut (Gilbert, G; D'Souza, P; Espinoza, N)

SURG 112B. Advanced Reading and Teaching for the EMT-1

(Same as SURG 212B) Advanced Topics in EMS and training in teaching BLS skills. (Graduate students register for 212B.) Topics include advanced assessment and treatment of the undifferentiated trauma patient (including advanced airway management, monitoring, and evaluation) and prehospital care in nontraditional locations. Prerequisites: SURG 111/211 A-C (or equivalent EMT-Basic certification), CPR for the Professional Rescuer certification, and consent of instructor. May be repeated for credit.

2-3 units, Win (Gilbert, G; D'Souza, P; Espinoza, N)

SURG 112C. Advanced Reading and Teaching for the EMT-1

(Same as SURG 212C) Advanced Topics in EMS and training in teaching BLS skills. (Graduate students register for 212C.) Topics include advanced assessment and treatment of patients in difficult and advanced situations - mass casualty incidents, assaults, pediatrics; and advanced emergency skills - ultrasound, suturing. Prerequisites: SURG 111/211 A-C (or equivalent EMT-Basic certification), CPR for the Professional Rescuer certification, and consent of instructor. May be repeated for credit.

2-3 units, Spr (Gilbert, G; D'Souza, P; Espinoza, N)

SURG 199. Undergraduate Research

Investigations sponsored by individual faculty members. Prerequisite: consent of instructor.

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

GRADUATE COURSES IN SURGERY**SURG 201. Basic Cardiac Life Support**

All medical students must be certified in Basic Cardiac Life Support before the end of the first (autumn) quarter. Students who provide documentation of certification received within six months prior to the date of matriculation will be exempted from the requirement. The course teaches one- and two-rescuer CPR, management of an obstructed airway, and CPR for infants and children. Upon completion of the course, students receive an American Heart Association certificate in BLS.

1 unit, Aut (Smith-Coggins, R)

SURG 202. Theory of International Humanitarian Surgery

(Same as SURG 102) Open to undergraduate, graduate, and medical students. Focus is on understanding the ethics of international surgical aid, the role of surgery in international health, humanitarian theory, the role of students in the international health setting, and business and medicine in the social sector. Opportunities for

international health service. Guest speakers include world-renowned physicians, CEOs, and public health workers.

4 units, Win (Samagh, S; Samagh, S; Laub, D; Chang, J)

SURG 203A. Human Anatomy

Introduction to human structure and function presented from a medical perspective. Introduction to the physical examination and frequently-used medical imaging techniques. Students are required to attend lectures, actively participate in seminar groups, and engage in dissection of the human body in the anatomy laboratory. Surgery 203A presents structure of the thorax, abdomen, pelvis and limbs.

11 units, Aut (Gosling, J; Whitmore, I)

SURG 203B. Human Anatomy

Continues the introduction to human structure and function from a medical perspective, the physical examination, and frequently-used medical imaging techniques. Students are required to attend lectures, actively participate in seminar groups, and engage in dissection of the human body in the anatomy laboratory. Surgery 203B presents structure of the head, neck and back.

4 units, Win (Gosling, J; Whitmore, I)

SURG 204. Introduction to Surgery and Surgical Techniques

Innovative introduction to the various aspects of surgery directed at pre-clinical MD students. Students participate in interactive clinical surgical scenarios animated by attending physicians. Covers the spectrum of surgical specialties. Includes scrubbing techniques, basic instrument handling, and the opportunity to scrub in on operations at Stanford Hospital.

1 unit, Aut (Greco, R)

SURG 205. Advanced Suturing Techniques

Builds upon skills taught in the Surgical Interest Group's introductory suturing workshops. Techniques such as suturing in a hole, suturing different tissues, and hand, instrument and laparoscopic knot tying.

1 unit, Aut (Woodard, G; Visser, B)

SURG 208. Plastic Surgery Tutorial

Diagnosis, theory, and practice of plastic and reconstructive surgery. Limited to two students per faculty member.

2 units, Aut (Staff), Win (Staff), Spr (Staff), Sum (Staff)

SURG 209. Plastic Surgery

Students participate in plastic and reconstructive surgery as functioning members of the clinical team. Students are exposed to operative surgery, emergency and trauma care, evaluation of operative candidates in the outpatient setting, and also attend teaching conferences. Limited to four students. Prerequisite: completion of first year or clinical experience.

1-18 units, Aut (Chang, J; Schendel, S; Lorenz, H; Longaker, M; Gurtner, G; Girod, S; Hentz, V; Lee, G), Win (Chang, J; Schendel, S; Lorenz, H; Longaker, M; Gurtner, G; Girod, S; Hentz, V; Lee, G), Spr (Staff), Sum (Chang, J; Schendel, S; Lorenz, H; Lo

SURG 211A. Emergency Medical Technician (EMT-1): Training and Application

(Same as SURG 111A) (Graduate students register for 211A.) Basics of life support outside the hospital setting; readiness training for emergencies on- or off-campus. Topics include emergency patient assessments, and cardiac, respiratory, and neurological emergencies. Lectures, practicals, and applications. Upon completion of SURG 111A,B,C or 211A,B,C, students are eligible to sit for the National Registry EMT licensure exam. Prerequisites: CPR certification; application (see <http://surg211.stanford.edu>), and consent of instructor.

3 units, Aut (Gilbert, G; D'Souza, P; Espinoza, N)

SURG 211B. Emergency Medical Technician (EMT-1): Training and Application

(Same as SURG 111B) (Graduate students register for 211B.) Continuation of 111A/211A. Approach to traumatic injuries. Topics include head, neck, and trunk injuries, bleeding and shock, burn emergencies, and environmental emergencies. Lectures, practicals, and applications. Upon completion of SURG 111A,B,C or 211A,B,C, students are eligible to sit for the National Registry EMT licensure exam. Prerequisite: 111A/211A and consent of instructor.

3 units, Win (Gilbert, G; D'Souza, P; Espinoza, N)

SURG 211C. Emergency Medical Technician (EMT-1): Training and Application

(Same as SURG 111C) (Graduate students register for 211C.) Continuation of 111B/211B. Special topics in EMS; topics include pediatric, obstetric, and gynecologic emergencies, EMS operations, mass casualty incidents, and assault. Lectures, practicals, and applications. Upon completion of SURG 111A,B,C or 211A,B,C, students are eligible to sit for the National Registry EMT certification exam. Prerequisite: 111B/211B, CPR-PR certification, and consent of instructor.

3 units, Spr (Gilbert, G; D'Souza, P; Espinoza, N)

SURG 212A. Advanced Reading and Teaching for the EMT-1

(Same as SURG 112A) Advanced Topics in EMS and training in teaching BLS skills (Graduate students register for 212A.) Topics include advanced airway and stroke management, abdominal emergencies, and prehospital pharmacology. Prerequisites: SURG 111/211 A-C (or equivalent EMT-Basic certification), CPR for the Professional Rescuer certification, and consent of instructor. May be repeated for credit.

2-3 units, Aut (Gilbert, G; D'Souza, P; Espinoza, N)

SURG 212B. Advanced Reading and Teaching for the EMT-1

(Same as SURG 112B) Advanced Topics in EMS and training in teaching BLS skills. (Graduate students register for 212B.) Topics include advanced assessment and treatment of the undifferentiated trauma patient (including advanced airway management, monitoring, and evaluation) and prehospital care in nontraditional locations. Prerequisites: SURG 111/211 A-C (or equivalent EMT-Basic certification), CPR for the Professional Rescuer certification, and consent of instructor. May be repeated for credit.

2-3 units, Win (Gilbert, G; D'Souza, P; Espinoza, N)

SURG 212C. Advanced Reading and Teaching for the EMT-1

(Same as SURG 112C) Advanced Topics in EMS and training in teaching BLS skills. (Graduate students register for 212C.) Topics include advanced assessment and treatment of patients in difficult and advanced situations - mass casualty incidents, assaults, pediatrics; and advanced emergency skills - ultrasound, suturing. Prerequisites: SURG 111/211 A-C (or equivalent EMT-Basic certification), CPR for the Professional Rescuer certification, and consent of instructor. May be repeated for credit.

2-3 units, Spr (Gilbert, G; D'Souza, P; Espinoza, N)

SURG 223. Wilderness Medicine

Open to all students. Wilderness-related illnesses and injuries; framework for dealing with emergencies in the backcountry. Hands-on workshops. Topics include high altitude medicine, backcountry orthopedics, hypothermia, snake envenomations, search and rescue, and travel medicine. Opportunity for certification in Wilderness First Aid.

4 units, Spr (Weiss, E; Lipman, G)

SURG 225. Transplantation Science

Offers medical students a more in-depth understanding of the field of transplantation. Develops an understanding of transplant immunology, tissue typing, immunopharmacology, and transplant pathology. Includes such topics as heart and heart/lung transplantation, kidney/pancreas transplantation, liver transplantation, bone marrow transplantation, and donor issues. Focus is on the field of transplantation as it relates to preoperative care and management of patients prior to transplantation as well as the long term care and follow-up of patients. Guest speakers. Prerequisites: SURG 218 (Anatomy); BIOC 200 (may be taken concurrently).

1 unit, Win (Esquivel, C)

SURG 230. Obesity in America

Prevalence and effects of the obesity epidemic in America and the growing prevalence of associated comorbidities such as diabetes, hypertension, hyperlipidemia, sleep apnea, and joint problems. Risk factors, multi-disciplinary treatment options, the role of food in society, patients' perspectives, and current research in the field. Includes fieldtrips to grocery stores and restaurants.

1 unit, Win (Morton, J; Woodard, G)

SURG 231. Healthcare in Developing Countries: Haiti and Beyond

Lunchtime lecture series open to all students. Aims to answer the deceptively simple question: How can we improve health in the developing world? Topics range from water sanitation to supply-side incentivization, from family planning to war zone surgery. Students gain useful skills for experience in international medicine. MD students and are eligible to apply for a sub-internship in surgery at Hopital Albert Schweitzer in Dechappelle, Haiti.

1 unit, Spr (Greco, R)

SURG 370. Medical Scholars Research

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

4-18 units, Aut (Staff), Win (Staff), Spr (Staff), Sum (Staff)

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