Genetics

Courses offered by the Department of Genetics are listed under the subject code GENE on the (http://explorecourses.stanford.edu/CourseSearch/search?view=catalog&catalog=&page=0&q=GENE&filter-catalognumber-GENE=on) Stanford Bulletin's (http://explorecourses.stanford.edu/CourseSearch/search?view=catalog&catalog=&page=0&q=GENE&filter-catalognumber-GENE=on) ExploreCourses web site (http://explorecourses.stanford.edu/CourseSearch/search?view=catalog&catalog=&page=0&q=GENE&filter-catalognumber-GENE=on).

An underlying theme in the department is that genetics is not merely a set of tools but a coherent and fruitful way of thinking about biology and medicine. To this end, the department emphasizes a spectrum of approaches based on molecules, organisms, populations, and genomes. It provides training through laboratory rotations, dissertation research, seminar series, didactic and interactive course work, and an annual three-day retreat of nearly 200 students, faculty, postdoctoral fellows, and research staff.

The mission of the department includes education and teaching as well as research; graduates from our program pursue careers in many different venues including research in academic or industrial settings, health care, health policy, and education. The department is especially committed to increasing diversity within the program, and to the training of individuals from traditionally underrepresented minority groups.

Master of Science in Human Genetics

The University requirements for the M.S. are described in the "Graduate Degrees (http://www.stanford.edu/dept/registrar/bulletin/4901.htm)" section of this bulletin.

The Department of Genetics offers an M.S. in Human Genetics, 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:

		Units
GENE 271	Human Molecular Genetics	4
GENE 272	Introduction to Medical Genetics	2-3
GENE 273	Introduction to Clinical Genetics Testing	1
GENE 274A	A Case Based Approach to Clinical Genetics	2
GENE 274B	A Case Based Approach to Clinical Genetics	2
GENE 275	Role Play and Genetic Counseling Observations	2
GENE 276	Genetic Counseling Clinical Rotations	4-7
GENE 278	Prenatal Genetic Counseling	1
GENE 279	Pediatric and Adult Genetic Counseling	1
GENE 280	Metabolic Genetic Counseling	1
GENE 281	Cancer Genetic Counseling	1
GENE 282A	Genetic Counseling Research Seminar	1
GENE 282B	Genetic Counseling Research Seminar	1
GENE 283	Genetic Counseling Research	1-8
GENE 284	Medical Genetics Seminar	1-2
GENE 285A	Genetic Counseling Seminar	2-3
GENE 285B	Genetics Counseling Seminar	2
GENE 285C	Genetic Counseling Seminar	2
GENE 286	Advanced Genetic Counseling Seminar	2

- several additional required courses (bioethics, research ethics and developmental biology),
- and are encouraged to take 2-4 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 Stanford's Master's Program in Human Genetics (http://www.med.stanford.edu/genetic-counseling) web site.

Doctor of Philosophy in Genetics

University requirements for the Ph.D. degree are described in the "Graduate Degrees (http://exploredegrees.stanford.edu/graduatedegrees)" 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 and genomics 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, genome functional analysis and human evolution), and application of model organisms such as bacteria, yeast, flies, worms, and mice to basic and translational areas of biomedical research. The department is especially strong in genomic and bioinformatic approaches to genome biology and evolution, and includes several genome-scale databases and Centers such as the Center for Genomics and Personalized Medicine (SCGPM), Saccharomyces Genome Database (SGD), the Stanford Microarray Database (SMD), and the Pharmacogenetics and Pharmacogenomics Knowledge Base (PharmGKB), the ENCODE project and 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 students, 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 carrying out 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 adviser, 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.

Emeritus: (Professor) Greg Barsh, Leonard Herzenberg, Uta Francke

Chair: Michael Snyder

Professors: Russ Altman, Anne Brunet, Carlos Bustamante, Michele Calos, Stanley Cohen, Ronald Davis, Andrew Fire, Judith Frydman, Margaret Fuller, Mark Kay, Stuart Kim, Karla Kirkegaard, Joseph Lipsick, Hiromitsu Nakauchi, Jonathan Pritchard, John Pringle, Matthew Scott, Tim Stearns, Lars Steinmetz, Anne Villeneuve

Associate Professors: Euan Ashley, Laura Attardi, Julie Baker, Atul Butte, James Ford, Gavin Sherlock, Aaron Gitler, Arend Sidow, Julien Sage, Zijie Sun, Hua Tang, Douglas Vollrath

Assistant Professors: Maria Barna, Michael Bassik, Ami Bhatt, Christina Curtis, Polly Fordyce, William Greenleaf, Anshul Kundaje, Jin Billy Li, Stephen Montgomery, Monte Winslow

Professor (Research): Leonore Herzenberg, J. Michael Cherry

Associate Professor (Teaching): Kelly Ormond

Assistant Professor (Clinical): Andrea Kwan

Courtesy Professor: Hank Greely, Alexander Urban

Courses

GENE 104Q. Law and the Biosciences. 3 Units.
Preference to sophomores. Focus is on human genetics; also assisted reproduction and neuroscience. Topics include forensic use of DNA, genetic testing, genetic discrimination, eugenics, cloning, pre-implantation genetic diagnosis, neuroscientific methods of lie detection, and genetic or neuroscience enhancement. Student presentations on research paper conclusions.

GENE 199. Undergraduate Research. 1-18 Unit.
Students undertake investigations sponsored by individual faculty members. Prerequisite: consent of instructor.

GENE 200. Genetics and Developmental Biology Training Camp. 1 Unit.
Open to first year Department of Genetics and Developmental Biology students, to others with consent of instructors. Introduction to basic manipulations, both experimental and conceptual, in genetics and developmental biology.
Same as: DBIO 200

GENE 202. Human Genetics. 4 Units.
Utilizes lectures and small group activities to develop a working knowlege of human genetics as applicable to clinical medicine. Basic principles of inheritance, risk assessment, and population genetics are illustrated using examples drawn from diverse areas of medical genetics practice including prenatal, pediatric, adult and cancer genetics. Practical aspects of molecular and cytogenetic diagnostic methods are emphasized. Existing and emerging treatment strategies for single gene disorders are also covered. Prerequisites: basic genetics.

GENE 205. Advanced Genetics. 3 Units.
For PhD students in any of the Biosciences Departments and Programs at Stanford University. Emphasis on developing the ability to solve problems using genetic ideas and methods, to understand the nature and reliability of genetic inference, and to apply genetic reasoning to biological research. Weekly paper discussions based on original research papers that define or illustrate the ideas and techniques covered in the lecture.

GENE 209. Current Topics in Human, Population, and Statistical Genomics. 2 Units.
Intensive seminar/workshop. Topics, drawn from current and past literature, may include: assessing and population genetic analysis of genomic variation; genome-to-phenome mapping; reconstructing demographic history from genome sequence data; domestication genomics; host-pathogen genome evolution; detecting signatures of selection; experimental design in human genetics; linkage and association mapping; ethical and social issues in human, plant, and animal genetics research. Emphasis on analysis and logic or experimental and observational genomics research. Faculty-led discussion with evaluation of response papers, problem sets, and intensive course project. May be repeated for credit.

GENE 210. Genomics and Personalized Medicine. 3 Units.
Principles of genetics underlying associations between genetic variants and disease susceptibility and drug response. Topics include: genetic and environmental risk factors for complex genetic disorders; design and interpretation of genome-wide association studies; pharmacogenetics; full genome sequencing for disease gene discovery; population structure and genetic ancestry; use of personal genetic information in clinical medicine; ethical, legal, and social issues with personal genetic testing. Hands-on workshop making use of personal or publicly available genetic data. Prerequisite: GENE 202, Gene 205 or BIOS 200.
Same as: DBIO 220

GENE 211. Genomics. 3 Units.
The goal of this course is to explore how different experimental strategies are applied to a variety of biological questions. By experimental strategy, we refer to both the general method and the logic with which the method is applied. An underlying theme of the course is that each strategy we discuss can be applied to problems that cut across different disciplines, for example immunology, cancer biology, or embryology. Genome evolution, organization, and function; technical, computational, and experimental approaches; hands-on experience with representative computational tools used in genome science; and a work knowledge of the scripting language Python.

GENE 212. Introduction to Biomedical Informatics Research Methodology. 3 Units.
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. Because the team projects start in the first week of class, attendance that week is strongly recommended. Prerequisites: BIOMEDIN 210 or 211 or 214 or 217 or consent of instructor.
Same as: BIOE 212, BIOMEDIN 212, CS 272

GENE 214. Representations and Algorithms for Computational Molecular Biology. 3-4 Units.
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.
Same as: BIOE 214, BIOMEDIN 214, CS 274

GENE 215. Frontiers in Biological Research. 1 Unit.
Students analyze cutting edge science, develop a logical framework for evaluating evidence and models, and enhance their ability to design original research through exposure to experimental tools and strategies. The class runs in parallel with the Frontiers in Biological Research seminar series. Students and faculty meet on the Tuesday preceding each seminar to discuss a landmark paper in the speaker's field of research. Following the Wednesday seminar, students meet briefly with the speaker for a free-range discussion which can include insights into the speakers' paths into science and how they pick scientific problems.
Same as: BIOC 215, DBIO 215

GENE 217. Translational Bioinformatics. 4 Units.
(Same as BIOMEDIN 217, 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.

GENE 218. Computational Analysis of Biological Information: Introduction to Python for Biologists. 2 Units.
Computational tools for processing, interpretation, communication, and archiving of biological information. Emphasis is on sequence and digital microscopy/image analysis. Intended for biological and clinical trainees without substantial programming experience.
Same as: MI 218, PATH 218

GENE 221. Current Issues in Aging. 2 Units.
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, 205 or BIOS 200.

GENE 224. Principles of Pharmacogenomics. 3 Units.
This course is an introduction to pharmacogenomics, including the relevant pharmacology, genomics, experimental methods (sequencing, expression, genotyping), data analysis methods and bioinformatics. The course reviews key gene classes (e.g., cytochromes, transporters) and key drugs (e.g., warfarin, clopidogrel, statins, cancer drugs) in the field. Resources for pharmacogenomics (e.g., PharmGKB, Drugbank, NCBI resources) are reviewed, as well as issues implementing pharmacogenomics testing in the clinical setting. Reading of key papers, including student presentations of this work; problem sets; final project selected with approval of instructor. Prerequisites: two of BIO 41, 42, 43, 44X, 44Y or consent of instructor.
Same as: BIOMEDIN 224

GENE 232. Advanced Imaging Lab in Biophysics. 4 Units.
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, microendoscopy, and optical trapping. Limited enrollment. Recommended: basic physics, Biology core or equivalent, and consent of instructor.
Same as: APPPHYS 232, BIO 132, BIO 232, BIOPHYS 232

GENE 233. The Biology of Small Modulatory RNAs. 2 Units.
Open to graduate and medical students. Explores recent progress and unsolved questions in the field of RNA intereference and microRNA biology. Students are required to read assigned primary literature before each class and actively participate in guided discussions on related technical and conceptual issues during class meetings. Assignments include critiques of assigned papers and developing a novel research proposal.
Same as: MI 233, PATH 233

GENE 234. Fundamentals of RNA Biology. 2 Units.
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.
Same as: MI 234, PATH 234

GENE 235. C. Elegans Genetics. 2 Units.
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.

GENE 241. Biological Macromolecules. 3-5 Units.
The physical and chemical basis of macromolecular function. Topics include: forces that stabilize macromolecular structure and their complexes; thermodynamics and statistical mechanics of macromolecular folding, binding, and allostery; diffusional processes; kinetics of enzymatic processes; the relationship of these principles to practical application in experimental design and interpretation. The class emphasizes interactive learning, and is divided equally among lectures, in-class group problem solving, and discussion of current and classical literature. Enrollment limited to 50. Prerequisites: Background in biochemistry and physical chemistry recommended but material available for those with deficiency in these areas; undergraduates with consent of instructor only.
Same as: BIOC 241, BIOPHYS 241, SBIO 241

GENE 243. Intellectual Propery: Scientific Evidence in Patent Litigation. 3 Units.
(Same as LAW 343) Open to clinical MD and graduate students. Explores the role of scientific experts in patent infringement litigation. In other areas of the law where scientific experts are used -- medical malpractice, environmental law, criminal law -- the science itself is often in dispute. In patent cases, however, the parties generally agree on the science. This affects the relationship between the lawyer and the expert and the substantive content of their interactions. Patent experts need to be able to explain science to the judge and jury. But they also must help the litigators choose which legal issues to press and which to concede, and to be aware of how the complications of the science might help, hurt, obscure or reveal how the law should be applied to the facts. The class examines judicial decisions and trial documents involving scientific evidence in patent litigation, followed by work in teams on final projects: simulations of expert testimony in a patent case. Simulations are performed at the end of the quarter before panels of practicing patent lawyers. Prerequisite: graduate students must have completed their required coursework and have TGR status.

GENE 244. Introduction to Statistical Genetics. 3 Units.
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.
Same as: STATS 344

GENE 245. Statistical and Machine Learning Methods for Genomics. 3 Units.
Introduction to statistical and computational methods for genomics. Sample topics include: expectation maximization, hidden Markov model, Markov chain Monte Carlo, ensemble learning, probabilistic graphical models, kernel methods and other modern machine learning paradigms. Rationales and techniques illustrated with existing implementations used in population genetics, disease association, and functional regulatory genomics studies. Instruction includes lectures and discussion of readings from primary literature. Homework and projects require implementing some of the algorithms and using existing toolkits for analysis of genomic datasets.
Same as: BIO 268, BIOMEDIN 245, CS 373, STATS 345

GENE 260. Supervised Study. 1-18 Unit.
Genetics graduate student lab research from first quarter to filing of candidacy. Prerequisite: consent of instructor.

GENE 267. Molecular Mechanisms of Neurodegenerative Disease. 4 Units.
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.
Same as: BIO 267, NENS 267

GENE 271. Human Molecular Genetics. 4 Units.
For genetic counseling students, graduate students in genetics, medical students, residents, and postdoctoral fellows interested in the practice of medical genetics and genomics. Gene structure and function; the impact of mutation and polymorphism as they relate to developmental pathways and human disease; mitochondrial genetics; approaches to the study of complex genetic conditions; GWAS and genome sequencing technologies; variant interpretation; gene therapy, stem cell biology, and pharmacogenetics. Undergraduates require consent of instructor and a basic genetics course.

GENE 272. Introduction to Medical Genetics. 2-3 Units.
For genetic counseling students, graduate students in human genetics, medical students, residents, and fellows; undergraduates with consent of instructor. Principles of medical genetics practice, including taking a family history, modes of inheritance and risk assessment, and mathematical principles of medical genetics (Bayes theorem, population genetics). An additional problem set is required for 3 units.

GENE 273. Introduction to Clinical Genetics Testing. 1 Unit.
For genetic counseling students, medical students, residents, and fellows. Uses a combination of case based assignments, laboratory observation and didactic lectures to introduce techniques and technology used in cytogenetics, molecular genetics and biochemical genetic testing, and to introduce clinical features of common genetic conditions that are commonly diagnosed through genetic testing.

GENE 274A. A Case Based Approach to Clinical Genetics. 2 Units.
For genetic counseling students, graduate students in genetics, medical students, residents and fellows. Case-based scenarios and guest expert lectures. Students learn skills in case preparation, management, and presentation, as well as content around common genetic disorders.

GENE 274B. A Case Based Approach to Clinical Genetics. 2 Units.
For genetic counseling students, graduate students in genetics, medical students, residents, and fellows. Case-based scenarios and guest expert lectures. Students learn skills in case preparation, management, and presentation, as well as content around common genetic disorders. This course is a continuation of GENE 274A, but may be taken individually with instructor permission.

GENE 275. Role Play and Genetic Counseling Observations. 2 Units.
Students role play aspects of genetic counseling sessions and learn through clinical observations. Observation includes genetic counseling sessions in prenatal, pediatric, and specialty settings.

GENE 276. Genetic Counseling Clinical Rotations. 4-7 Units.
For genetic counseling students only. Supervised clinical experiences. May be repeated for credit. Prerequisite: GENE 275.

GENE 278. Prenatal Genetic Counseling. 1 Unit.
Internet-based course for genetic counseling students, graduate students in genetics, medical students, residents, and 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.

GENE 279. Pediatric and Adult Genetic Counseling. 1 Unit.
Internet based course for genetic counseling students, graduate students in genetics, medical students, residents, and 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, the pediatric genetics medical examination, dysmorphology, introduction to laboratory genetic testing, development of a differential diagnosis, and resources for case management and family support.

GENE 280. Metabolic Genetic Counseling. 1 Unit.
Internet based course for genetic counseling students, graduate students in genetics, medical students, residents, and 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.

GENE 281. Cancer Genetic Counseling. 1 Unit.
Internet based course for genetic counseling students, graduate students in genetics, medical students, residents, and fellows; genetic counseling students should take this course in conjunction with their initial cancer genetics rotation. Topics include: cancer biology and cytogenetics; diagnosis and management of common cancer genetic syndromesiquest; predictive testing; psychology of cancer genetic counseling; and topics recommended by ASCO guidelines.

GENE 282A. Genetic Counseling Research Seminar. 1 Unit.
For genetic counseling students only. Facilitated discussions on identifying a topic and mentor for genetic counseling departmental research projects.

GENE 282B. Genetic Counseling Research Seminar. 1 Unit.
For genetic counseling students only. Lectures and facilitated discussions on research methodology for genetic counseling departmental research projects. Prerequisite: GENE 282A.

GENE 283. Genetic Counseling Research. 1-8 Unit.
Genetic counseling students conduct clinical research projects as required by the department for graduation. May be repeated for credit. Pre- or corequisite: GENE 282.

GENE 284. Medical Genetics Seminar. 1-2 Unit.
Presentation of research and cases. Students enrolling for 2 units also attend and report on external seminars. May be repeated for credit.

GENE 285A. Genetic Counseling Seminar. 2-3 Units.
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. Undergraduates may enroll in Autumn Quarter with consent of instructor. Extra paper required for 3 units.

GENE 285B. Genetics Counseling Seminar. 2 Units.
Year-long seminar primarily for genetic counseling students. Winter: the impact of chronic illness and genetic disease in a developmental manner.

GENE 285C. Genetic Counseling Seminar. 2 Units.
Year-long seminar primarily for genetic counseling students. Spring: applying therapeutic counseling approaches to the practice of genetic counseling.

GENE 286. Advanced Genetic Counseling Seminar. 2 Units.
For genetic counseling students only. Psychosocial issues associated with genetic counseling cases are discussed through presentation of cases that students have seen throughout their training. Professional development topics will be included. Must be taken for 3 quarters. Prerequisites: GENE 285 A,B,C and 276.

GENE 287. CARDIOVASCULAR GENETICS. 1 Unit.
Internet-based course for genetic counseling students, graduate students in genetics, medical students, residents, and fellow; genetic counseling students should take this course in conjunction with their cardiovascular genetics rotation. Topics include: Basic cardiology principles, including relevant anatomy and physiology; diagnosis, management and genetic testing as it relates to common inherited cardiovascular conditions in both the pediatric and adult setting; predictive genetic testing issues specific to inherited cardiovascular conditions; psychologic issues related to sudden death conditions. This course is designed for genetic counseling students, medical students, residents, post-doctoral fellows and nurses interested in inherited cardiovascular conditions.

GENE 299. RSEARCH. 0-60 Units.
.

GENE 399. Graduate Research. 1-18 Unit.
Investigations sponsored by individual faculty members. Prerequisite: consent of instructor.

GENE 801. TGR Project. 0 Units.
.

GENE 802. TGR Dissertation. 0 Units.
.