CURRICULUM IN GENETICS AND MOLECULAR BIOLOGY (GRAD)

Contact Information
Curriculum in Genetics and Molecular Biology
http://gmb.unc.edu

Jeff Sekelsky, Director

The Curriculum in Genetics and Molecular Biology is an interdepartmental predoctoral training program leading to a Ph.D. degree in genetics and molecular biology. The goal of this program is to train students to be creative, sophisticated research scientists within the disciplines of genetics and molecular biology. To this end, we emphasize acquisition of a foundation of knowledge, accumulation of the laboratory skills required for implementing research objectives, and development of the ability to formulate experimental approaches to solving contemporary problems in the biological sciences. During their first year, students enroll in graduate-level courses and participate in laboratory rotations. Subsequently, students select a faculty research advisor and establish an advisory committee. Research work is done in the laboratory facilities of the individual faculty member and is supported primarily by faculty research grants.

The curriculum faculty have appointments in 13 departments in the School of Medicine, the School of Dentistry, the Eshelman School of Pharmacy, and the College of Arts and Sciences. The faculty represent diverse research interests that use the tools of genetics, molecular biology, and biochemistry to address fundamental questions in the areas of cell cycle regulation, chromosome structure, development and disease models, DNA repair and recombination, genome stability, evolutionary genetics, genomics, human genetics, neurobiology, pathogens and immunity, signal transduction, transcription, and gene regulation and virology. Students are able to choose from a variety of biological systems and questions for their thesis research.

Requirements for Admission for Graduate Work

Applications from students with good academic records and interest in research careers in genetics and molecular biology are favorably considered. Applicants preferably have majored or minored in one of the following disciplines: genetics, biology (zoology or botany), microbiology, chemistry, mathematics, physics, or biophysics. They usually have taken calculus and organic and physical chemistry, although these are not essential. Applicants are accepted to begin their initial studies in the fall. They must apply to the program through a unified application program known as the Biological and Biomedical Sciences Program (BBSP). Students apply for graduate study in the biological or biomedical sciences at UNC–Chapel Hill. Students interested in any of the BBSP research areas apply to BBSP, and those whose application portfolio places them highest on the admission list are asked to visit Chapel Hill for interviews. Students who are ultimately admitted to UNC–Chapel Hill make no formal commitment to a Ph.D. program. After completing their first year of study students leave BBSP and join a thesis laboratory and matriculate into one of 15 participating Ph.D. programs. During their first year BBSP students are part of small, interest-based groups led by several faculty members. These groups meet frequently and provide a research community for students until they join a degree-granting program. The application consists of Graduate Record Examination (GRE) scores, transcripts of records, three letters of recommendation, and a statement of purpose, all submitted through the Web-based application system of The Graduate School. Students are encouraged to apply as early as possible, preferably before December 1. (Applicants seeking a master’s degree are not considered for admission.)

Financial Aid

Stipends for predoctoral students are available from an NIH predoctoral training grant and from the University. Tuition, student fees, and graduate student health insurance are also covered by the training grant and the University.

In addition to the dissertation requirements of The Graduate School (four full semesters of credit including at least six hours of doctoral dissertation; a written preliminary examination, an oral examination, and a dissertation), students in the Curriculum in Genetics and Molecular Biology must meet the following requirements:

- complete four didactic courses (GNET 621 and either GNET 631 OR GNET 632 are required; the other two may come from any appropriate combination of full-semester courses or five-week modules, with three modules being equivalent to a full course; at least one module or course must have a quantitative, statistical, or computational focus)
- one seminar course in which at least one-third of the final grade is based upon class participation
- act as a teaching assistant for one semester
- participate in a student seminar series as an attendee until the end of the third year
- present in the student seminar series in the third and subsequent years
- participate in the curriculum’s annual retreat
- attend the weekly seminar series sponsored by the curriculum and the Carolina Center for Genome Sciences
- publish at least one peer-reviewed research article as first or co-first author

Students are required to rotate through at least three laboratories before choosing a thesis advisor. It is strongly recommended that students attend national meetings in order to better understand how their research fits with progress in their field.

Professors

Shawn Ahmed, Telomere Replication and Germline Immortality in C. elegans
Albert S. Baldwin, Regulation of Gene Expression, Control of Oncogenesis and Apoptosis
Victoria Bautch, Molecular Genetics of Blood Vessel Formation in Mouse Models
Kerry S. Bloom, Mechanisms of Chromosome Segregation in Yeast, Chromosome and Spindle Dynamics
Jay Brennan, AMP-activated Protein Kinase Signaling, Neurodegeneration and Metabolic Disease
Patrick Brennwald, Examination of Problems in Membrane Trafficking and Cell Polarity Using Genetics
Kathleen Caron, Genetically Engineered Animal Models in the Study of Human Disease
Frank L. Conlon, Mesodermal Patterning and Heart Development, T-Box Genes
Jeanette Gowen Cook, Integrating DNA Replication Control with Checkpoint Signaling
Gregory P. Copenhaver, Regulation of Meiotic Recombination in Higher Eukaryotes
Stephen T. Crews, Neurogenomics and Developmental Neuroscience
Blossom Damania, Viral Oncogenes, Signal Transduction, Transcription and Immune Evasion of KSHV/RRV
Jeffery L. Dangl, Plant disease resistance and cell-death control, plant genomics
Channing J. Der, Oncogenes, Ras Superfamily Protein, Signal Transduction
Dirk P. Dittmer, Anti-lymphoma Therapies
Bob Duronio, Genetics of Cell-Cycle Control during Drosophila Development
Beverly J. Erede, Yeast Molecular Genetics, MAP-kinase Activation Pathways, Regulation of Cell Differentiation
Eric T. Everett, Genetics of Acquired and Congenital Disorders of Craniofacial Development
Bob Goldstein, Generation of Cell Diversity in Early Development of C. elegans
Jack D. Griffith, HIV, Transcription, Electron Microscopy
Mark Heise, Genetics of Arbovirus Virulence and Immune Evasion
Corbin D. Jones, Population Genetics and Evolution in Drosophila
Tal Kafri, HIV-I Vectors for Gene Therapy and Functional Genomic Applications, and as a Means to Study Basic HIV-1 Biology
Joseph Kieber, Molecular Genetic Analysis of Hormone Signaling in Arabidopsis
Nobuyo Maeda, Genetics Modeling of Atherosclerosis in Mice
Terry Magnuson, Mammalian Genetics, Epigenetics, Genomics
William F. Marzluff, Regulation of RNA Metabolism in Animal Cells
A. Gregory Matera, Biogenesis of Small Ribonucleoproteins in Health and Disease
Steven W. Matson, Biochemistry and Genetics of DNA Helicases from E. coli and Yeast
Karen L. Mohlke, Human Genetics and Genomics, Diabetes, Complex Diseases
Deborah O'Brien, Molecular Regulation of Mammalian Spermatogenesis and Fertilization
Bernard Weissman, Synthesis and Vector Development for Human Gene Therapy
Corbin D. Jones, Population Genetics and Evolution in Drosophila
Charles Perou, Genomic and Molecular Classification of Human Tumors to Guide Therapy
Mark Peifer, Cell Adhesion, Signal Transduction and Cancer
Daniel Pomp, Genetic Architecture of Complex Trait Predisposition
Dale Ramsden, V(D)J Recombination, DNA Double Strand Break Repair
R. Jude Samulski, Development of Virus-based Delivery Systems for Use in Human Gene Therapy
Aziz Sancar, Structure and Function of DNA Repair Enzymes, Biological Clock
Jeff J. Sekelsky, Genetics of Genome Instability in Drosophila
Norman E. Sharpless, Tumor Suppressor Genes, Genetics of Cancer and Aging
Jill Dowen, Three-Dimensional Genome Architecture and Gene Regulation in Development and Disease
Michael Emanuele, Cell Cycle Regulation by the Ubiquitin System
Jimena Giudice, Alternative Splicing, Epigenetic and Intracellular Trafficking in Heart and Skeletal Muscle Development and Diseases
C. Ryan Miller, Preclinical Experimental Therapeutics and Biomarker Research in Gliomas
Jason W. Reed, Study of Therapeutic Targets for the Treatment of Pancreatic and Colorectal Cancer
Ellen R. Weiss, Regulation of G-Protein-Coupled Receptor Signal Transduction Pathways
Bernard E. Weissman, Tumor Suppressor Genes, Cancer Genetics
Kirk Wilhemsen, Genetic Mapping, Neurodegenerative Diseases
Yue Xiong, Cancer Biology, Mammalian Cell Cycle, Tumor Suppressor Genes
Yanping Zhang, Genetics and Mechanisms of Cancer Cell Growth and Division

**Associate Professors**

Aravind Asokan, Synthetic Virology and Vector Development for Human Gene Therapy
Jonathan Berg, Clinical Adult and Cancer Genetics
Scott Bultman, Mouse Models of Human Disease, Chromatin-Modifying Factors, Epigenetics
Adrienne D. Cox, Ras Family Oncogenes and Signaling, Cellular Radiation Response, Lipid Modification and Drug Development
Ian Davis, Mechanisms of Transcription Factor Deregulation in Cancer Development
Amy S. Gladfelter, Cytoskeleton Dynamics, Biophysical Cell Biology, Cytoplasm Organization
Sarah R. Grant, Plant-Pathogen Interactions with a Focus on Bacterial Virulence
Jonathan Juliano, Malaria Drug Resistance, Diversity and Population Evolution
William Kim, Exploration of the Role of Hypoxia-Inducible Factor in Tumorogenesis
C. Ryan Miller, Preclinical Experimental Therapeutics and Biomarker Research in Gliomas
Jason W. Reed, Study of Therapeutic Targets for the Treatment of Pancreatic and Colorectal Cancer

**Assistant Professors**

Anthony Amelio, Camp Signaling, Gene Regulation, Alternative Splicing
J. Mauro Calabrese, Epigenetic Control by Long Noncoding RNAs, Genomics, Stem Cells, Cancer, Human Genetic Disorders
Jill Dowen, Three-Dimensional Genome Architecture and Gene Regulation in Development and Disease
Michael Emanuele, Cell Cycle Regulation by the Ubiquitin System
Jimena Giudice, Alternative Splicing, Epigenetic and Intracellular Trafficking in Heart and Skeletal Muscle Development and Diseases
Gaorav Gupta, Genetics Modeling, Neurodegenerative Diseases
Folami Ideraadullah, Genetics, Toxicants, and Nutrition: Role of Gene-Environment Interactions in Epigenetic Gene Regulation during Development
Samir Kelada, Genetics and Genomics of Environmentally Induced Asthma

**Curriculum in Genetics and Molecular Biology (GRAD)**
Daniel Mckay, Developmental Genomics, Regulation of Gene Expression
Zachary Nimchuk, Plant Developmental Genetics and Stem Cell Regulation
Chad Pecot, Biology of Metastatic Cancer, Sirna Regulation of Gene Expression in Tumors
Douglas Phanstiel, Molecular Mechanisms Underlying Acquisition of Disease States in Cells
Jeremy Purvis, Signal Transduction in Cancer and Stem Cells
Yuliya Pylayeva-Gupta, Immunomodulatory Mechanisms in Pancreatic Cancer and Metastasis
Elizabeth Shank, Chemically Mediated Interactions between Microbes
Shehzad Sheikh, Immune Responses to the Microbiome in Crohn’s Disease and Ulcerative Colitis
Celia Shiau, Function and Development of Macrophages and Brain Microglia; Regulation of Inflammation and Innate Immune Activation; Genetic, Genomic, Cellular, and Imaging Approaches
Scott Williams, Asymmetric Cell Division in Development and Disease, Notably Hematopoietic Malignancies
Eunice Yoon, Epigenetics, Gene Regulation, and Disease, Notably Breast and Renal Cell Carcinoma

GNET

Advanced Undergraduate and Graduate-level Courses

GNET 621. Principles of Genetic Analysis I. 3 Credits.
Prerequisite for undergraduates, BIOL 202. Permission of the instructor for undergraduates. Genetic principles of genetic analysis in prokaryotes and lower eukaryotes.
Grading status: Letter grade
Same as: BIOL 621.

GNET 622. Principles of Genetic Analysis II. 4 Credits.
Principles of genetic analysis in higher eukaryotes; genomics.
Requisites: Prerequisite, BIOL 621.
Grading status: Letter grade
Same as: BIOL 622.

GNET 623. Developmental Genetics Seminar. 1 Credit.
Permission of the instructor. Presentations of current research or relevant papers from the literature on development by students will be followed by open forum discussion of relevant points, and critique of presentation skills. Two hours per week.
Grading status: Letter grade.

GNET 624. Developmental Genetics. 3 Credits.
Permission of the instructor for undergraduates. Genetic and molecular control of plant and animal development. Extensive reading from primary literature.
Grading status: Letter grade
Same as: BIOL 624.

GNET 625. Seminar in Genetics. 2 Credits.
Permission of the instructor for undergraduates. Current and significant problems in genetics. May be repeated for credit.
Repeat rules: May be repeated for credit; may be repeated in the same term for different topics; 12 total credits. 6 total completions.
Grading status: Letter grade
Same as: BIOL 625.

GNET 631. Advanced Molecular Biology I. 3 Credits.
Required preparation for undergraduates, at least one undergraduate course in both biochemistry and genetics. DNA structure, function, and interactions in prokaryotic and eukaryotic systems, including chromosome structure, replication, recombination, repair, and genome fluidity. Three lecture hours a week.
Grading status: Letter grade
Same as: BIOL 631, BIOL 631, MCRO 631.

GNET 632. Advanced Molecular Biology II. 3 Credits.
Required preparation for undergraduates, at least one undergraduate course in both biochemistry and genetics. The purpose of this course is to provide historical, basic, and current information about the flow and regulation of genetic information from DNA to RNA in a variety of biological systems. Three lecture hours a week.
Grading status: Letter grade
Same as: BIOL 632, BIOL 632, MCRO 632.

GNET 635. Clinical and Counseling Aspects of Human Genetics. 3 Credits.
Topics in clinical genetics including pedigree analysis, counseling/ethical issues, genetic testing, screening, and issues in human research. Taught in a small group format. Active student participation is expected.
Requisites: Prerequisite, BIOL 425 or GNET 634; Permission of the instructor.
Grading status: Letter grade
Same as: BIOL 529.

GNET 636. Basic Elements of Probability and Statistical Inference I. 4 Credits.
Required preparation, two semesters of calculus (such as MATH 231, 232). Fundamentals of probability; discrete and continuous distributions; functions of random variables; descriptive statistics; fundamentals of statistical inference, including estimation and hypothesis testing.
Grading status: Letter grade
Same as: BIOS 550.

GNET 645. Quantitative Genetics of Complex Traits. 1 Credit.
Students will learn about various topics that form the basis for understanding quantitative genetics of complex traits with biomedical and agricultural relevance. The ultimate goal of quantitative genetics in this postgenomic era is prediction of phenotype from genotype, namely deducing the molecular basis for genetic trait variation.
Requisites: Prerequisite, GNET 621.
Grading status: Letter grade.

GNET 646. Principles and Experimental Approaches of Mammalian Genetics. 1 Credit.
This course will focus on the laboratory mouse as a model organism to learn fundamental genetic concepts and understand how state-of-the-art experimental approaches are being used to elucidate gene function and the genetic architecture of biological traits.
Grading status: Letter grade.

GNET 647. Human Genetics and Genomics. 1 Credit.
The course covers principles and modern approaches of human genetics and genomics, including human genetic variation, linkage, genome-wide association analysis, sequencing for variant discovery in monogenic and complex diseases, regulatory variation, the molecular basis of human disease, and functional validation of disease variants.
Grading status: Letter grade.
GNET 655. Issues in Human Genetics. 1 Credit.
This course will provide an overview of methods in human genetics during the critical reading of selected literature and work of speakers that will present in the Friday Seminar Series.
Grading status: Letter grade.

GNET 675. Computational Genetics. 1 Credit.
A course on systems genetics focused on student participation and the development of targeted multidisciplinary responses to genetic questions.
Grading status: Letter grade.

GNET 680. Modeling Human Diseases in Mice. 1 Credit.
Permission of the instructor. This course will provide an overview of the use of the mouse as an experimental model for determining factors, both genetic and environmental, that contribute to human diseases. One seminar hour a week.
Grading status: Letter grade.

Graduate-level Courses
GNET 701. Genetic Lecture Series. 1 Credit.
Open to genetics students only. Diverse but current topics in all aspects of genetics. Relates new techniques and current research of notables in the field of genetics.

GNET 702. Student Seminars. 1 Credit.
Required of all candidates for the degree in genetics. A course to provide public lecture experience to advanced genetics students. Students present personal research seminars based on their individual dissertation projects. Lectures are privately critiqued by fellow students and genetics faculty.

GNET 703. Student Seminars. 1 Credit.
Required of all candidates for the degree in genetics. A course to provide public lecture experience to advanced genetics students. Students present personal research seminars based on their individual dissertation projects. Lectures are privately critiqued by fellow students and genetics faculty.

GNET 742. Introduction to UNIX and Perl Programming for biomedical data analysis. 1 Credit.
This module will introduce UNIX and Perl programming. It is mainly targeted towards biomedical scientists who would be able to use Perl to analyze, transform, and manage large datasets.

GNET 743. Introductory Statistical Analysis in R for Biomedical Scientists. 1 Credit.
This module will introduce the data analysis environment R and use it to illustrate basic concepts in data manipulation, plotting of complex data, and basic statistical modeling. Class examples will be general and will aim to build familiarity and confidence with R and data analysis.

GNET 744. Biological Sequence Analysis, Protein-Structure, and Genome-Wide Data. 2 Credits.
This module provides an introduction to basic protein structure/ function analyses combining sequence informatics and macromolecular structure. In the second half the focus will switch to analysis of genome-wide datasets and methods used for the analysis of such “big data.

GNET 749. Practical RNA-Seq. 2 Credits.
This course is designed to familiarize students with everything needed to run an RNA-Seq experiment. There will be minimal emphasis on theory and heavy focus on practical aspects. There are no formal prerequisites required for this course and no prior experience with UNIX or the command line interface is expected.
Same as: PHCO 749.

GNET 750. Genomics of Complex Human Disease. 2 Credits.
Human complex diseases are major focus in human genomics. They have important genetic components, but inheritance is probabilistic and not deterministic. This graduate seminar will cover the main approaches (genome-wide association, next-generation sequencing, and structural variation in case-control and pedigree studies) and current knowledge in the main disease areas.

GNET 801. Cell Cycle Regulation and Cancer. 3 Credits.
This journal club-style discussion course will focus on molecular events that regulate normal cell cycle progression, and on how deregulation of the cell cycle leads to cancer. Classes will follow the development of the cell cycle field chronologically, learning how current concepts and paradigms have evolved through scientific inquiry.
Same as: PATH 801.

GNET 850. Training in Genetic Teaching. 3 Credits.
Required preparation, two courses in genetics. Permission of the instructor. Principles of genetic pedagogy. Students are responsible for assistance in teaching genetics and work under the supervision of the faculty, with whom they have regular discussion of methods, content, and evaluation of performance. (Throughout the year.) Staff.

GNET 865. Advanced Nutritional Biochemistry: Nutrigenetics and Nutrigenomics. 2 Credits.
Permission of the instructor. Course focuses on nutrigenetics and nutrigenomics with an emphasis on the genetic and dietary interactions predisposing one to increased risk of disease.
Same as: NUTR 865.

GNET 891. Special Topics. 1-3 Credits.
Advance topics in current research in statistics and operations research.
Repeat rules: May be repeated for credit; may be repeated in the same term for different topics.
Same as: MATH 891, BCB 891.

GNET 905. Research in Genetics. 1-15 Credits.
May be repeated for credit.
Same as: BIOL 921.

GNET 993. Master’s Research and Thesis. 3 Credits.
Permission of the department. Students are not accepted directly into the M.S. program.
Repeat rules: May be repeated for credit.

GNET 994. Doctoral Research and Dissertations. 3 Credits.