CURRICULUM IN GENETICS AND MOLECULAR BIOLOGY (GRAD)

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, development of the ability to formulate experimental approaches to solving contemporary problems in the biological sciences, and completion of an original research project. 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 14 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, 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, 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 specific Ph.D. program. During their first year, BBSP students are part of small, first-year groups led by several faculty members. These groups meet regularly and provide a research community for students until they join a degree-granting program. After completing their first year of study, students leave BBSP, join a dissertation laboratory, and matriculate into one of 15 participating Ph.D. programs. The BBSP application consists of Graduate Record Examination (GRE) scores (optional), 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. Applications are not accepted after the deadline, usually at the end of November. (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 GNET 631) 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)
- complete one seminar/journal club course that focuses on critical reading of the literature
- 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 annual retreat held jointly with the Department of Genetics and the Curriculum in Bioinformatics and Computational Biology
- attend the weekly seminar series sponsored by the curriculum and the Department of Genetics
- 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 dissertation advisor. It is strongly recommended that students attend national meetings 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
Jonathan Berg, Clinical Adult and Cancer Genetics
Patrick Brennwald, Cell Biology and Physiology
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
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
Ian Davis, Mechanisms of Transcription Factor Deregulation in Cancer Development
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
Michael Emanuele, Cell Cycle Regulation by the Ubiquitin System
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*
Jonathan Juliano, Malaria Drug Resistance, Diversity and Population Evolution
Joseph Kieber, Molecular Genetic Analysis of Hormone Signaling in *Arabidopsis*
William Kim, Exploration of the Role of Hypoxia-Inducible Factor in Tumorigenesis
Amy Shaub Maddox, Mechanisms of Cell Shape Change
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
Karen L. Mohlke, Human Genetics and Genomics, Diabetes, Complex Diseases
Fernando Pardo-Manuel de Villena, Meiotic Drive, Chromosome Segregation, Non-Mendelian Genetics
Mark Peifer, Cell Adhesion, Signal Transduction and Cancer
Charles Perou, Genomic and Molecular Classification of Human Tumors to Guide Therapy
Jeremy Purvis, Signal Transduction in Cancer and Stem Cells
Dale Ramsden, V(D)J Recombination, DNA Double Strand Break Repair
Aziz Sancar, Structure and Function of DNA Repair Enzymes, Biological Clock
Jeff Sekelsky, Genetics of Genome Instability in *Drosophila*
Brian Strahl, Histone Modifications and Gene Regulation
Lisa Tarantino, Genetic Mapping of Complex Behavioral Traits
Joan Taylor, Regulation of Vessel Development (Arteriogenesis) and Vessel Tone (Hypertension)
Nancy Thomas, Molecular Epidemiological and Translational Studies of Melanoma
Cyrus Vaziri, Integration of DNA Replication and Repair
Jason Whitmire, Genetic Regulation of T Cell Responses to Virus Infection

Associate 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
Gaorav Gupta, Genome Integrity in Breast Cancer
Zhongchao Han, Genomic DNA Transfer, Drug-Gene Delivery and Nanomedicine
Nate Hathaway, Mechanisms of Mammalian Genome Regulation, Chemical Biology and Drug Discovery
Erin Heinzen, Identification and Functional Characterization of Highly Penetrant Risk Factors in Neurodevelopmental Disorders
Folami Ideraabdullah, Genetics, Toxicants, and Nutrition: Gene-Environment Interactions in Epigenetic Gene Regulation
Jonathan Juliano, Malaria Drug Resistance, Diversity and Population Evolution
Samir Kelada, Genetics and Genomics of Environmentally Induced Asthma
Sarah Linnsteadt, Genetic and Transcriptional Mechanisms of Increased Chronic Pain and PTSD
Pengda Liu, Biochemistry and Biophysics
Paul Maddox, Mitotic Mechanisms and Chromosome Dynamics
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
Yuliya Pylayeva-Gupta, Immunomodulatory Mechanisms in Pancreatic Cancer and Metastasis
Jason W. Reed, Plant Development, Auxin Signaling, Light Responses
Gregory Scherrer, Genetic and Molecular Mechanisms of Pain Perception and Opioid Receptor Function
Shehzad Sheikh, Immune Responses to the Microbiome in Crohn's Disease and Ulcerative Colitis
Karl Shpargel, Roles of Chromatin-Modifying Enzymes in Developmental Epigenetics and Disease
Jason Stein, Genome Variation that Affects the Structure and Development of the Brain and Risk for Neuropsychiatric Illness
Scott Williams, Asymmetric Cell Division in Development and Disease, Epithelial Differentiation

Assistant Professors

Katie Baldwin, Cellular and Molecular Mechanisms of Astrocyte Development in the Mammalian Brain
Rob Dowen, Regulation of Fat Metabolism During Development, Aging, and Disease
Jimena Giudice, Alternative Splicing, Epigenetic and Intracellular Trafficking in Heart and Skeletal Muscle Development and Diseases
Kacy Gordon, Development and Evolution of the Germ Line Stem Cell Niche
Kathryn Hoadley, Integrative Genomic Characterization of Cancer and Precancer
Qingyun Liu, Genetics
Brian C Miller, Developing Personalized Cancer Immunotherapies by Targeting Myeloid Cells
Justin Milner, Transcriptional and Epigenetic Regulation of T Cell Differentiation During Infection and Cancer
John Morris IV, Modeling Mechanisms of Epigenetic and Genomic Heterogeneity that Connect Cancer Driver Mutations with Malignant Identity
Jonathan Parr, Molecular Epidemiology and Evolution of Infectious Diseases
Douglas Phanstiel, Molecular Mechanisms Underlying Acquisition of Disease States in Cells
Jesse Raab, Regulation and Function of Altered Chromatin Remodeling Complex Activity
Laura Raffield, Environmental Risk Factors for Cardiometabolic Diseases, Alzheimer's Disease and Related Dementias, and Related Quantitative Traits
Christoph Rau, The Transcriptomic and Epigenomic Landscape Underlying Cardiovascular Disorders
Celia Shiau, Function and Development of Macrophages and Brain Microglia; Inflammation and Innate Immune Activation

Keriayn Smith, Context Specific Functions of Long Noncoding RNAs
Ageliki Tsagaratou, Epigenetic and Transcriptional Regulation in T Cell Differentiation, Function and Disease
Hyejung Won, Genetics of Psychiatric Illnesses and Neurobiological Mechanisms
Anthony Zannas, Biomolecular Mechanisms Linking Psychosocial Stress with Disease Risk

GNET

Advanced Undergraduate and Graduate-level Courses

GNET 603. MiBio Seminar. 2 Credits.
This class is designed to 1) enhance students' ability to present scientific material to their peers in a comprehensive, cohesive manner, 2) familiarize students with scientific concepts and technologies used in multiple disciplines, 3) expose students to cutting edge research, 4) prepare students to gain substantial meaning from seminars and to ask questions, and 5) enhance students' ability to evaluate scientific papers and seminars.

Rules & Requirements
Grading Status: Letter grade.
Same as: BIOC 603, BIOL 603, CBPH 603.

GNET 621. Principles of Genetic Analysis I. 3 Credits.
Genetic principles of genetic analysis in prokaryotes and lower eukaryotes.

Rules & Requirements
Requisites: Prerequisite, BIOL 202 or BIOL 220; or permission of the instructor for students lacking the prerequisite.
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.

Rules & Requirements
Requisites: Prerequisite, BIOL 621.
Grading Status: Letter grade.
Same as: BIOL 622.

GNET 623. Developmental Genetics Seminar. 1 Credits.
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.

Rules & Requirements
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.

Rules & Requirements
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.

Rules & Requirements
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. 4 Credits.
This course explores cutting edge research in molecular biology -- the investigation at molecule-scale of the mechanisms behind life. We briefly review core-principles in molecular biology, then investigate more recent research that extends or overturns these core principles.

Rules & Requirements
Requisites: Prerequisites, BIOL 202, or BIOL 220, or CHEM 430, and permission of the course director.
Grading Status: Letter grade.
Same as: BIOC 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.

Rules & Requirements
Grading Status: Letter grade.
Same as: BIOC 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.

Rules & Requirements
Requisites: Prerequisite, BIOL 425; permission of the instructor for students lacking the prerequisite.
Grading Status: Letter grade.
Same as: BIOL 529.

GNET 645. Quantitative Genetics of Complex Traits. 1 Credits.
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.

Rules & Requirements
Grading Status: Letter grade.
Same as: BCB 645.

GNET 646. Mouse Models of Human Disease. 1 Credits.
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.

Rules & Requirements
Grading Status: Letter grade.
Same as: NUTR 646.

GNET 647. Human Genetics and Genomics. 1 Credits.
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.

Rules & Requirements
Grading Status: Letter grade.

GNET 655. Issues in Human Genetics. 1 Credits.
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.

Rules & Requirements
Grading Status: Letter grade.

GNET 675. Computational Genetics. 1 Credits.
A course on systems genetics focused on student participation and the development of targeted multidisciplinary responses to genetic questions.

Rules & Requirements
Grading Status: Letter grade.

GNET 680. Modeling Human Diseases in Mice. 1 Credits.
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.

Rules & Requirements
Grading Status: Letter grade.

GNET 701. Genetic Lecture Series. 1 Credits.
Diverse but current topics in all aspects of genetics. Relates new techniques and current research of notables in the field of genetics.

Rules & Requirements
Grading Status: Letter grade.
Same as: BIOL 711.

GNET 702. Student Seminars. 1 Credits.
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.

Rules & Requirements
Grading Status: Letter grade.
Same as: BIOL 702.

GNET 703. Student Seminars. 1 Credits.
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.

Rules & Requirements
Grading Status: Letter grade.
Same as: BIOL 713.

GNET 722. Population Genetics. 1 Credits.
This short course will cover methods of inferring/estimating natural selection, including the Dn/Ds ratio, the McDonald-Kreitman test, and the Poisson Random Field model. The course will feature discussions of high-profile publications that describe the application of these methods to yield insights into the forces that have shaped organismal evolution.

Rules & Requirements
Grading Status: Letter grade.
Same as: BCB 722.

GNET 730. Fundamentals of Quantitative Image Analysis for Light Microscopy. 1 Credits.
This course is a practical introduction to quantitative analysis of light microscopy images. During the class students will follow tutorials that will guide them through common tasks in analysis of biological images. They will be introduced to basic concepts of image processing like image registration, filtering, object detection etc.

Rules & Requirements
Grading Status: Letter grade.
Same as: BCB 730.

GNET 742. Introduction to UNIX and Python Programming for Biomedical Data Analysis. 1 Credits.
This module will introduce UNIX and Python programming. It is mainly targeted towards biomedical scientists who would be able to use Python to analyze, transform, and manage large datasets.

Rules & Requirements
Grading Status: Letter grade.

GNET 743. Introductory Statistical Analysis in R for Biomedical Scientists. 1 Credits.
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.

Rules & Requirements
Grading Status: Letter grade.

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."

Rules & Requirements
Grading Status: Letter grade.

GNET 747. Development of New Applications for Next Generation Sequencing. 2 Credits.
This class is designed to shed new light on wide variety of tools available for developing new ideas for NGS applications.

Rules & Requirements
Requisites: Prerequisites, BIOL 201 and 202.
Grading Status: Letter grade.

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.

Rules & Requirements
Grading Status: Letter grade.
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.

Rules & Requirements
Grading Status: Letter grade.

GNET 760. Advanced Topics in CRISPR-Based Genome Engineering:Origins, Applications, and Ethical Considerations. 1 Credits.
This graduate-level course is designed to teach students about the origins of CRISPR-Cas genome engineering technology, its applications to research and human health, and the ethical/societal considerations surrounding this powerful technology. Emphasis will be made on recent literature, new applications, discoveries and bioethics. Students interested in taking this class must have taken an advanced Genetics or Molecular Biology course.

Rules & Requirements
Grading Status: Letter grade.

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.

Rules & Requirements
Grading Status: Letter grade.
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.

Rules & Requirements
Grading Status: Letter grade.

GNET 865. Advanced Nutritional Biochemistry: Nutrigenomics and Precision Nutrition. 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.

Rules & Requirements
Grading Status: Letter grade.
Same as: NUTR 865.

GNET 870. Writing Fellowship Proposals. 1 Credits.
Provides practical experience to predoctoral students in writing fellowship proposals, using the NIH F31 as a template. Students will have weekly writing assignments, with feedback given by students and faculty. Open to 2nd and 3rd year students in the Curriculum or by permission of the instructor.

Rules & Requirements
Grading Status: Letter grade.
Same as: BCB 870.

GNET 888. Responsible Conduct of Research. 1 Credits.
Provides advanced predoctoral students with an understanding of issues relevant to conducting biomedical research as responsible citizens. It fulfills the NIH requirement for continued RCR training. Open to 4th and 5th year students in the Biology, Genetics and Molecular Biology, and Biochemistry PhD programs or by permission of the instructor.

Rules & Requirements
Grading Status: Letter grade.

GNET 891. Special Topics. 1-3 Credits.
Advance topics in current research in statistics and operations research.

Rules & Requirements
Repeat Rules: May be repeated for credit; may be repeated in the same term for different topics.
Grading Status: Letter grade.
Same as: MATH 891, BCB 891.

GNET 905. Research in Genetics. 1-15 Credits.
May be repeated for credit.

Rules & Requirements
Grading Status: Letter grade.
Same as: BIOL 921.

GNET 992. Master's (Non-Thesis). 3 Credits.
Rules & Requirements
Repeat Rules: May be repeated for credit.

GNET 993. Master's Research and Thesis. 3 Credits.
Permission of the department. Students are not accepted directly into the M.S. program.

Rules & Requirements
Repeat Rules: May be repeated for credit.

GNET 994. Doctoral Research and Dissertation. 3 Credits.
Rules & Requirements
Repeat Rules: May be repeated for credit.

Contact Information

Curriculum in Genetics and Molecular Biology
Visit Program Website (http://gmb.unc.edu)

Director of Graduate Studies
Daniel McKay
dmckay1@email.unc.edu

Past Director of Graduate Studies
Jeff Sekelsky
sekelsky@email.unc.edu

Student Services Manager
John Cornett

jcornett@email.unc.edu