Genetics (GN)

GN 301 Genetics in Human Affairs (3 credit hours)
Appreciation and understanding of genetics in everyday life. Topics include basic principles of transmission genetics, molecular genetics, population genetics, and the effects of the environment on gene expression and phenotype. Applications of genetics in human development and disorders, genetic testing for medical and forensic purposes, and genetic engineering will be covered. Basic principles as well as ethical, legal, social, and public health issues will be covered.

GEP Natural Sciences, GEP Interdisciplinary Perspectives
Typically offered in Fall, Spring, and Summer

GN 311 Principles of Genetics (4 credit hours)
Basic concepts and principles of prokaryotic and eukaryotic genetics. Mendelian inheritance, polygenic inheritance, linkage and mapping, chromosome aberrations, population genetics, evolution, DNA structure and replication, gene expression, mutation, gene regulation, extranuclear inheritance, bacterial and viral genetics, and recombinant DNA technology.

Prerequisite: BIO 183 or ZO 160
Typically offered in Fall, Spring, and Summer

GN 312 Elementary Genetics Laboratory (1 credit hours)
Genetic experiments and demonstrations using a variety of bacterial, plant and animal organisms. Mendelian inheritance, linkage analysis, population genetics, cytogenetics, biochemical genetics, DNA isolation, electrophoresis, and Southern blotting.

Corequisite: GN 311
Typically offered in Fall and Spring

GN 421/GN 521 Molecular Genetics (3 credit hours)
Biological macromolecules and their interactions, DNA topology, eukaryotic genome structure, chromatin and chromosome structure, transcription and transcription regulation, epigenetics, RNAi and RNA processing, recombinant DNA technology, genetic transformation and cloning of plants and animals. Bacteria, viruses, plants, animals and fungi as genetic systems. Students cannot receive credit for both GN 421 and GN 521.

Prerequisite: C- or better in GN 311
Typically offered in Fall and Spring

GN 423 Population, Quantitative and Evolutionary Genetics (3 credit hours)
This course is an introduction to population, quantitative and evolutionary genetics. This course will acquaint students with basic population genetics models. The course will cover genetic variation; measures of genetic variation; basic and advanced topics of selection; ecological genetics; inbreeding; genetic drift and effective population size; mutation; neutral theory and coalescence; gene flow and population structure; linkage disequilibrium and recombination; quantitative genetics; heritability;' quantitative trait loci; molecular population genetics and evolution.

Prerequisite: GN 311 and (MA 131 or MA 141)
Typically offered in Fall only

GN 425 Advanced Genetics Laboratory (2 credit hours)
This is a challenging advanced genetics laboratory designed to provide research and communication training and in-depth understanding of modern genetics through hands-on activities. Students will participate in a semester-long supervised research project in contemporary genetics using a model genetic organism and state-of-the-art techniques. The project will be directly related to research in the coordinating faculty member's laboratory. The project will require literature review, hypothesis development, experimental design and execution, data analysis and presentation of results in written and oral form.

Prerequisite: GN 312; Corequisite: GN 421
Typically offered in Fall and Spring

GN 427 Introductory Bioinformatics (3 credit hours)
This course is an introduction to bioinformatics for genetic and biological sciences. The course will provide a foundation in biological computing that includes command line interfaces, reformatting data, creating and editing graphics, automating analyses and database access, and scripting in biological programming languages used for bioinformatics such as Python, Perl, and R. Laptop required.

Prerequisite: GN 311 and (MA 131 or MA 141) with grades of C- or better
Typically offered in Fall only

GN 428 Introduction to Machine Learning in Biology (3 credit hours)
New techniques in genomics have revolutionized biology, but generate large quantities of data that present challenges in extracting signal from noise. This course will provide students the basic skills to manipulate and integrate different types of biological datasets and to learn how to mine them using data analysis tools ranging from basic to state of the art. Machine learning methods provide a framework to analyze vast amounts of biological information and extract meaningful signals. By the end of the semester, students will have had exposure to a variety of modern machine learning tools for classification and prediction. We will focus on exploration of DNA data (with millions of variants), expression data (> 20,000 genes), and microbiome data (thousands of features), combined with various disease/experimental measurements. The course will cover the basics of loading and exploring datasets using visualization, followed by basic machine learning basic methods including classification and regression algorithms.

Prerequisite: C- or better in GN 311 and C- or better in MA 131 or MA 141 and C- or better in ST 311
Typically offered in Spring only

GN 434 Genes and Development (3 credit hours)
Overview of pivotal experiments in embryology and developmental genetics; genes and genetic pathways that control development in animal model systems and humans; focus on the application of molecular genetic approaches to the study of genes and development; reading and discussion of primary scientific literature. Cannot receive credit for both GN 434 and BIO 361.

Prerequisite: C- or better in GN 311
Typically offered in Fall and Summer

GN 441/GN 541 Human and Biomedical Genetics (3 credit hours)
This course is an in depth study of human and biomedical genetics and the role of genetics in human health and disease. The course will aquaint students with contemporary knowledge of genetics in disease causation and susceptibility, the use of model organisms to inform human biology and contemporary topics in human genetics research like epigenetics, therapeutic cloning, gene therapy, role of genetics in response to drugs and predictive medicine. Credit cannot be given for both 441 and 541.

Prerequisite: C- or better in GN 421
Typically offered in Fall only

GN 450/GN 550 Conservation Genetics (3 credit hours)
The main objective of this course is to expose upper division undergraduate students and graduate students to conservation genetic tools and applications. Students will learn the genetic and genomic theory and methods commonly used in conservation and management of species. In addition, the course will provide hands-on experience working on current conservation projects here at North Carolina State University. Working in groups, the students will collect, run, and analyze those data for a scientific paper. The final project for all students will be a conservation genetic grant proposal.

Prerequisite: GN 311
Typically offered in Spring only

GN 451 Genome Science (3 credit hours)
Genomic approaches with a foundation in classical and molecular genetics, including both historical strategies used in early major genome projects, and cutting edge contemporary methods for genomics and systems biology; the sequencing, assembly, and annotation of genomes and transcriptomes; use of genomic methods to tackle problems in epigenetics, metagenomics, and proteomics; application to a wide variety of species and biological questions, including evolution and human health; reading, discussion, and presentation of current scientific literature.

Prerequisite: C- or better in GN 311
Typically offered in Spring only

GN 453 Personal Genomics (3 credit hours)
This course will teach students the principles and practices of data analysis associated with human genetic research. Students will gain an understanding of how DNA variation explains human ancestry and how DNA variation is used to identify genes affecting complex traits. Students will analyze real data sets to determine human ancestry and quantitative traits using computational tools presented in the course.

Prerequisite: C- or better in GN 311 and C- or better in ST 311
Typically offered in Spring only

GN 456 Epigenetics, Development, and Disease (3 credit hours)
Scientists are just beginning to fully appreciate how our genes and the environment interact to influence human development and disease. The emerging field of epigenetics offers new insights into these complex connections. Epigenetics is the study of heritable changes in gene expression and phenotypes caused by mechanisms other than changes in the underlying DNA sequence. Topics may include imprinting, mechanisms driving epigenetic modifications, how environmental exposures may influence your grandchildren's health, why identical twins exhibit differences in behavior or disease susceptibility, and epigenetic and environmental bases of diverse diseases. We will also discuss experimental strategies for studying epigenetics. JR standing.

Prerequisite: B or better in GN 311
Typically offered in Spring only

GN 461 Advanced Bioinformatics (3 credit hours)
This course provides in-depth experience in applying bioinformatic computing techniques to experimental data with a focus on the genetic and biological sciences. The course will provide experience in genome sequence analysis and assembly, extracting, manipulating and visualizing genetic and molecular data, analysis of macromolecular sequences, and generating and visualizing phylogenetic date. Laptop required.

Prerequisite:GN 427 and ST 311 with grades of C- or better
Typically offered in Spring only

GN 490 Genetics Colloquium (1 credit hours)
This course will involve critical study of research in genetics. Students will evaluate primary research publication on prepared topics assigned by instructor, with emphasis on review of recent and current research.

Prerequisite: GN 421
Typically offered in Spring only

GN 496 Genetics Research Experience (3 credit hours)
GN 496 provides an opportunity for students to gain real-world experience by conducting independent research in a genetics research program. A minimum of 135 hours must be completed for the three hours credit. The experience must be arranged by the student and approved by the Director of the Undergraduate Genetics Program in advance of beginning the work. To gain approval, students must submit the completed GN 496 Contract, signed by their GN 496 supervisor (Research Mentor) and by their academic advisor. The student is required to write a research paper evaluating the results of their project. In addition to the work described in the contract, students will complete a series of reflective written assignments during and at the end of their GN 496 experience.

Minimum of sophomore standing. Limited to Genetics Majors and Genetics Minors. Students must submit required signed course contract prior to registration.
Typically offered in Fall, Spring, and Summer

GN 497 Genetics Teaching Experience (3 credit hours)
GN 497 provides an opportunity for students to gain experience in an aspect of genetics education research and/or developing, implementing, and evaluating the effectiveness of materials for use in the genetics classroom. A minimum of 135 hours must be completed for the three hours credit. The experience must be arranged by the student and approved by the Director of the Undergraduate Genetics Program in advance of beginning the work. To gain approval, students must submit the completed GN 497 Contract, signed by their GN 497 Teaching Mentor and by their academic advisor. The student is required to write a scientific paper evaluating the results of their project. In addition to the work described in the contract, students will complete a series of reflective written assignments during and at the end of their GN 497 experience.

Minimum of sophomore standing. Limited to Genetics Majors and Genetics Minors. Students must submit required signed course contract prior to registration.
Typically offered in Fall, Spring, and Summer

GN 521/GN 421 Molecular Genetics (3 credit hours)
Biological macromolecules and their interactions, DNA topology, eukaryotic genome structure, chromatin and chromosome structure, transcription and transcription regulation, epigenetics, RNAi and RNA processing, recombinant DNA technology, genetic transformation and cloning of plants and animals. Bacteria, viruses, plants, animals and fungi as genetic systems. Students cannot receive credit for both GN 421 and GN 521.

Prerequisite: C- or better in GN 311
Typically offered in Fall and Spring

GN 541/GN 441 Human and Biomedical Genetics (3 credit hours)
This course is an in depth study of human and biomedical genetics and the role of genetics in human health and disease. The course will aquaint students with contemporary knowledge of genetics in disease causation and susceptibility, the use of model organisms to inform human biology and contemporary topics in human genetics research like epigenetics, therapeutic cloning, gene therapy, role of genetics in response to drugs and predictive medicine. Credit cannot be given for both 441 and 541.

Prerequisite: C- or better in GN 421
Typically offered in Fall only

GN 550/GN 450 Conservation Genetics (3 credit hours)
The main objective of this course is to expose upper division undergraduate students and graduate students to conservation genetic tools and applications. Students will learn the genetic and genomic theory and methods commonly used in conservation and management of species. In addition, the course will provide hands-on experience working on current conservation projects here at North Carolina State University. Working in groups, the students will collect, run, and analyze those data for a scientific paper. The final project for all students will be a conservation genetic grant proposal.

Prerequisite: GN 311
Typically offered in Spring only

GN 685 Master's Supervised Teaching (1-3 credit hours)
Teaching experience under the mentorship of faculty who assist the student in planning for the teaching assignment, observe and provide feedback to the student during the teaching assignment, and evaluate the student upon completion of the assignment.

Prerequisite: Master's student
Typically offered in Fall and Spring

GN 690 Master's Examination (1-9 credit hours)
For students in non-thesis master's programs who have completed all other requirements of the degree except preparing for and taking the final master's exam.

Prerequisite: Master's student
Typically offered in Fall only

GN 693 Master's Supervised Research (1-9 credit hours)
Instruction in research and research under the mentorship of a member of the Graduate Faculty.

Prerequisite: Master's Student
Typically offered in Spring only

GN 695 Master's Thesis Research (1-9 credit hours)
Thesis Research

Prerequisite: Master's Student
Typically offered in Fall and Spring

GN 696 Summer Thesis Research (1 credit hours)
For graduate students whose programs of work specify no formal course work during a summer session and who will be devoting full time to thesis research.

Prerequisite: Master's student
Typically offered in Summer only

GN 699 Master's Thesis Preparation (1-9 credit hours)
For students who have completed all credit hour requirements and full-time enrollment for the master's degree and are writing and defending their thesis.

Prerequisite: Master's Student
Typically offered in Fall only

GN 701 Molecular Genetics (3 credit hours)
A discussion of the structure and function of genetic material at a molecular level. Consideration of both prokaryotic and eukaryotic systems. The aim to describe genetics in terms of chemical principles.

Prerequisite: GN 311
Typically offered in Fall only

GN 702 Cellular and Developmental Genetics (3 credit hours)
Regulation of genes involved in cellular function, differentiation and development in eukaryotes. Presentation of biological systems and model organisms used to study genetic control of cellular and developmental processes.

Prerequisite: GN 701
Typically offered in Spring only

GN 703 Population and Quantitative Genetics (3 credit hours)
Mutation and origin of genetic variation. Measuring genetic variation in natural populations. Gene and genotype frequencies. Hardy-Weinberg equilibrium. Values, means, genetic and environmental variance, heritability of quantitative traits. Random genetic drift and inbreeding. Natural and artifical selection. Theory and tests of models of maintenance of genetic variation. Molecular evolution of genes and proteins. Genome evolution.

Prerequisite: GN 311 and ST 512
Typically offered in Spring only

GN 713/ANS 713 Quantitative Genetics and Breeding (3 credit hours)
Quantitative and population genetic theory of breeding problems; partitioning of genetic variance, maternal effects, genotype by environment interaction and genetic correlation; selection indexes; design and analysis of selection experiments; marker-assisted selection.

Prerequisite: GN 509, ST 512
Typically offered in Fall only

GN 720/HS 720/CS 720 Molecular Biology In Plant Breeding (3 credit hours)
Theory and principles of molecular biology applied to plant breeding. Understanding of the relationship between genes and crop traits. Principles and molecular mechanisms of crop traits, and their applications to solve breeding problems and improve crop traits, which include heterosis, male/female sterility, self-incompatibility, polyploidy, double haploid, protoplast fusion, random mutagenesis, plant regeneration, transgenic breeding, advanced genome editing for breeding, gene silencing, gene activation, gene drive, plant synthetic biology, metabolic engineering, epigenetics for trait improvement, gene stacking, decoy and R genes, and bioconfinement.

P: CS 211 or GN 311 or equivalent, and PB 421 or equivalent.
Typically offered in Spring only

GN 721/ST 721 Genetic Data Analysis (3 credit hours)
The course aims to provide students with the relevant background knowledge and quantitative skills for conducting genetic data analysis to evaluate the genetic effects of complex traits. The course will focus on statistical methodologies and analytical strategies for population-based association studies with genotype and sequencing data collected from whole genome and exome. The specific topics include genetic variants; genetic identity coefficients and its applications; heritability; Hardy-Weinberg disequilibrium; recombination; linkage disequilibrium and association mapping; genome-wide association studies (GWAS); population substructures; multiple testing; single-variant and multi-variant association methods; next-generation sequencing (NGS) data and rare variant analysis; copy number variant analysis; analysis using summary statistics.

Prerequisite: ST 511 or equivalent
Typically offered in Fall only

GN 725/FOR 725 Forest Genetics (3 credit hours)
Application of genetic principles to silviculture, management and wood utilization. Emphasis on variation in wild populations, the bases for selection of desirable qualities and fundamentals of controlled breeding.

Typically offered in Spring only

GN 735 Functional Genomics (3 credit hours)
Methodology of experimental genomics; genome sequencing, gene expression arrays, genomic screens, proteomics. Aims and achievements of microbial, plant, animal, human genome projects. Applications of genomics including parasitology, breeding, functional genomics, evolutionary genetics. Interface with bioinformatics, data technology.

Prerequisite: GN 701
Typically offered in Spring only

GN 745/HS 745/CS 745 Quantitative Genetics In Plant Breeding (1 credit hours)
Theory and principles of plant quantitative genetics. Experimental approaches of relationships between type and source of genetic variability, concepts of inbreeding, estimations of genetic variance and selection theory.

Prerequisite: CS(GN, HS) 541, ST 712, course in quantitative genetics recommended
Typically offered in Spring only

GN 746/HS 746/CS 746 Cytogenetics in Plant Breeding (2 credit hours)
Theory and principles of plant breeding methodology including population improvement, selection procedures, genotypic evaluation, cultivar development and breeding strategies.

Typically offered in Spring only

GN 756/ST 756 Computational Molecular Evolution (3 credit hours)
Phylogenetic analyses of nucleotide and protein sequence data. Sequence alignment, phylogeny reconstruction and relevant computer software. Prediction of protein secondary structure, database searching, bioinformatics and related topics. Project required.

Prerequisite: GN 311 and ST 511
Typically offered in Fall only

GN 757/ST 757/HS 757 Quantitative Genetics Theory and Methods (3 credit hours)
The essence of quantitative genetics is to study multiple genes and their relationship to phenotypes. How to study and interpret the relationship between phenotypes and whole genome genotypes in a cohesive framework is the focus of this course. We discuss how to use genomic tools to map quantitative trait loci, how to study epistasis, how to study genetic correlations and genotype-by-environment interactions. We put special emphasis in using genomic data to study and interpret general biological problems, such as adaptation and heterosis. The course is targeted for advanced graduate students interested in using genomic information to study a variety of problems in quantitative genetics.

Prerequisite: ST 511
Typically offered in Fall only

GN 758/MB 758 Microbial Genetics & Genomics (3 credit hours)
Structure and function in microbial genetics, with emphasis on microbial genome organization, stable maintenance and evolution. DNA mutation and repair pathways, transcriptional and translational regulation, DNA replication and recombination and characterization of recombinant DNA molecules. Applications of genetic and genomic analysis methods to microbial processes, including strain construction, genome manipulation, and enhancement of gene expression.

Prerequisite: BCH 451 or GN 311
Typically offered in Spring only

GN 761/PB 761/BCH 761 Advanced Molecular Biology Of the Cell (3 credit hours)
An advanced graduate class involving integrated approaches to complex biological questions at the molecular level, encompassing biochemistry, cell biology and molecular genetics. The course will focus on an important, current area of research in eukaryotic biology using the primary scientific literature, and will involve class discussions, oral presentations, and a written research proposal.

Typically offered in Spring only

GN 768/BCH 768 Nucleic Acids: Structure and Function (3 credit hours)
An advanced treatment involving integrated approaches to biological problems at the molecular level, encompassing biochemistry, cell biology and molecular genetics. Broad, multidisciplinary approaches to solving research problems in biology and thecritical study of primary scientific literature, the development of a research proposal, oral presentations and class discussions.

Prerequisite: BCH 701 and 703
Typically offered in Spring only

GN 810 Special Topics in Genetics (1-6 credit hours)
Critical study of selected areas and special topics of current interest in genetics and related fields.

Typically offered in Fall and Spring

GN 820 Special Problems (1-6 credit hours)
Special topics designed for additional experience and research training.

Prerequisite: Advanced Graduate standing
Typically offered in Fall and Spring

GN 850 Professionalism and Ethics (1 credit hours)
The course is designed to give students background in professionalism, scientific ethics and responsible conduct of science. Topics include the role of the scientist in society, ethical theory, data acquisition and ownership, scientific midconduct,authorship, peer review, conflicts of interest and commitment, intellectual property, ethics of teaching and mentoring, ethical treatment of animal and human subjects, ethics of genetics research, job hunting and interviewing.

Prerequisite: Graduate standing
Typically offered in Fall only

GN 860/HS 860/CS 860 Plant Breeding Laboratory (1 credit hours)
Visitation of plant breeding projects in the Depts. of CS and HS at NC State, along with commercial seed companies. Discussion and viewing of breeding objectives, methods and equipment and teaching and practice of hybridization methods.

P: CS 741 or GN 741 or HS 741
Typically offered in Spring only

GN 861/HS 861/CS 861 Plant Breeding Laboratory (1 credit hours)
Visitation of plant breeding projects in the Depts. of CS and HS at NC State, along with commercial seed companies. Discussion and viewing of breeding objectives, methods and equipment and teaching and practice of hybridization methods.

P: CS 741 or GN 741 or HS 741
Typically offered in Fall only

GN 885 Doctoral Supervised Teaching (1-3 credit hours)
Teaching experience under the mentorship of faculty who assist the student in planning for the teaching assignment, observe and provide feedback to the student during the teaching assignment, and evaluate the student upon completion of the assignment.

Prerequisite: Doctoral student
Typically offered in Fall and Spring

GN 890 Doctoral Preliminary Examination (1-9 credit hours)
For students who are preparing for and taking written and/or oral preliminary exams.

Prerequisite: Doctoral student
Typically offered in Fall and Spring

GN 893 Doctoral Supervised Research (1-9 credit hours)
Instruction in research and research under the mentorship of a member of the Graduate Faculty.

Prerequisite: Doctoral student
Typically offered in Fall and Spring

GN 895 Doctoral Dissertation Research (1-9 credit hours)
Dissertation Research

Prerequisite: Doctoral student
Typically offered in Fall, Spring, and Summer

GN 896 Summer Dissertation Research (1 credit hours)
For graduate students whose programs of work specify no formal course work during a summer session and who will be devoting full time to thesis research.

Prerequisite: Doctoral student
Typically offered in Summer only

GN 899 Doctoral Dissertation Preparation (1-9 credit hours)
For students who have completed all credit hour requirements, full-time enrollment, preliminary examination, and residency requirements for the doctoral degree, and are writing and defending their dissertations.

Prerequisite: Doctoral student
Typically offered in Fall, Spring, and Summer