GENETICS MAJOR: GENOMICS OPTION (B.S.)

https://colsa.unh.edu/molecular-cellular-biomedical-sciences/program/ bs/genetics-major-genomics-option

Description

The **Genetics:Genomics program (GEN)** explores the world of genetics and genomics in plants, animals, and microbes. Genomics is the study of genomes and includes topics like DNA structure and function, highthroughput sequencing, and computational comparison of the genomes of different organisms. The Genetics faculty strongly value hands-on learning and many GEN students conduct undergraduate research under the supervision of our faculty. GEN graduates are prepared for successful careers in biotechnology fields or for entry into a variety of graduate school or health professional programs.

The Genetics program offers course work and laboratories in:

- molecular genetics
- bioinformatics
- human genetics
- · comparative genomics
- · plant genetics
- · microbial genetics
- · population and evolutionary genetics

Students in the Genetics program may participate in a variety of experiential learning activities including:

- · independent research experiences in laboratories of UNH faculty
- work at the <u>Hubbard Center for Genome Studies</u> or <u>Research</u> <u>Computing Center</u>
- · internships at biotechnology companies in the Greater Boston area
- · internships with genetics counselors at area medical centers

GEN graduates have been successful in attaining careers as:

- research scientists and laboratory technicians in
 - biotechnology and pharmaceutical companies
 - academic research programs
 - forensics
 - · biomedical research centers & medical schools
 - · government agencies
- · genetic counselors
- educators
- · technical support associates

GEN graduates are prepared for further education in:

- professional health programs
 - genetic counseling
 - <u>medical school</u>
 - dental school

- allied health programs (<u>physician assistant</u>, <u>pharmacist</u>, <u>nursing</u> or <u>pathologist's assistant</u>)
- veterinary school
- graduate programs such as
 - Genetics and Genomics
 - Integrative Biology
 - Neurogenomics
 - Molecular Biology
 - Microbiology
 - Environmental Sciences
 - Public Health
 - Computer Science

Requirements

Degree Requirements

Minimum Credit Requirement: 128 credits

Minimum Residency Requirement: 32 credits must be taken at UNH

Minimum GPA: 2.0 required for conferral*

Core Curriculum Required: Discovery & Writing Program Requirements

Foreign Language Requirement: No

All Major, Option and Elective Requirements as indicated. *Major GPA requirements as indicated.

Major Requirements

Students majoring in Genetics with the Genomics option take seven Foundation courses, six Bioscience Core courses, four Genetics Core courses and five Major Elective courses. One capstone experience, supervised and approved within the major, is required of all seniors. The capstone explores areas of interest based on the integration of prior learning. In addition, all other University requirements must be completed, including those for the University Discovery Program and the Writing Program.

A minimum grade of C- minus or better is required in statistics and all Bioscience Core, Genetics Core, and Major Elective courses.

Required Courses

| Code | Title | Credits |
|------------------------|--|---------|
| Foundation Courses | | |
| CHEM 403 | General Chemistry I | 4 |
| CHEM 404 | General Chemistry II | 4 |
| CHEM 545 & CHEM 546 | Organic Chemistry and Organic Chemistry Laboratory ² | 5 |
| MATH 424B | Calculus for Life Sciences ³ | 4 |
| BIOL 528 | Applied Biostatistics I | 4 |
| PHYS 401 | Introduction to Physics I | 4 |
| PHYS 402 | Introduction to Physics II | 4 |

¹ Fulfills Physical Science Discovery requirement

² Students applying to health profession schools need a full year of Organic Chemistry, a full year of introductory Biology, and a full year of English. CHEM 651/CHEM 653 and CHEM 652/CHEM 654 should be taken in place of CHEM 545/CHEM 546; ENGL 502 or ENGL 503 is suggested in addition to ENGL 401. See <u>Pre-Professional Health</u> <u>Program advising</u>.

³ Fulfills Quantitative Reasoning Discovery requirement

| Code | Title | Credits |
|--------------------------------|---|---------|
| Bioscience Core Courses | | |
| BIOL 411 | Introductory Biology. Molecular and Cellular ⁴ | 4 |
| BIOL 412 | Introductory Biology. Evolution, Biodiversity and Ecology | 4 |
| GEN 604 | Principles of Genetics | 4 |
| BMS 503 & BMS 504 | General Microbiology and General Microbiology Laboratory | 5 |
| BMCB 605 | Principles of Cell Biology | 4 |
| BMCB 658 & BMCB 659 | General Biochemistry and General Biochemistry Lab | 5 |

⁴ Fulfills Biological Science Discovery requirement, Discovery Inquiry requirement, and Discovery laboratory requirement

| Code | Title | Credits |
|------------------------------|---|---------|
| Genetics Core Courses | | |
| GEN 606 | Genetics Lab | 4 |
| MCBS 401 | Professional Perspectives in Molecular, Cellular, and Biomedical Sciences | 1 |
| GEN 711 | Genomics and Bioinformatics | 4 |
| Select one of the following: | | |
| GEN 704 | Microbial Genetics and Genomics | 5 |
| GEN 771 | Molecular Genetics | 4 |

Electives

Five (5) unique major electives are required.

| Code | Title | Credits |
|-------------------------------|---|---------|
| Required Electives | | |
| GEN 712 | Programming for Bioinformatics | 5 |
| GEN 721 | Comparative Genomics | 4 |
| Code | Title | Credits |
| Population/Evolutionary Gen | etics Electives | |
| Select two from the following | g: | |
| GEN 705 & GEN 725 | Population Genetics and Population Genetics Lab ⁵ | 5 |
| GEN 713 | Microbial Ecology and Evolution | 4 |
| GEN 715 | Molecular Evolution | 4 |
| GEN 772 | Evolutionary Genetics of Plants | 4 |
| | | |
| Code | Title | Credits |
| Bioscience Electives | | |
| Select one from the following | g: | |
| GEN 704 | Microbial Genetics and Genomics ⁵ | 5 |
| GEN 705 & GEN 725 | Population Genetics and Population Genetics Lab ⁵ | 5 |
| GEN 706 | Human Genetics | 4 |
| GEN 713 | Microbial Ecology and Evolution | 4 |
| GEN 715 | Molecular Evolution | 4 |
| GEN 717 | Molecular Microbiology | 5 |
| GEN 771 | Molecular Genetics | 4 |
| GEN 772 | Evolutionary Genetics of Plants | 4 |
| GEN 795 | Investigations in Genetics (4 credit minimum) ⁶ | 1-4 |
| GEN 795W | Investigations in Genetics (4 credit minimum) ⁶ | 1-4 |
| GEN 799 | Senior Thesis (4 credit minimum) ⁶ | 1-4 |
| GEN 799H | Honors Senior Thesis (4-credit minimum) ⁶ | 1-4 |
| ANSC 602 | Animal Rights and Societal Issues | 4 |
| ANSC 612 | Genetics of Animals | 4 |
| ANSC 701 | Physiology of Reproduction | 4 |
| BIOL 704 | Plant-Microbe Interactions | 3 |
| BIOL 706 | Data Science with R for the Life Sciences | 4 |
| BIOL 711 | Experimental Design & Analysis | 4 |
| BIOL 752 | New England Mushrooms: a Field and Lab Exploration | 4 |
| BMCB 750 | Physical Biochemistry | 3 |
| BMCB 753 | Cell Culture | 5 |
| BMCB 754 | Molecular Biology Research Methods | 5 |

| BMCB 760 | Pharmacology | 4 |
|-------------------------|---|-----|
| BMCB 763 | Biochemistry of Cancer | 4 |
| BMCB 794 | Protein Structure and Function | 4 |
| BMS 650 | Molecular Diagnostics | 4 |
| BMS 702 | Endocrinology | 4 |
| BMS 705 | Immunology | 3 |
| BMS 706 | Virology | 3 |
| BMS 718 | Mammalian Physiology | 4 |
| BMS 719 | Host-Microbe Interactions | 4 |
| BMS 735 | Molecular and Cellular Parasitology | 4 |
| BMS 740 | Human Microbiome | 4 |
| INCO 790 | Advanced Research Experience (4-credit minimum) $^{ m 6}$ | 1-4 |
| NR 706 | Soil Ecology | 4 |
| ZOOL 625 & ZOOL 626W | Principles of Animal Physiology and Animal Physiology Laboratory | 5 |
| ZOOL 690 | Evolution | 4 |
| ZOOL 736 | Genes and Behavior | 4 |
| Z00L 777W | Neuroethology | 4 |

⁵ This course can count as both a Bioscience Major Elective AND a Population or Evolutionary Genetics Major Elective IF students take one additional Bioscience Major Elective.

⁶ Must be a research project with a genetics focus

Capstone

The capstone explores areas of interest based on the integration of prior learning. The capstone requirement may be satisfied through a course, created work or product, or some form of experiential learning (e.g., honors thesis, mentored research project, or other special student activity). Students may take more than one capstone course. Capstone completion is never displayed on Degree Works; your advisor will certify capstone completion at the time of graduation. Students must have 90 credits or more when completing their capstone requirement. Contact your advisor for questions about capstones.

| Code | Title | Credits |
|---------------------------|---|---------|
| Approved Capstone Courses | | |
| GEN 704 | Microbial Genetics and Genomics | 5 |
| GEN 705 | Population Genetics | 5 |
| & GEN 725 | and Population Genetics Lab | |
| GEN 715 | Molecular Evolution | 4 |
| GEN 717 | Molecular Microbiology | 5 |
| GEN 790 | Undergraduate Teaching Experience (4 credit minimum; classroom presentation required) | 1-4 |
| GEN 795 | Investigations in Genetics (4-credit minimum) ⁶ | 1-4 |
| GEN 795W | Investigations in Genetics (4-credit minimum) ⁶ | 1-4 |
| GEN 799 | Senior Thesis (4-credit minimum) ⁶ | 1-4 |
| GEN 799H | Honors Senior Thesis (4-credit minimum) ⁶ | 1-4 |
| INCO 790 | Advanced Research Experience (4-credit minimum) ⁶ | 1-4 |

⁶ Must be a research project with a genetics focus

Degree Plan

Sample Degree Plan

This sample degree plan serves as a general guide; students collaborate with their academic advisor to develop a personalized degree plan to meet their academic goals and program requirements.

| First Year | | |
|--------------------|--|---------|
| Fall | | Credits |
| BIOL 411 | Introductory Biology: Molecular and Cellular | 4 |
| MCBS 401 | Professional Perspectives in Molecular, | 1 |
| | Cellular, and Biomedical Sciences | |
| ENGL 401 | First-Year Writing | 4 |
| CHEM 403 | General Chemistry I | 4 |
| Discovery course | | 4 |
| | Credits | 17 |
| Spring | | |
| BIOL 412 | Introductory Biology: Evolution, Biodiversity and Ecology | 4 |
| MATH 424B | Calculus for Life Sciences | 4 |
| CHEM 404 | General Chemistry II | 4 |
| Discovery course | | 4 |
| | Credits | 16 |
| Second Year | | |
| Fall | | |
| GEN 604 | Principles of Genetics | 4 |
| BMCB 605 | Principles of Cell Biology | 4 |
| BIOL 528 | Applied Biostatistics I | 4 |
| Discovery course | | 4 |
| | Credits | 16 |
| Spring | | |
| GEN 606 | Genetics Lab | 4 |
| BMS 503 | General Microbiology | 5 |
| & BMS 504 | and General Microbiology Laboratory | |
| CHEM 545 | Organic Chemistry | 5 |
| & CHEM 546 | and Organic Chemistry Laboratory | |
| Discovery course | Que lite | 4 |
| Thind Man | Credits | 18 |
| | | |
| | Dragramming for Disinformation | F |
| GEN / 12 | | 5 |
| & BMCB 659 | and General Biochemistry Lab | 5 |
| PHYS 401 | Introduction to Physics I | 4 |
| Discovery course | | 4 |
| | Credits | 18 |
| Spring | | |
| GEN 711 | Genomics and Bioinformatics | 4 |
| GEN 721 | Comparative Genomics | 4 |
| PHYS 402 | Introduction to Physics II | 4 |
| Discovery course | | 4 |
| | Credits | 16 |
| Fourth Year | | |
| Fall | | |
| Genetics Core cou | Irse | 4 |
| Major Elective (Po | pp/Evol Genetics; possible Capstone) | 4 |
| Elective (any cour | rse) | 4 |
| Elective (any cour | se) | 4 |
| | Cradita | 16 |

| Spring | |
|------------------------------------|---------|
| Major Elective (Bioscience) | 4 |
| Major Elective (Pop/Evol Genetics) | 4 |
| Elective (any course) | 4 |
| Elective (any course) | 3-5 |
| Credits | 15-17 |
| Total Credits | 132-134 |

Student Learning Outcomes

Program Learning Outcomes Core Knowledge in Genetics

- Students will be able to describe DNA, its role, structure, how DNA is packaged in the chromosomes in terms of histones, nucleosomes, and chromatin, including its discovery, how has modern genomics influenced, and differences between prokaryotes and eukaryotes.
- Students will be able to describe the central dogma of molecular biology, including specific details related to replication, transcription, and translation.
- Students will be able to define and describe evolution, how drift, gene flow, mutation, natural selection, recombination, within a population genetic framework, may result in evolution.
- Students will be able to describe the differences between mitosis and meiosis and how errors in these processes may effect phenotype, cause disease, etc.
- Students will be able to evaluate how genes and the environment can interact to produce a phenotype, including allelic differences and changes in gene regulation.
- Students will be able to describe the concept of deep time, and how comparing genes and genomes allows us to understand evolution and relatedness between species.
- Students will be able to use pedigrees to determine mode of inheritance of a trait.
- Students will be able to describe ethical issues related to modern genomics and implications for health care and insurance, interpersonal relationships, family planning, etc.
- Students will be able to describe high-throughput sequencing, and how it has changed the practice of modern genetics.

Quantitative Literacy, Inquiry & Analysis

- Students will be able to apply the scientific method to examine experimental evidence and draw informed conclusions.
- Students will be able to use graphs to represent scientific data.
- Students will be able to apply statistical methods to interpret scientific data.

Critical Thinking & Problem Solving

- Students will be able to use data to troubleshoot an unexpected outcome .
- Students will be able to apply core knowledge to critically interpret scientific data.

Written Communication

• Students will demonstrate written skills to communicate scientific knowledge and experimental data.

Oral Communication

• Students will be able to demonstrate oral presentation skills to communicate scientific knowledge and experimental data.