Course Requirements for the Ph.D. or M.S. Degree in Genetics

All students must

- Take a minimum of **10-11 courses***
- Register for **exactly 10 units total** (research plus courses) **each quarter**, including summer; this total includes research units for rotations or degree work, which are not addressed in this course document
- Earn a **minimum grade** of B- in the Core Requirements that can be taken for a grade
- Maintain at least a **B average** in all Core Requirements
- Students must manually change the grading option from +/- to a LTR or S/NC
- If a course can be taken for a LTR grade and student wants it to count towards course requirements, then the grading option must be set to LTR

These are the categories of courses:

1. Core Requirements
    a. Specific required courses (N=7)
    b. Statistics core requirement (N=1 from several options)
    c. Computational core requirement (N=1 from several options)
2. Electives (N>=2)

Outside of the core requirements, course offerings change frequently, and every student's interests and needs are different. We therefore encourage you to

- Ask yourself what types of courses will be most helpful for your graduate career, especially after the first couple of quarters
- Discuss course selection with other Genetics students, your first-year faculty mentor, and your research advisors
- Talk to the Graduate Program Director if you would like a variance
- Consult the Stanford Bulletin (https://explorecourses.stanford.edu/) for the latest details on available courses

1. Core Requirements

1.a. These specific courses must be taken.

- GENE 200 (Training Camp)
- BIOS 200 (Foundations in Experimental Biology, Aut)
- GENE 205 (Advanced Genetics, Win)
- GENE 211 (Genomics, Win)
- GENE 215 (Frontiers in Biological Research, Aut & Spr)
    - Must register for twice; counts as one course
- MED 255 (The Responsible Conduct of Research, Aut, Win, Spr)
    - Fills up fast; register early, preferably in first year!

- GENE 219 (Current Issues in Genetics)
    - Each quarter of your first year; counts as one course
    - If it puts you over 10 units do not register for it but you must attend

1. b. Statistics Core Requirement

One of these must be taken. Substitutions are quite commonly made and can be done so with the consent of the Graduate Program Director, if you have taken and passed an equivalent course previously, for example in your undergraduate studies.[1]

STATS 112	Principles of Data Science	Quantitative Introductory/ Intermediate	Broad intro to data science and machine learning, requires CS 106A or equivalent
STATS 141	Biostatistics	Statistics Introductory	Introduction to Biostatistics integrated with statistical computing in R
EPI 259	Introduction to Probability and Statistics for Epidemiology	Statistics Intermediate	Covers fundamentals of Biostatistics with an emphasis on medical applications

1. c. Computational Core Requirement

All Genetics PhD students should gain a basic familiarity with programming/bioinformatics. We are willing to accept any prior coursework or experience to satisfy this requirement. For example, one of the following courses could fulfill this requirement. Or, previous undergraduate or online classes that include programming would also satisfy this requirement, for example in your undergraduate studies[1].

GENE 218 (MI 218, PATH 218)	Computational Analysis of Biological Information: Introduction to Python for Biologists	Programming Introductory	Appropriate for students who have no or little programming experience.
CS 106A	Programming Methodology	Programming Introductory	Appropriate for students who have no or little programming experience, and want a deep, time-intensive introduction to programming
GENE 214	Representations and Algorithms for Computational Molecular Biology	Programming Intermediate	Requires programming. Programming assignments throughout the quarter and then a final exam.
IMMUNOL 206	Introduction to Applied Computational Tools in Immunology	Bioinformatics Introductory /Intermediate	Exposure to web-based databases and analysis suites for immunological and genomic data
BIODS 205	Bioinformatics for Stem Cell and Cancer Biology	Bioinformatics Intermediate	Appropriate for students with biology program and no background in computer science. Topics include analysis of bulk and single-cell sequencing data, single gene to whole-genome analysis, machine learning, and data visualization. Basic programming experience is recommended but not required
CS 229	Machine Learning	Machine Learning Advanced	Requires advanced programming and mathematics; highly recommended for students who want to develop methods that involve machine learning

[1]Appendix 1, a list of quantitative electives, contains possibly appropriate alternatives

*If a student has taken a computational course in the past then that is one less course they need to take. Their total course load would be 10 classes.

2. Electives

The following electives are examples that have been historically popular among students or faculty. This list is not comprehensive; you are welcome to take any course that furthers your progress to your degree.

Any of the quantitative courses in 1.b., 1.c., or Appendix 1 that were not taken to fulfill a core requirement may be an elective as well.

GENE206	Epigenetics, Win, not every year
BIO 244	Molecular Evolution, Spr
GENE 235	C. elegans Genetics, Win, alternate years
BIO 222	Exploring Neural Circuits
BIO 258	Developmental Neurobiology
CBIO 275	Tumor Immunology
INDE 210	Foundations of Cancer Biology and Pathology
STEMREM 201A	Stem Cell Biology & Regenerative Medicine
DB 210	Developmental Biology
GENE 221	Current Issues in Aging
GENE 234	Fundamentals of RNA Biology
GENE 247	Genomic approaches to the study of human disease
IMMUNOL 230	Cellular and Molecular Immunology
GENE 242	Genetics of Emerging Viruses
GENE 220	Genetics, Ethics and Society
GENE 207	Microfluidics Device Laboratory
GENE 213	AI, Genes and Ethics
GENE 229	How we age
GENE 223	Aging: Science and Technology for Longevity
GENE 226	Longevity Venture Capital
GENE 225	Healthcare Venture Capital

Example First Year Course Curriculum

Fall

- GENE 200 – Training Camp (1.a.)
- BIOS 200 – Foundations in Experimental Biology (1.a.)
- GENE 215 – Frontiers in Biological Research (1.a.)
- GENE 219 – Current Issues in Genetics (1.a.)

Winter

- GENE 211 – Genomics (1.a.)
- GENE 205 – Advanced Genetics (1.a.)
- GENE 219 – Current Issues in Genetics (1.a.)

Spring

- GENE 215 – Frontiers in Biological Research (1.a.)
- MED 255 – The Responsible Conduct of Research (1.a.)
- CS 106A – Programming Methodology (1.b.)
- GENE 219 – Current Issues in Genetics (1.a.)

Note that this curriculum would fulfill all Core 1.a. requirements and the 1.c. requirement, leaving the 1.b. requirement and electives to the second year and beyond.

Appendix 1: Additional quantitative electives

Class Catalog	Description
GENE 244	Introduction to Statistical Genetics
GENE 245	Computational Algorithms for Statistical Genetics
CS 278	Social Computing
STATS 116	Theory of Probability
STATS 202	Data Mining and Analysis
BIOMEDIN 216	Lecture component of BIOMEDIN 214
BIOMEDIN 210	Modeling biomedical systems
BIOS 241	Data wrangling with bash
BIOS 249	Single-cell spatial-omics
CS 324	Advances in foundation models
CS 131	Computer vision: foundation & applications
CS 230	Deep learning
CS 231N	Deep learning for computer vision
CS 224W	Machine learning with graphs
CS 168	Modern algorithmic toolbox
CS 228	Probabilistic graphical models
STATS 261	Analysis of discrete data
STATS 305A/B/C	Applied statistics I
STATS 217	Intro stochastic processes I
STATS 216	Intro to statistical learning
STATS 315A/B/C	Modern appl stat: learning II
EPI 261	Analysis of discrete data
EPI 262	Intermediate biostatistics: regression, prediction, survival analysis
CS273B / GENE236:	Deep learning for genomics and biomedicine
CS273C / GENE 222:	Cloud computing for Biology and Healthcare