# Ph.D. Program in Genetics, Genomics, and Cancer Biology

## Program Requirements

### Required Courses

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>GE 501, 511, 521, 531</td>
<td>Experimental Methods Pre-entry, I, II, III (3 research rotations are usually required)</td>
<td>3 each</td>
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<tr>
<td>GE 612</td>
<td>Genetics of Model Organisms</td>
<td>3</td>
</tr>
<tr>
<td>GE 636</td>
<td>Regulation of Cell Cycle and Apoptosis</td>
<td>3</td>
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<tr>
<td>GE 637</td>
<td>Advanced Human Genetics</td>
<td>3</td>
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<tr>
<td>GE 651</td>
<td>Pathobiology of Cancer</td>
<td>2</td>
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<tr>
<td>GE 652</td>
<td>Molecular Basis of Cancer</td>
<td>2</td>
</tr>
<tr>
<td>GE 710, 720, 730</td>
<td>Seminar</td>
<td>1 each</td>
</tr>
<tr>
<td>GE 910, 920, 930</td>
<td>Research</td>
<td>Variable</td>
</tr>
<tr>
<td>Bi 525</td>
<td>Biochemistry and Molecular Biology – Genetic Information Transfer</td>
<td>3</td>
</tr>
<tr>
<td>GC 550</td>
<td>Foundations in Biomedical Sciences</td>
<td>10</td>
</tr>
<tr>
<td>GC 645</td>
<td>Genomics &amp; Bioinformatics</td>
<td>3</td>
</tr>
<tr>
<td>GC 640</td>
<td>Research Ethics: The Responsible Conduct of Research</td>
<td>1</td>
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<tr>
<td>GC 730</td>
<td>Planning &amp; Writing Research Grants</td>
<td>1</td>
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<tr>
<td>NS 740</td>
<td>Applied Statistics in Neuroscience</td>
<td>3</td>
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### Recommended Elective Courses

<table>
<thead>
<tr>
<th>Course Code</th>
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<th>Credits</th>
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<tbody>
<tr>
<td>GC 665</td>
<td>Cell Signaling</td>
<td>4</td>
</tr>
<tr>
<td>IMP 505 A and B</td>
<td>Fundamentals of Immunology, Parts 1 and 2</td>
<td>2 each</td>
</tr>
<tr>
<td>IMP 600</td>
<td>Microbiology</td>
<td>2</td>
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</tbody>
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## Course Descriptions / Required Courses

**GE 501, 511, 521, 531**  
Experimental Methods Pre-entry, I, II, III (Siracusa)  
Credits 3  
Each semester/session; must complete 3 rotations

Supervised rotations in faculty research laboratories. This course provides formal training in laboratory methods and experimental design obtained by rotations through the laboratories of different preceptors working on diverse problems in genetics. Emphasis is placed on the principles of scientific methodology and experimental design, recording and interpretation of data, and technical reporting of data.
GE 612  Genetics of Model Organisms (TBN)
Credits 3
Spring I
This course explores advanced (beyond those covered in the GC 550 core course) topics in the molecular genetics of eukaryotes. Primarily centered on mammalian genetics and using the mouse as a model system, it also covers selected topics in the yeast, Drosophila and zebra fish model systems. After a brief review of the principles of Mendelian genetics, including equal segregation and independent assortment, the course will cover (among other topics): the mouse as a genetic model, manipulating the mouse genome, genetic mapping of single and complex traits, non-Mendelian inheritance and epigenetic modification of the genome, bioinformatics and mouse models of human disease. The course will conclude with topics of interest in the non-mammalian systems.

GE 636  Regulation of Cell Cycle and Apoptosis (Calabretta)
Credits 3
Fall
Factors controlling cell growth and mechanisms initiating cell proliferation will be discussed. Foremost will be a consideration of proto-oncogenes and their role in the regulation of cell cycle traverse. Mechanisms of proto-oncogene activation to oncogenes and the role of oncogenes and suppressor genes in uncontrolled cell proliferation and cell transformation will be discussed via a consideration of original papers and student presentations. Assigned reading.

GE 637  Advanced Human Genetics (Siracusa)
Credits 3
Spring II
This mammalian genetics course assumes a basic knowledge of molecular biology, molecular genetics and classical genetics. It covers a wide range of topics from clinical cytogenetics, Mendelian genetics with examples of specific diseases, population genetics and multifactorial inheritance, to physical mapping, genome informatics, mutation detection and more diseases that exemplify certain genetic principles. Finally, functional genomics, including DNA microarray analyses and applications and SNPs (single nucleotide polymorphisms) and applications are introduced.

GE 651  Pathobiology of Cancer (Rui)
Credits 3
Spring II
The course covers the classification of human cancers, characteristics of neo-plastic cells, epidemiology of cancers, causes of cancer, experimental carcinogenesis and the immune response against neoplastic cells. Lectures and discussions are held on these individual topics. Assigned readings.

GE 652  Molecular Basis of Cancer (Nevalainen)
Credits 2
Spring I
This advanced seminar course emphasizes the molecular and genetic basis of neoplasia, including oncogene activation, tumor suppressor genes, chromosomal translocation and deletions. Models of multistep tumorigenesis in transgenic mice.
GE 710, 720, 730  
Seminars in Genetics I, II, III (Faculty)  
Credits 1  
Fall, Spring I, Spring II  
Students and faculty report on recent developments in areas of research interest on departmental research projects. Visiting scientists are also invited to present seminars. Required for all graduate students in Genetics.

GE 910, 920, 930  
Research (Siracusa)  
Credits variable  
Fall, Spring, Summer  
Under the supervision of a member of the graduate faculty and guidance of a thesis research committee, the student will learn research design, methodology, and experimental techniques relevant to the graduate program. Research leading to the doctoral thesis is a major requirement for the Ph.D. degree and will occupy a dominant part of the student’s time and attention.

BI 525  
Biochemistry and Molecular Biology - Genetic Information Transfer (Hou)  
Credits 3  
Prerequisite: GC 550 or equivalent  
Spring I  
This course focuses on current advances of molecular biology research for the understanding of genetic information transfer from DNA to RNA to protein. Topics include DNA replication, repair, and recombination, RNA transcription, processing, and regulation, protein synthesis, ribosome, and quality control. The course will contain formal lectures, as well as student presentations, and two examinations.

GC 550  
Foundations of Biomedical Sciences (Jaynes)  
Credits 10  
Fall  
This course is designed to provide a basic knowledge of biochemistry, genetics, molecular biology and cellular biology to the beginning student. The primary goal is to convey knowledge of the molecular and cellular mechanisms controlling cell, tissue and organ system function using material drawn from biochemistry, cell biology, genetics, pharmacology and physiology. The course will familiarize the student with the powerful technologies used in scientific research and will train the student in the communication of science through informal sessions on evaluation of published literature, scientific writing, oral presentations, and information retrieval.

GC 640  
Research Ethics: The Responsible Conduct of Research (Flynn)  
Credits 1  
Fall, Spring I, Spring II  
This graduate seminar course is designed to familiarize students with the ethical dilemmas inherent to the conduct of research. Topics to be discussed include codes of ethical behavior, research design, conflicts of interest, informed consent and the appropriate use of animals. The student will be required to prepare a paper on the analysis of one or more case studies.
GC 645  Genomics & Bioinformatics (Gonye)
Credits 3
Spring II
To provide students with an overview and understanding of the utility of genomic-scale data in a biomedical setting and the computational and analytical tools used with these high dimensional data sets. Various topics will be covered leading to the highly integrated state of the art approaches in use today. Lecture materials will be combined with hands on tutorials and weekly projects in an integrated fashion. Several guest presentations from on campus experts will supplement the course content. Students should gain a broad working knowledge of the issues and capabilities of genomics, bioinformatics and their integration.

GC 730  Planning and Writing a Research Grant (Grunwald)
Credits 1
Fall
This course is designed to provide students with instruction and practical experience in the art of planning and writing a research grant proposal. Students will become familiar with the structure of a research grant, including the development of the major sections of a grant proposal such as specific aims, background and significance, and experimental design. Development of the experimental design section will include approaches to discussion of experimental rationale, detailed research methods, expected results and interpretations, and potential pitfalls and alternatives. Students will also learn about the peer review process and how to critique a grant proposal. NIH-style grants will serve as the model for this course, although the general principles of grant organization and writing will be applicable to all research grants. Students will gain practical experience by sequential production of three written documents: (1) an NIH-style Specific Aims Page, (2) a Research Plan based upon expansion and development of one specific aim, and (3) an NIH-style critique of a grant proposal.

NS 740  Applied Statistics in Neuroscience (Sterling)
Credits 2
Prerequisite: GC 550 or equivalent
Spring II
This course serves as a graduate level introduction into applied data analytic strategies focused in the neurosciences. An understanding of hypothesis testing, the relationship of design and analysis, and the interpretation of statistical tests of significance will be strongly emphasized. Methods for collecting and organizing study data, including an introduction to data analytic software such as SPSS and SAS, will be discussed. The ultimate objective of the proposed course is to provide graduate level neuroscience students with sufficient skill to independently enact various forms of data analysis.

Course Descriptions / Elective Courses

GC 665  Cell Signaling (Joseph/Wedegaertner)
Credits 4
Prerequisite: GC 550 or equivalent
Spring I
This course will focus on the regulation of cell function through an understanding of signal transduction mechanisms. Emphasis will be placed on cell biology aspects of signaling pathways, structure-function of signaling proteins, dysregulation of signaling pathways in disease and the mechanism of action of drugs that target signaling proteins.
IMP 505 A and B  Fundamentals of Immunology, Parts 1 and 2 (Sykulev)

Credits 2 each

Prerequisite: GC 550 or equivalent

Spring I

Part A: Innate immunity, immune receptor diversity; antigen processing and presentation; T and B cells. The format will involve both lecture and discussion of specific topics, and students will be encouraged to acquire an understanding of classical and modern immunological concepts through analysis of their experimental bases. Discussion of critical techniques in Immunology will be incorporated throughout the course. Assigned reading. A comprehensive 6 week course

Part B: Immune tolerance, microbial immunity; transplantation; tumor immunology. The format will involve both lecture and discussion of specific topics, and students will be encouraged to acquire an understanding of classical and modern immunological concepts through analysis of experimental bases. Discussion of critical techniques in Immunology will be incorporated throughout the course. Assigned reading. Prerequisite: IMP 505A. A comprehensive 6 week course

IMP 600  Microbiology (Alugupalli)

Credits 2

Spring I

This course provides students with an introduction to the field of Microbiology. Lectures will focus on particular infectious agents and will discuss pathogenesis, immunology, physiology, cell biology, pharmacology, and molecular biology of these organisms.