

Ph.D. Program in Biochemistry and Molecular Pharmacology

Program Requirements

Required Courses

Credits

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|-----------------------|---|----------|
| BI 501, 511, 521, 531 | Research Rotations (3 research rotations are usually required) | 3 each |
| BI 525 | Biochemistry and Molecular Biology – Genetic Information Transfer | 3 |
| PR 613 | Macromolecular Structure and Function I | 3 |
| BI 710, 720, 730 | Seminar – must enroll for 9 terms | 2 each |
| BI 910, 920, 930 | Dissertation Research | Variable |
| GC 550 | Foundations in Biomedical Sciences | 10 |
| GC 640 | Research Ethics: The Responsible Conduct of Research | 1 |
| NS 740 | Applied Statistics in Neuroscience | 2 |
| GC 730 | Planning & Writing a Research Grant | 1 |

Elective Courses

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|-----------|---|---|
| BI 535 | Biochemistry and Molecular Biology – Metabolism | 3 |
| BI 612 | Advanced Topics in Protein Function and Dysfunction | 3 |
| BI 614 | Macromolecular Structure and Function II | 3 |
| PR 522 | General Pharmacology | 3 |
| GC 630 | Fundamentals of Clinical Trials | 3 |
| GC 645 | Genomics and Bioinformatics | 3 |
| GC 665 | Cell Signaling | 4 |
| GE 612 | Genetics of Model Organisms | 3 |
| GE 636 | Regulation of Cell Cycle and Apoptosis | 3 |
| GE 637 | Advanced Human Genetics | 3 |
| GE 651 | Pathobiology of Cancer | 2 |
| GE 652 | Molecular Basis of Cancer | 2 |
| CB 615 | Developmental Biology I – Embryology | 3 |
| CB 625 | Mechanisms of Development | 3 |
| IMP 505 A | Fundamentals of Immunology | 2 |
| IMP 505 B | Immune System in Health and Disease | 2 |
| NS 700 | Cellular Neurophysiology | 4 |
| NS 715 | Molecular and Cellular Neuroscience | 3 |

Course Descriptions

BI 501, 511, 521, 531

Research Rotation Pre-entry, 1, 2, 3 (Merry)

Credits 3

Each semester/session; must complete 3 rotations

Students rotate through faculty laboratories to gain experience with a wide variety of basic laboratory techniques.

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.

PR 613 Macromolecular Structure and Function I (Pascal)

Credits 3

Prerequisite: GC 550 or equivalent

Spring I

Protein and nucleic acid structure and function, focusing on energetic forces that guide folding, and computer modeling to predict structures. To reveal protein and nucleic acid structures we will study optical spectroscopy (absorbance, fluorescence, circular dichroism), electrophoresis, mass spectroscopy, magnetic resonance spectroscopy, and X-ray crystallography. We aim to develop your critical, analytical and problem-solving abilities in structural biology. Lectures on Monday and Friday will be supplemented by problem sessions or hands-on experience on Wednesdays, in the classroom, laboratories, or offices.

BI 710, 720, 730 Seminar (Course Coordinator changes from semester to semester)

Credits 2

Fall, Spring I, Spring II

The purpose of this course is to provide a forum for the presentation and critical evaluation of recent publications in biology, including the experimental approaches taken and the conclusions drawn. The course consists of a series of oral student presentations to be discussed and evaluated by two attending faculty members following the seminar. As a part of the course, the students are expected to attend the department's guest speaker seminars and meet with the speakers to further discuss their work. Assigned reading.

BI 910, 920, 930 Research (Merry)

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.

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

Spring I

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 con-sent 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 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 will sufficient skill to independently enact various forms of data analysis.

BI 535 Biochemistry and Molecular Biology - Metabolism (Cingolani)

Credits 3

Prerequisite: Organic Chemistry

Spring II

The topics covered include the catabolic and anabolic pathways of carbohydrate, lipid, and amino acid metabolism and their biochemical interrelationships and regulation. Also addressed will be research directed at understanding the biochemical basis of a few selected diseases, as well as current research efforts in the field of metabolic regulation. Assigned reading.

BI 612 Advanced Topics in Protein Function and Dysfunction (Wickstrom)

Credits 3

Prerequisite: GC 550

Fall

This course will focus on current topics in protein folding and turnover that are involved in neurodegeneration, immune dysfunction, and cancer. Students will study protein structure, function, modification, and breakdown in cells and tissues in states of health and disease. We will connect the structural problems to their resulting pathologies. Faculty will present didactic lectures, followed by individual student presentations of designated relevant recent papers. Grading is based on oral presentations and a literature review term paper.

BI 614 Macromolecular Structure and Function II (Scott/Root)

Credits 3

Prerequisite: PR 613

Spring II

The course will introduce students to the biological role of ligand binding and catalysis with an emphasis on experimental techniques to study the function of macromolecules. Topics include bimolecular, multivalent, cooperative and competitive binding kinetics and thermodynamics and methods for their study (dialysis, fluorescence, biosensor, calorimetry), an overview of enzyme chemical mechanisms, and detailed discussion of enzyme kinetics including single and multisubstrate reactions, steady state and pre-steady state methods, inhibition kinetics and allostery.

GC 630 -- Fundamentals of Clinical Trials (Keith)

Credits 3

Prerequisite: Statistical Methods (NS 740 or GC 660)

Fall

This course introduces the fundamentals of design and analysis of clinical trials. Some of the design issues discussed include specifying and operationalizing the scientific question of interest, the role of a control group randomization, blinding, and sample size determination. The course focuses on statistical aspects of the analysis of clinical trials, including various statistical estimation and testing procedures, the intent to treat principle, interim analysis, and statistical and scientific inference. Students learn to critically review published reports of clinical trials through participation in small group discussions and individual written critiques.

GC 645 Genomics and Bioinformatics (Vadigepalli)

Credits 3

Prerequisite: GC 550 or equivalent

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 665 Cell Signaling (Joseph/Wedegaertner)

Credits 4

Prerequisite: GC 550 or equivalent

Spring II

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.

GE 612 Genetics of Model Organisms (TBN)

Credits 3

Spring 1

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

Prerequisite: GC 550 or equivalent

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

Prerequisite: GC 550 or equivalent

Spring II

This is a team taught human genetics course that assumes a basis 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 2

Prerequisite: GC 550 or equivalent

Spring I

The course covers the classification of human cancers, characteristics of neoplastic 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

Prerequisite: GC 550 or equivalent

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.

IMP 505 A : Fundamentals of Immunology - 2 Credits (Sykulev)

Credits 2 each

Spring I

Prerequisite: GC 550 or equivalent

A comprehensive course encompassing the major areas of Immunology: innate immunity, immune receptor diversity; antigen processing and presentation; T and B cells. The format for this course 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.

IMP 505 B: Immune System in Health and Disease – 2 Credits (Sykulev)

Credits 2 each

Prerequisite: GC 550 or equivalent

Spring I

Prerequisite: IMP 505A or equivalent.

The course discusses the role of the immune system in maintaining health: immune tolerance, microbial immunity; transplantation; tumor immunology. The format for this course 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.

CB 615 Developmental Biology I - Embryology (Grunwald/Philp)

Credits 3

Fall

Embryogenesis encompasses development of an organism from fertilization to birth. This course will describe the fundamental and historical concepts of morphogenesis, and cell differentiation as they pertain to the early embryo, body axis formation, and development and maturation of the major organ systems, including the placenta. Emphasis will be placed on comprehensive descriptions of developmental systems.

CB 625 Mechanisms of Development (Menko/Walker)

Credits 3

Prerequisite: GC 550 or equivalent

Spring I

This course builds on topics covered in GC550 and applies them to mechanisms of cell differentiation and development. There is a strong emphasis on cell biology, biochemistry and genetics as student explore such dynamic cell processes as polarity, communication, migration, signaling, and morphogenesis. This course is designed to help develop student skills in analyzing and presenting papers; each didactic lecture is accompanied by a student run analysis of a relevant paper from the literature. There also is an intensive grant writing component to this course through which students are provided with one on one faculty assistance during each phase of their writing process.

NS 700 Cellular Neurophysiology (O'Leary)

Credits 4

Prerequisite: GC 550 or equivalent

Spring I

a graduate lecture/seminar/ laboratory survey course that introduces students to concepts and experimental approaches in the neurosciences. The course will provide students with an understanding of the structure and function of the nervous systems at the cellular and systems levels, including an introduction to the organization of nerve cells and tissues, principles of neurophysiology and neuropharmacology, organization and function of motor and sensory systems, and central integration. This is obtained through a combination of didactic lectures as well as hands on laboratory sessions during two two-hour class sessions per week

NS 715 Molecular and Cellular Neuroscience (Merry)

Credits 3

Prerequisite: GC 550 or equivalent

Spring II

This course provides a detailed analysis of molecular and cellular neuroscience through the combination of didactic lectures and journal article based discussions. An emphasis will be placed on approaches used to investigate questions in several general ideas, including developmental neuroscience, cellular signaling, second messengers and the molecular genetic basis of behavior and disease. Lectures and discussion of primary literature expand on and deepen understanding in particular areas of molecular and cellular neuroscience introduced Neuro I. In addition a section on molecular genetic control of neurologic function and behavior will introduce new concepts and approaches to the study of neuronal dysfunction and disease. The inclusion of primary literature in the course promotes an understanding of analytical approaches to questions in neuroscience as well as critical scientific thinking. The primary literature also makes more accessible to students many of the techniques used in molecular and cellular neuroscience. Moreover the combination of didactic and discussion sessions for each topic allows the integration of knowledge acquisition with an analytical assessment of experimental molecular and cellular neuroscience.