Sanford Burnham Prebys Medical Discovery Institute
Graduate School of Biomedical Sciences

2019-2020 Course Catalog

Updated August 21, 2019
WELCOME
The Graduate School of Biomedical Sciences at Sanford Burnham Prebys Medical Discovery Institute offers the Doctor of Philosophy (Ph.D.) degree in Biomedical Sciences.

MISSION STATEMENT AND VISION

PROGRAM MISSION

The mission of the Sanford Burnham Prebys Medical Discovery Institute (SBP) Graduate School of Biomedical Sciences is: *Educating students to become the innovative biomedical scientists of the future.*

PROGRAM VISION

With state-of-the-art technology, an entrepreneurial mindset and a highly personalized program, SBP is dedicated to educating the next generation of outstanding biomedical scientists who will drive future cutting-edge basic and translational research.

PROGRAM LEARNING OUTCOMES (PLOs)

The Ph.D. Program in Biomedical Sciences at SBP Graduate School of Biomedical Sciences has the following learning outcomes that are aligned with the mission and vision of SBP, and which define the program:

- **PLO 1:** Strong foundational knowledge
- **PLO 2:** High quality biomedical research
- **PLO 3:** Innovative critical thinking and experimental design
- **PLO 4:** Clear written communication in standard academic genres such as grant proposals, poster presentations, and scientific articles
- **PLO 5:** Excellent oral communication skills
COURSEWORK OVERVIEW

Each student must successfully complete five core courses, six tutorials and one elective course in the first two years. A minimum of 80 course units is required prior to graduation. Students accrue eight course units per quarter.

Core Courses:
- SBP 260 Molecules to Systems (M2S), 4 units, Fall Year 1
- SBP 272 Responsible Conduct in Scientific Research (RCSR), 3 units, Fall Year 1
- SBP 265 Introductory Statistics (Stats), 4 units, Spring Year 1
- SBP 275 Biological Databases as a Research Tool (BDRT), 4 units, Fall Year 2
- SBP 263 Modern Drug Discovery Technologies (MDDT), 4 units, Spring Year 2

Other Courses:
- SBP 281 Graduate Tutorials (1 unit each)
- GRES 291 Graduate Research (units vary by quarter)
- 1 Elective Course (By the end of Year 2)

Course descriptions and current syllabi are online at http://sbpdiscovery.org/gsbscourses. Note: you must be on the SBP network and/or logged in to access the website.

GRES 291 - Graduate Research (1-8 units, every quarter)
Students enroll in GRES291 Graduate Research each quarter starting with the first quarter. Students are assessed on Overall Research Design, Technical Skills, Data Analysis, Communication Skills and Work Habits. Participation in laboratory research is an ongoing requirement and an integral part of the learning experience. The number of credits per quarter will vary based on courses taken. Graduate Research is evaluated via a rubric and a letter grade each quarter.

Data Club
At Data Club, students give oral presentations on their research progress and their presentation skills are evaluated. Meetings are held once a month (September through April) and every student must present at least once per year. All students in the program must attend the monthly seminars. Each presenter is responsible for inviting their faculty mentor to the meeting.
**COURSE DESCRIPTIONS**

**SBP 260 – Molecules to Systems (M2S),** 4 units, Fall quarter
Mondays & Thursdays, 9am - 11am, some Wednesdays and Fridays
Course Directors: Dr. Alessandra Sacco & Dr. Crystal Zhao; SBP faculty lecturers

The Molecules to Systems course is a broad-based survey course designed for first year graduate students to obtain broad exposure to a variety of scientific approaches and research in a wide variety of scientific disciplines related to biomedicine.

By the end of the course the student will:
- **CLO 1:** Obtain broad exposure to a large range of research topics in biomedicine.
- **CLO 2:** Have broad exposure to Sanford Burnham Prebys faculty, and exposure to the breadth of research at our Institute.
- **CLO 3:** Obtain experience in presenting/discussing/critiquing scientific papers.
- **CLO 4:** Acquire experience in written communication skills.

**SBP 272 – Responsible Conduct of Scientific Research (RCSR),** 3 units, Fall quarter
Tuesdays, 10am - 12:00pm
Course Director: Dr. Alessandra Sacco & Dr. Guy Salvesen

The Responsible Conduct of Scientific Research course is an overview course designed for first year graduate students to gain an understanding of the nine Responsible Conduct of Research (RCR) Core Areas outlined by the Office of Research Integrity (ORI). The course will include special emphasis of SBP policies and best practices.

Upon successful completion of this program, students will be able to:
- **CLO 1:** Understand the principles and practices governing the nine Office of Research Integrity core areas in the Responsible Conduct of Research.
- **CLO 2:** Understand the guidelines and available options for addressing specific challenges/concerns and potential misconduct in scientific research.
- **CLO 3:** Obtain experience in presenting/discussing/evaluating a variety of case studies involving ethical considerations in biomedical research and potential scientific misconduct.

**SBP 265 – Introductory Statistics (Stats),** 4 units, Winter quarter
Thursdays, 12pm - 2pm
Course Director: Dr. Michael G. Walker, Consulting Instructor

This course will describe and illustrate the statistical methods most commonly used in biomedical research, including clinical trials. The emphasis is on concepts and practical applications, not theory or proofs. Students will learn descriptive statistics, t-tests, analysis of variance, correlation, regression, factorial designs, power, and sample size. Students will learn how to use R statistics software to perform these analyses.
Upon successful completion of this course, students will be able to:

CLO 1: Identify appropriate statistical methods to analyze an experiment.
CLO 2: Design efficient and informative experiments.
CLO 3: Critique the statistical methods used in published biomedical literature.
CLO 4: Perform the following statistical analyses using statistics software: descriptive statistics, t-tests, analysis of variance, linear regression, power and sample size calculation and factorial experiment design.

SBP 275 – Biological Databases as a Research Tool (BDRT), 4 units, Fall quarter
Mondays, 10am - 12pm, Every other Thursday, 10am - 12pm
Course Directors: Dr. Adam Godzik
Practical Session Instructor: Dr. Andrew Hodges

This course provides introduction to several popular biological databases (UniProt, PDB, TCGA) and illustrates their role in the research process in structural biology, microbiology and medicine, with specific applications to cancer research. Practical hands-on sessions allow students to work with leading public bioinformatics databases and tools targeted to cancer and biomedical research.

Upon successful completion of this course:
CLO 1: Students will become familiar with the leading biological databases, their role in establishing data exchange formats and concepts of open research.
CLO 2: Students will be able to perform basic database searches and match the appropriate database to match their research problem.
CLO 3: Students will learn to analyze and integrate results from different experimental techniques, learn about different experimental pipelines and protocols and compare them to the protocols followed in their own labs.

SBP 263 - Modern Drug Discovery Technologies (MDDT), 4 units, Spring quarter
Wednesdays, 10am - 12pm
Course Director: Dr. Guy Salvesen and Chris Larson

The course covers the basic principles of a wide range of drug discovery approaches and provides students with real examples including those ongoing at Sanford Burnham Prebys Medical Discovery Institute (SBP). Lecturers include program faculty and staff whose laboratories are actively involved in discovering and developing drugs against therapeutically relevant targets, or who have held leadership positions in pharma and biotech. This course is cross-listed at UC San Diego as PHAR 228, PATH 228.

Upon successful completion of this program, students will be able to:
CLO 1: Understand the modern drug discovery process, pertaining to small molecules and biologics.
CLO 2: Understand the principles, design, and practical aspects of both biochemical and cellular high-throughput screening for hit identification in small molecule drug discovery.
CLO 3: Understand the principles, design, implementation, advantages and pitfalls of structure-based and fragment-based drug design. This includes understanding the practical aspects of virtual docking in small molecule drug design.

CLO 4: Understand the basic principles of the hit validation and hit to lead optimization processes that precede the selection of drug candidates for human trials.

CLO 5: Design a sound written 2-3 page drug discovery and development assignment succinctly addressing significance to human health, innovation, and most suitable approaches to be used, and target product profile.
TUTORIAL DESCRIPTIONS

SBP 281 - Graduate Tutorials (1 unit, Fall/Winter/Spring quarters)
Tutorials cover specific subject areas and are individualized, small group sessions with 1-2 students that are led by a faculty expert. Tutorials meet twice in two different weeks, usually for two hours at a time. Dates and times set upon faculty and student availability.

What Cells Look Like
Dr. Nigel Calcutt, UCSD
This tutorial will give students an introduction to the organization of cells and their fundamental structure:function relationships. Warning - looking down microscopes may be necessary!

The student will learn:
CLO 1: Methods of cell visualization, including light (brightfield, fluorescence and confocal) and electron microscopy.
CLO 3: Organelles and cell:cell interactions
CLO 3: How cells specialize and organize into tissues and organs.

Bringing the Outside In: Endocytic Mechanisms and Therapeutics
Dr. Cosimo Comisso
This tutorial will provide students with a functional understanding of the major endocytic pathways that are employed by mammalian cells and how each pathway exhibits unique biological functions. Students will also acquire an appreciation of how the control of endocytic pathways can be harnessed to develop novel therapeutic strategies for a myriad of human diseases.

The student will learn:
CLO 1: Introduction to different mechanisms of endocytosis.
CLO 2: Understanding the unique molecular drivers and functions of endocytic pathways.
CLO 3: Grasping how endocytosis can be modulated to treat disease.

Secrets in the Software: Understanding the Role of the Epigenome in Gene-Regulation and Human Disease
Ani Deshpande
A number of highly specific chemical modifications coordinately regulate the hardwired script embedded in the genome. These modifications are central to cellular identity and play pivotal roles in several key processes including proliferation, cell cycle regulation, DNA damage response, and metabolism among other things. An increased understanding of epigenetics has provided tantalizing new insights into how tight control of gene-regulation is attained at the cellular level. A tsunami of epigenome-scale studies have also provided important insights into development and disease. It is now abundantly clear that a number of human diseases, including cancer show dysregulation of specific epigenetic pathways, offering novel avenues for therapeutic intervention. This tutorial will give students an introduction to the basic principles of epigenetics, with a broad
perspective on the different types of epigenetic regulation, the role of epigenetics in cellular differentiation, organismal function and human disease.

The student will learn:

**CLO 1:** Basic principles of epigenetics with a focus on how cells with the same recipe book make different recipes.

**CLO 2:** Layers of epigenetic regulation: mechanisms of epigenetic regulation, including histone, DNA and RNA modifications.

**CLO 3:** Epigenetics in health and disease: Contribution of epigenetic dysregulation to human disease

Required reading in advance of first tutorial: Chapter 35, Histone Modification and Cancer from David Allis’ book titled Epigenetics.

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**Developmental Genetics**  
**Dr. Duc Dong**  
This tutorial will cover developmental approaches to studying gene function. Topics of discussion may include: forward/reverse genetics, classes of mutations, pattern formation, lineage specification/differentiation/reprogramming, signal transduction, transcriptional regulation, and genetic approaches using animal models (mainly flies, fish, and mice), congenital diseases, birth defects, etc.

The student will learn:

**CLO 1:** The variety of mutations that can occur and what we can learn from them.

**CLO 2:** Forward and reverse genetic approaches to gene discovery and characterization.

**CLO 3:** Genetic technologies available in in vivo models: their potential and limitations.
Principles of Protein Structure
Dr. Adam Godzik
The goal of this tutorial is to learn how to quickly analyze protein structure. Topics such as how to find coordinates of a protein, how to look at a protein, how to describe a protein and how to compare it to other structures will be discussed. The tutorial would consist of two stages. In the first stage all the steps of a protein structure would be covered together with the instructor. In the second stage, the student would go through all the steps him/herself under gentle supervision.

The student will learn:
CLO 1: Ability to download from PDB and display a 3D structure of a protein.
CLO 2: Ability to perform standard analysis of the structure in ribbon representation and describing and identifying the fold.
CLO 3: Comparing and aligning the structures of homologous proteins and identifying similarities and differences between them.

Evolution of proteins – from multiple alignments to phylogenetic trees
Dr. Adam Godzik
The goal of this tutorial is to learn how to perform rudimentary evolutionary analysis of a protein family. Starting from a sequence of a selected protein, the tutorial would cover the steps of finding homologs, building the multiple alignments and building a phylogenetic tree. Special emphasis would be put on learning how to prepare publication quality multiple alignments and trees and questions of statistical reliability at each step. The tutorial would consist of two stages. In the first stage, all the steps for a protein family would be covered together with the instructor. In the second stage, the student would go through all the steps him/herself under gentle supervision.

The student will learn:
CLO 1: Ability to identify homologs, perform multiple alignment and calculating a simple phylogenetic tree.
CLO 2: Working experience with several standard bioinformatics programs: BLAST (NIH web interface) for identifying homologs and ClustalX for multiple alignment and TreeView for phylogenetic tree visualization.

*Students must have taken and passed Principles of Protein Structure or be well versed in protein structures before registering for Evolution of Proteins.
Molecular Mechanisms of Aging  
Dr. Malene Hansen  
The goal of this tutorial is to provide students with a working knowledge of the current theories of aging, and how common genetic model organisms are used to study the molecular basis of aging. Students should acquire an appreciation of how genetics can be used in such systems, in particular the nematode C. elegans, to learn about fundamental aspects of how an organism ages.

The student will learn:  
CLO 1: Introduction to different theories of aging.  
CLO 2: Advantages of using C. elegans as a genetic model organism.  
CLO 3: Utilizing C. elegans to study conserved mechanisms of aging.

Membranes and Membrane Proteins  
Dr. Francesca Marassi  
Biological membranes are essential for cellular life. These ancient structures evolved very early on before the split from the last universal common ancestor that led to the three branches of cellular life: bacteria, archaea and eukarya. The chemical composition and structural organization of biological membranes indicate that they emerged through a process of co-evolution of their two principal components: the lipid bilayer and the proteins integrated within it. The lipid bilayer provides an elastic yet ion-impermeable barrier for the effective compartmentalization of specialized cellular components, while integral membrane proteins mediate all interactions of cells with each other and with the outside world through their specific functions in transmembrane transport, signaling, adhesion and much more. Due to their importance, membrane proteins are major targets of biomedical research and drug discovery efforts aimed at understanding their biological functions and harnessing their therapeutic potential.

Pathogens and the Innate Immune System  
Dr. Victor Nizet, UCSD  
This tutorial will give students and introduction into some of the fundamental components of human innate immunity to bacterial infection, how some of the most important human infectious disease pathogens subvert the immune system to produce disease, and how new therapeutic approaches can be contemplated at this host-pathogen interface.

The student will learn:  
CLO 1: An understanding of the multi-faceted components of our innate immune system  
CLO 2: The essential characteristics that distinguish disease-causing microrganisms from nonpathogenic flora.  
CLO 3: How understanding microbial virulence mechanisms offers opportunities for therapeutic intervention
Protease Inhibitors and Diagnostics
Dr. Anthony O'Donohue
This tutorial will provide students with an understanding of protease inhibitor design and development, with a particular focus on protease inhibitors used to treat HIV and Multiple Myeloma. In addition, students will learn how unregulated protease activity can be used as a diagnostic for cancer and inflammatory diseases.

Student Learning Outcomes
CLO 1. Introduction to the multiple classes of protease and their mechanism of action
CLO 2. Learn how to design a protease inhibitor using substrate and structural information
CLO 3. Understand how dysregulation of proteases in certain diseases can be used as a diagnostic


Genomics-based analysis of metabolic interactions in human microbiome
Dr. Andrei Osterman
As a result of this tutorial, the students will understand fundamentals and specific bioinformatics tools for genome-based in silico metabolic reconstruction and phenotype predictions. They will be prompted to apply this knowledge toward real-life human gut microbiome data sets, analyze and interpret the results of analysis in terms of microbial community structure, interactions and potential impacts for diagnostic and therapy.

The student will learn:
CLO 1: Understanding principles of genomics-based metabolic reconstruction methodology.
CLO 2: Hands-on practice with bioinformatics tools supporting this methodology.
CLO 3: Grasping host-microbiome metabolic interactions: fundamental and translational implications.

RNA Biology
Dr. Tariq Rana, UCSD
RNA-mediated gene silencing (RNAi) is initiated by double stranded RNA helix that can be exogenously introduced or endogenously created from small non-coding RNAs called micro RNAs. RNAi has become a standard experimental tool in virtually every biology lab and the therapeutic potential of this technology is aggressively being harnessed. Understanding the structure and function of RNAs that trigger RNAi has illuminated broad functions of the ancient RNAi machinery in animals and plants and has provided guidelines to achieve efficient gene silencing for biological and therapeutic applications of RNAi. In this tutorial, we will discuss our current understanding of various gene silencing mechanisms and a few examples of therapeutic applications in metabolic, cancer, and neurodegeneration disease models

- **CLO1**: Understanding of the fundamental principles governing nucleic acid structure and function
Protein Localization
Dr. Guy Salvesen
Part one of this tutorial will provide students with a working knowledge of the mechanisms of protein sorting in cells, the topological relationships of secreted and cellular protein pools, and the nature of the sorting signals. In part two of the tutorial students will present on a specific topic assigned to them in part one of the tutorial.

The student will learn:
CLO 1: Students will understand how animal cells deal with the requirements for sorting and transporting proteins to specific locations in cells and tissues.
CLO 2: Students will learn of the different cellular environments experienced by cytosolic, vesicular, and transmembrane proteins.
CLO 3: Students will understand functional properties of a protein dictated by its cellular localization, by researching and presenting on a topic related to their thesis research.

Cell Adhesion and Migration
Dr. Dwayne Stupack, UCSD
Students will learn and appreciate the basic classes of cell adhesion molecules, including selectins, cadherins and integrins. The sensory roles and cellular fates of these molecules during cell migration will be discussed, with a particular emphasis on the mechanical anchorage, signaling, and cytoskeletal reorganization mediated by each.

CLO1: The student will appreciate the four main categories of adhesion molecules, and the mechanisms underlying the use of each.
CLO2: Using integrins as a model system, the student will understand signal-driven conformational changes in proteins and the regulation of cellular adhesion.
CLO3: The student will establish a working knowledge of biomechanical forces and the turnover of attachment sites on cells migrating in 2D or 3D environments.

Molecular Basis of Tumor Metastasis
Dr. Jing Yang
Completion of this tutorial should provide students with a comprehensive review of the main cellular mechanisms driving tumor metastasis, the key signaling pathways underlying these processes. This tutorial will also introduce students to the various experimental systems to study metastasis and major questions and major questions remaining in tumor metastasis research.

Student Learning Outcomes:
CLO 1. Understanding key cellular mechanisms driving tumor metastasis.
CLO 2. Understanding major molecular pathways driving tumor metastasis.
CLO 3. Introduction of various experimental models to study tumor metastasis.

ELECTIVES

SBP’s neighboring institutions allow our students to take elective classes on a space available basis. Students may choose from the following courses:

UCSD Biomedical Sciences Courses
Any course in the BMS track (BIOM) at UCSD. A list of courses can be found at: http://biomedsci-db.ucsd.edu/course_search_results?t=all.

The Scripps Research Institute Courses
Any course at The Scripps Research Institute. A list of courses can be found at: https://education.scripps.edu/graduate/doctoral-program/customizable-curriculum/

Cancelled, Discontinued, Filled Classes
Ability to take UCSD or TSRI courses is not guaranteed. Courses offered through the UCSD Biomedical Sciences graduate program follow all UCSD policies regarding cancelled, discontinued, or filled courses. Courses taken at The Scripps Research Institute (TSRI) strictly follow TSRI policies. Please check with Graduate Program coordinator for current course status.

In addition to traditional coursework, SBP students have access to a variety of career and professional development workshops and participate in an annual retreat.

OETIS Workshops & Events
The Office of Education, Training, and International Services (OETIS) holds workshops and events to help students and postdocs prepare for the next step in their career. These include, but are not limited to, a monthly “Careers & Coffee” panel with guest speakers, CV and resume review sessions with OETIS staff, presentation skills practice (“Podium Pointers”), and writing workshops. Students are encouraged to attend and participate. An events blast is sent via email each month, and a calendar can be found on the Intranet: http://intranet/academicsupport/otas/workshops/calendar-grid/Pages/default.aspx.

Annual Student Retreat
An annual research-oriented retreat held at a southern California location is scheduled during the Spring quarter. The retreat allows all students the opportunity to present their research results, and provides graduate students and faculty with the unique opportunity to interact with colleagues in various research programs in an informal setting.