2026-2027
Course Catalog

Sanford Burnham Prebys
Graduate School of Biomedical Sciences

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WELCOME

The Graduate School of Biomedical Sciences (GSBS) at Sanford Burnham Prebys offers the Doctor of Philosophy (Ph.D.) degree in Biomedical Sciences.

MISSION STATEMENT AND VISION

Program Mission: *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, Sanford Burnham Prebys 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 Sanford Burnham Prebys Graduate School of Biomedical Sciences (GSBS) has established the following program learning outcomes, which align with the mission and vision of Sanford Burnham Prebys:

PLO 1: Integrate knowledge across biomedical disciplines to develop explanations of biological phenomena
PLO 2: Synthesize the biomedical literature into a research direction
PLO 3: Design a rigorous biomedical experiment to test a hypothesis
PLO 4: Perform appropriate experimental protocols using advanced biomedical research techniques
PLO 5: Analyze biological data using adequate quantitative methods
PLO 6: Communicate scientific findings in an audience-appropriate format
PLO 7: Explain translational applicability of their biomedical research in an audience-appropriate format

COURSEWORK

Each student must successfully complete five core courses and eight tutorials within the first two years. A minimum of 96 credit units is required to graduate. Of these, at least 64 credit units must be earned prior to holding the Qualifying Exam (pre-candidacy), and at least 32 additional credit units must be earned between the Qualifying Exam (post-candidacy) and the Thesis Defense. Students accrue eight credit units per quarter.

In addition to traditional coursework, GSBS students participate in Graduate Research, Data Club, Responsible Conduct of Scientific Research training, and the Annual Retreat, and have access to a variety of co-curricular activities.

COURSEWORK				
	YEAR 1	**YEAR 2**	**YEAR 3**	**YEAR 4+**
SBP 260 – Molecules to Systems (4 units)	Fall			
SBP 273 – Scientific Communication (2 units)	Winter			
SBP 265 – Introductory Statistics (2 units)	Spring			
SBP 275 – Computational Biology and Bioinformatics (2 units)		Winter		
SBP 263 – Modern Drug Discovery Technologies (3 units)		Spring		
Tutorials (8 required; 1 approved elective may substitute for 2 tutorials)	(First 2 years)			
GRES 291 – Graduate Research (1-8 units)	Graduate Research (Pre-Candidacy)			
GRES 991 – Thesis Research (8 units)			Thesis Research (Post-Candidacy)	

CORE COURSES

SBP 260 – Molecules to Systems (M2S)

Year 1, Fall quarter, 4 units
Course Director: Dr. Alessandra Sacco
The Molecules to Systems course is a broad-based survey course that offers first year graduate students an introduction to a range of scientific approaches and research across various scientific disciplines related to biomedicine.

Program Learning Outcomes (PLOs)

This course fulfills the introduction of the following PLOs:
PLO 1: Integrate knowledge across biomedical disciplines to develop explanations of biological phenomena
PLO 2: Synthesize the biomedical literature into a research direction
PLO 3: Design a rigorous biomedical experiment to test a hypothesis

Course Learning Outcomes (CLOs)

Upon successful completion of this program, students will be able to:
CLO 1: Explain core concepts of modulation of gene expression
CLO 2: Explain core concepts of cellular signaling
CLO 3: Explain core concepts of development and aging
CLO 4: Explain core concepts of inter-organ communication
CLO 5: Design experiments to address a scientific question
CLO 6: Discuss a published manuscript in class, that synthesizes goals, strengths and weaknesses (key elements) and future research direction of the study
CLO 7: Synthesize the key elements and future research direction of a published study

SBP 273 – Scientific Communication (SciCom)

Year 1, Winter quarter, 2 units
Course Directors: Dr. Alessandra Sacco & Dr. Nisha Cavanaugh
Effective communication is essential for a successful scientific career. The Scientific Communication course is designed to provide first-year students with an overview of how to develop and enhance their skills in both oral and written formats. This course helps students achieve their GSBS program milestones and equips them to communicate their research effectively to both scientific and non-scientific audiences.

Program Learning Outcomes (PLOs)

This course fulfills the introduction or expansion of the following PLOs:

PLO 1: Integrate knowledge across biomedical disciplines to develop explanations of biological phenomena

PLO 2: Synthesize the biomedical literature into a research direction

PLO 3: Design a rigorous biomedical experiment to test a hypothesis

PLO 4: Perform appropriate experimental protocols using advanced biomedical research techniques

PLO 6: Communicate scientific findings in an audience-appropriate format

Course Learning Outcomes (CLOs)

Upon successful completion of this program, students will be able to:

CLO 1: Write a scientific abstract that summarizes the key elements of a biomedical study.

CLO 2: Write a specific aims page that proposes a compelling biomedical research direction.

CLO 3: Design a poster that proposes an early-stage biomedical research project

CLO5: Deliver a biomedical research poster presentation

CLO6: Deliver a brief oral talk on a biomedical study that is accessible to a nonscientific audience.

CLO7: Provide peer feedback that reflects standards of scientific communication.

SBP 265 – Introductory Statistics (Stats)

Year 1, Spring quarter, 2 units

Course Instructor: Dr. Liam Mueller

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 rather than theory or proofs. Students will be trained on descriptive statistics, t-tests, analysis of variance, correlation, regression, factorial designs, power, and sample size, as well as in the use R statistics software to perform these analyses.

Program Learning Outcomes (PLOs)

This course fulfills the introduction of the following PLOs:

PLO 1: Integrate knowledge across biomedical disciplines to develop explanations of biological phenomena

PLO 5: Analyze biological data using adequate quantitative methods

Course Learning Outcomes (CLOs)

Upon successful completion of this course, students will be able to:

CLO1: Design experiments appropriate for their research questions.

CLO2: Apply appropriate statistical methods to test a hypothesis.

CLO3: Critique the statistical methods used in biomedical studies.

CLO4: Use the R statistical programming language to perform analyses common in biomedical studies.

SBP 275 – Computational Biology and Bioinformatics (CBB)

Year 2, Winter quarter, 2 units

Course Director: Dr. Kevin Yip

This course introduces fundamental concepts, technologies, and data types in genomics and bioinformatics. Guidelines for using databases and advanced computational tools to analyze Big

Data will be discussed. Practical hands-on sessions will provide students experience with leading public bioinformatics databases and tools targeted to cancer and biomedical research, including RNAseq, CHIPseq, pathway enrichment.

Program Learning Outcomes (PLOs)

This course fulfills the introduction or expansion of the following PLOs

PLO 1: Integrate knowledge across biomedical disciplines to develop explanations of biological phenomena

PLO 3: Design a rigorous biomedical experiment to test a hypothesis

PLO 4: Perform appropriate experimental protocols using advanced biomedical research techniques

PLO 5: Analyze biological data using adequate quantitative methods

Course Learning Outcomes (CLOs)

Upon successful completion of this course, students will be able to:

CLO1: Describe core bioinformatics concepts used in genomic data analysis

CLO2: Apply standard bioinformatics tools to both process and analyze RNA sequencing

SBP 263 - Modern Drug Discovery Technologies (MDDT)

Year 2, Spring quarter, 3 units (MDDT)

Course Directors: Dr. Eric Wang and Dr. Chris Larson

The course introduces the foundational principles of a various drug discovery approaches, featuring real-life examples, including those from ongoing at Sanford Burnham Prebys Medical Discovery Institute (SBP). Lecturers are delivered by program faculty and staff whose laboratories are actively involved in discovering and developing drugs against therapeutically relevant targets, as well as by experts with leadership positions in pharma and biotech. This course is cross-listed at UC San Diego as PHAR 228, PATH 228.

Program Learning Outcomes (PLOs)

This course fulfills the introduction of the following PLOs

PLO 1: Integrate knowledge across biomedical disciplines to develop explanations of biological phenomena

PLO 2: Synthesize the biomedical literature into a research direction

PLO 3: Design a rigorous biomedical experiment to test a hypothesis

PLO 6: Communicate scientific findings in an audience-appropriate format

PLO 7: Explain translational applicability of their biomedical research in an audience-appropriate format

Course Learning Outcomes (CLOs)

CLO1: Describe the primary components of the modern drug discovery to development process

CLO2: Explain the factors that underlie how drug targets are selected

CLO3: Justify which of the 4 major drug modalities (small molecules, biologics, nucleic acids, and cell therapies) is most appropriate for a particular drug target

CLO4: Design an assay testing funnel for a selected drug target

CLO5: Explain the primary components of how clinical trials are conducted

ELECTIVE COURSE

One approved elective of 1-credit hour or more may substitute for two of the eight required tutorials. Students may take additional electives, but only one elective may be applied as a tutorial substitute. GSBS will share approved offerings from local universities, as they become available.

GRADUATE RESEARCH – GRES 291

Every quarter until candidacy, 1-8 units (GRES291)
Students enroll in GRES291 Graduate Research beginning in their first quarter and continue each quarter through candidacy in their 3rd Year of study. The number of units earned per quarter varies depending on courses taken. Graduate Research is evaluated via a rubric and a letter grade each quarter.

Students are evaluated each quarter using a standardized rubric and receive a letter grade based on their performance in the following core areas: (1) Strong Foundational Knowledge in the Sciences, (2) High Quality Biomedical Research, (3) Innovative Critical Thinking and Experimental Design, (4) Clear Written Communication in Standard Academic Genres, and (5) Excellent Communication Skills.

Participation in laboratory research is an ongoing requirement and an integral part of the learning experience.

THESIS RESEARCH – GRES 991

Every quarter, post-candidacy, 8 units (GRES991)
Participation in laboratory research and GSBS-related activities are ongoing requirements and integral parts of the learning experience. Once students complete their coursework and successfully defend their Qualifying Exam, they become Ph.D. candidates. Once a student is a PhD candidate, they enroll in GRES991 Thesis Research for 8 units each quarter through graduation. Students continue to be assessed on their progress in the 5 PLOs and mastery is expected by the time of graduation.

TUTORIALS

(1 unit, Fall/Winter/Spring/Summer quarters in the first 2 years of studies)
Tutorials are individualized, small group sessions led by a faculty expert, typically involving 1-3 students. Each tutorial consists of two sessions that are approximately 2 hours each. Sessions are scheduled at least one week apart to allow students time to complete an assignment, project, or other activity, depending on the tutorial. Beginning in Fall 2022, students are required to complete eight tutorials within the first two years of study. One approved elective will substitute for two tutorials. Additional electives may be taken, but will not substitute for additional tutorials.

Bedside-to-Bench

Dr. Evan Snyder
Case-based tutorial. How to generate testable hypotheses & informative experiments from actual patient presentations. How to do clinical correlation. How to generate proposals and papers that fulfill the NIH definition of “high impact” for the Significance section. What does rational translational science really look like. Might include actual patient engagement.

Cell Adhesion and the Extracellular Matrix
Dr. Yu Yamaguchi
Cell adhesion and the extracellular matrix are crucial for tissue morphogenesis and the maintenance of tissue architecture and function in multicellular organisms. Abnormalities in cell-cell and cell-matrix adhesions play key roles in the development, progression, and phenotypic modulation of human diseases. This tutorial will cover the fundamental structure and function of molecules involved in cell adhesion and the extracellular matrix with an emphasis on their relevance to human diseases.

Cell-Cell Communication
Dr. Giovanni Paternostro
Cell-cell communication is a fundamental aspect of biology and medicine. It makes multicellular life possible, and it is hard to think of a disease that is not affected, at least indirectly, by cell-cell communication. This tutorial can be tailored to cover foundational knowledge or advanced topics, depending on the background of the students.

Cellular Stress Responses
Dr. Caroline Kumsta
In this tutorial, we will define “stress” and discuss how stress can induce systemic as well as cell-specific stress responses in an organism. Students will gain a general understanding of how stress responses evolved from prokaryotes to eukaryotes (with the heat shock response as an example) and learn about the molecular mechanisms underlying stress responses, heavily relying on studies in model organisms. Specifically, we will examine how stress is sensed, and then integrated into signal transduction pathways that lead to adaptive transcriptional responses. As their homework assignment students will choose a specific stress, relevant or adjacent to their research (e.g., hypoxia, oxidative stress, starvation, osmotic stress, heat stress), and prepare an overview of the learned molecular concepts.

Clinical Shadowing
Dr. Angela Lou
The Clinical Shadowing Tutorial provides SBP graduate students with a unique opportunity to observe real-time patient care alongside their clinical mentor, Dr. Angela Liou, in the pediatric hematology/oncology clinic at UCSD Rady Children’s Hospital. Through direct exposure to clinical encounters, students gain insight into how scientific discoveries shape medical decision-making and how even the most fundamental bench research can translate into meaningful patient outcomes. This experience is designed to broaden clinical perspective, inspire translational thinking, and help students develop clinically relevant research questions informed by their interactions with patients and families.

Current topics in Neurodegeneration - Model Systems to Mechanisms
Dr. Timothy Huang
This tutorial will cover key aspects of neurodegeneration, including clinical features, pathology, genetic risk variants and inherited forms of disease, model systems used to study neurodegeneration, and potential therapeutic targeting strategies. Recent advances in cellular and molecular aspects of neurodegeneration will also be discussed.

Diversity and Representation in Biomedical Research - Why it Matters
Dr. Svasti Haricharan
This tutorial will (1) explain existing disparities based on race and ethnicity in datasets and experimental model systems used in routine biomedical research (with a focus on

cancer), (2) outline how these disparities impact real world healthcare outcomes for people in the US, and (3) teach students the differences between genetic and social aspects of race, ethnicity and gender as they pertain to molecular biology.

Genetic Mechanisms of Development and Regeneration in Disease and Aging (*Offsite)
Dr. Duc Dong
This tutorial will cover genetic mechanisms of development and regeneration and how these processes are affected in degenerative diseases and aging, with emphasis on organogenesis. Topics of discussion may include: forward/reverse genetics, classes of mutations, pattern formation, specification/differentiation/regeneration/aging, somatic stem cells, signal transduction, transcriptional regulation, and genetic approaches using in vivo models (mainly flies, fish, and mice), birth defects, degenerative diseases, aging, rejuvenation, therapeutic approaches, etc.
*(*This tutorial is held offsite at Scintillon)*

Glycosylation
Dr. Hudson Freeze
The goal of this tutorial is for students to become conversant in glyco-speak and to identify those areas of Glycobiology that apply to their own interests.

Hallmarks of Aging
Dr. Caroline Kumsta
In this tutorial, we will review the 2023 manuscript ”Hallmarks of aging: An expanding universe” by Lopez-Otin et al. and discuss age-related changes associated with the twelve hallmarks (genomic instability, telomere attrition, epigenetic alterations, loss of proteostasis, disabled macroautophagy, deregulated nutrient-sensing, mitochondrial dysfunction, cellular senescence, stem cell exhaustion, altered intercellular communication, chronic inflammation, and dysbiosis) as well as the experimental approaches and interventions designed to counteract these age-related changes. As their homework, students will choose a specific hallmark to describe in depth with the added objective to integrate their own research project with the hallmark of aging.

Liver Fibrosis
Dr. David Brenner
In Session 1, students will be presented with a review of fibrosis in general, liver fibrosis, and the relationship between the metabolic syndrome, MASH, and liver fibrosis. In Session 2, students will deliver an oral presentation addressing a topic assigned to them in Session 1.

Metabolic Control of Cell Fate and Regeneration
Dr. Ahmed Mahmoud
This tutorial will explore how cellular metabolism governs cell identity, plasticity, and regenerative capacity across tissues. Students will learn how shifts in metabolic state regulate cell proliferation, differentiation, and tissue repair. We will discuss key signaling pathways, mitochondrial function, and metabolite-driven epigenetic mechanisms that link bioenergetics to gene expression. The tutorial will also introduce experimental approaches used to study metabolic regulation of cell fate, including metabolomics, mitochondrial functional assays, and stable isotope tracing. By integrating concepts from development, regeneration, and disease, students will gain a framework for understanding how metabolic reprogramming can be leveraged to modulate disease progression and promote tissue regeneration.

Mitochondrial Structure, Function, and Disease
Dr. Kevin Tharp
Part one of this tutorial will provide students with a working knowledge of mitochondrial structure/function and discuss available methods to measure these dynamic processes. Part two will focus on mitochondrial contributions to disease - related to participant's research. The goal of this tutorial is to provide students with sufficient expertise to initiate studies related to mitochondrial biology.

Regulation of transcription and cell type-specific gene expression
Dr. Lorenzo Puri
It will cover basic mechanism that regulates cell-type specific gene expression at the level of epigenetics and dynamic changes in 3D genome, in particular chromatin interactions that define structural and functional regulatory genomic structures. This will introduce students to current knowledge and technologies for analysis of gene Expression

Role of Aging in Cancer
Dr. Peter Adams
The incidence of most adult human cancers increases dramatically with age. The reasons for this are not well understood. This tutorial will consider the types of molecular, cellular and tissue damage that accumulate with age and their potential role in age-dependence of cancer

Sepsis: More than a Cytokine
Dr. Ben Croker
Sepsis represents a broad clinical syndrome triggered by diverse pathogens. This tutorial will explore genetic studies and the assumptions underlying current models of sepsis that support clinical trials, with a view to recent advances in pathogen recognition, cellular responses to pathogen recognition, and resolution of inflammation. At the conclusion of this tutorial, students will be able to critically evaluate sepsis models, and identify the clinical parameters that increase the risk of poor outcomes in sepsis patients with a view to integrating these factors into experimental design.

Targeting Cancer Metabolism
Dr. Andrei Osterman
Completion of this tutorial should provide students with a basic understanding of metabolic rewiring in cancer cells, and what constitutes potential metabolic targets for cancer therapy. Using specific examples (such as “glutamine addiction” in melanoma cells), students will learn about combining metabolomics and gene interference for target discovery and validation. In the second session, students will present and defend their proposed strategy for pursuing a selected drug target (e.g. in glutamine metabolism).

Use of Extracellular Vesicles in Bionanomedicine
Dr. Massimo Bottini
Extracellular vesicles are lipid bilayer-delimited particles released by all cell types to carry out diverse functions during both physiologic and pathological processes, including remove unnecessary molecules from the cells’ cytosol and plasma membrane, deliver information cargoes into target cells, and initiate biomineralization. They have been used as diagnostic and prognostic biomarkers as well as therapeutic targets and carriers for active agents. The tutorial will cover standard knowledge on extracellular vesicles, with a particular emphasis on their use as novel (nano) carriers for active agents. **The second session may include an off-site lab visit.*

What Cells Look Like (*Offsite)
Dr. Nigel Calcutt,
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: (1) Methods of cell visualization, including light (brightfield, fluorescence and confocal) and electron microscopy, (2) Organelles and cell:cell interactions, (3) How cells specialize and organize into tissues and organs. **This tutorial is held offsite at UCSD.*

Tutorial Portfolio 2026-2027					
Tutorial Title	**Tutorial Instructor**	**Fall 2026**	**Winter 2027**	**Spring 2027**	**Summer 2027**
Bedside-to-Bench	Dr. Evan Snyder			X	X
Cell Adhesion and the Extracellular Matrix	Dr. Yu Yamaguchi			X	
Cell-Cell Communication	Dr. Giovanni Paternostro	X	X	X	X
Cellular Stress Responses	Dr. Caroline Kumsta	X			
Clinical Shadowing	Dr. Angela Liou	X	X		
Current Topics in Neurodegeneration	Dr. Timothy Huang				X
Diversity and Representation in Biomedical Sciences	Dr. Svasti Haricharan		X		
Genetic Mechanisms of Development and Regeneration in Disease and Aging (*Offsite)	Dr. Duc Dong				X
Glycosylation	Dr. Hudson Freeze	X	X	X	X
Hallmarks of Aging	Dr. Caroline Kumsta		X		
Liver Fibrosis	Dr. David Brenner		X		
Metabolic Control of Cell Fate and Regeneration	Dr. Ahmed Mahmoud		X		
Mitochondrial Structure, Function, and Disease	Dr. Kevin Tharp		X		
Regulation of Transcription	Dr. Lorenzo Puri			X	
Role of Aging in Cancer	Dr. Peter Adams			X	X
Sepsis: More Than a Cytokine	Dr. Ben Croker				X
Targeting Cancer Metabolism	Dr. Andrei Osterman			X	
Use of Extracellular Vesicles in Bionanomedicine	Dr. Massimo Bottini		X		
Using HTS to Accelerate Research and Discovery	Dr. Alex Colas	X	X	X	
What Cells Look Like (*Offsite)	Dr. Nigel Calcutt		X	X	

DATA CLUB

Data Club offers students a forum to present their research progress and receive feedback on their oral presentation skills. Meetings are held in-person, one to three times per month from October through April. First-, second-, and third-year students are required to present at least once per academic year and must invite their faculty mentor to attend. Attendance is mandatory. Unexcused absences will result in a a designation of Unstatisfactory on the academic transcript. A detailed schedule is available for registered students by clicking on the Data Club link at sbpdiscovery.org/GSBSintranet.

ANNUAL STUDENT RETREAT

Each spring, the graduate school hosts an annual research-focused retreat. The retreat provides students with the opportunity to present their research and engage with faculty and peers from various programs in an informal setting. Participation in the retreat is mandatory.

RESPONSIBLE CONDUCT OF SCIENTIFIC RESEARCH

The Responsible Conduct of Scientific Research offers first-year graduate students with an overview of the nine Responsible Conduct of Research (RCR) Core Areas as outlined by the Office of Research Integrity (ORI). An emphasis is placed on Sanford Burnham Prebys policies and best practices, providing students with a strong foundation in ethical research practices.

OLAD WORKSHOPS & EVENTS

The Office of Learning and Development (previously, Office of Education, Training, and International Services) provides career and professional development workshops and events to support students and postdocs in preparing for their next career steps. Workshop topics include oral and written communication (e.g. fellowship writing, manuscript writing, presentation skill development), career exploration and career preparation, CV and resume review sessions, and presentation skills practice sessions (“Podium Pointers”). Students are encouraged to attend and actively participate in these workshops. A monthly events bulletin blast with dates and details is emailed to students.

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