2025-2026
Course Catalog

Sanford Burnham Prebys
Graduate School of Biomedical Sciences

Updated July 1, 2025

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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: Strong foundational knowledge in the sciences
PLO 2: High quality biomedical research
PLO 3: Innovative critical thinking
PLO 4: Clear written communication in standard academic genres
PLO 5: Excellent oral communication skills

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, an 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 (4 units)	Winter			
SBP 265 – Introductory Statistics (2 units)	Spring			
SBP 275 – Computational Biology and Bioinformatics (2 units)		Winter		
SBP 263 – Modern Drug Discovery Technologies (2 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)	

*Subject to change

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. Strong foundational knowledge
PLO 3. Innovative critical thinking
PLO 4. Clear written communication in standard academic genres
PLO 5. Excellent oral communication skills

Course Learning Outcomes (CLOs)

By the end of the course the student will be able to:
CLO 1: Demonstrate knowledge of key scientific concepts in the biomedical sciences.
CLO 2: Engage with faculty to explore various scientific research areas and methodologies, and critically evaluate the research conducted at the Institute.
CLO 3: Demonstrate proficiency in presenting, discussing and critically evaluating scientific papers.
CLO 4: Articulate scientific concepts and arguments through writing.

SBP 273 – Scientific Communication (SciCom)

Year 1, Winter quarter
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

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

PLO 1: Strong foundational knowledge – Introductory Level
PLO 3: Innovative critical thinking – Introductory Level
PLO 4: Clear written communication in standard academic genres – Expanded Level
PLO 5: Excellent oral communication skills – Expanded Level

Course Learning Outcomes

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

CLO 1: Communicate their research effectively in oral and written formats.
CLO 2: Critically evaluate others' work and provide constructive feedback.
CLO 3: Tailor their communication to scientific and non-scientific audiences.

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: Strong foundational knowledge
PLO 3: Innovative critical thinking
PLO 4: Clear written communication in standard academic genres

Course Learning Outcomes (CLOs)

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 – 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. Strong foundational knowledge – Introductory level

PLO 2. High quality biomedical research – Introductory level

PLO 3. Innovative critical thinking – Expanded Level

Course Learning Outcomes (CLOs)

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

CLO 1. Establish data exchange formats and apply concepts of open research

CLO 2. Perform basic database searches and match the appropriate database to their research problem

CLO 3. 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)

Year 2, Spring quarter, 2 units (MDDT)

Course Directors: Dr. Guy Salvesen 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. Strong foundational knowledge – Expanded level

PLO 2. High quality biomedical research – Introductory level

This course fulfills the expansion of the following PLO

PLO 3. Innovative critical thinking – Introductory Level

PLO 4: Clear written communication in standard academic genres – Expanded Level

PLO 5: Excellent oral communication skills – Introductory Level

Course Learning Outcomes (CLOs)

- **CLO 1:** Be able to discuss with instructors and fellow students the modern drug discovery and development process
- **CLO 2:** Critically examine how drug targets are chosen and evaluated
- **CLO 3:** Be able to explain the 4 major drug modalities (small molecules, biologics, nucleic acids, and cell therapies), the advantages and disadvantages of each modality, and for which classes of drug targets each of the 4 modalities may be more or less useful
- **CLO 4:** Be able to communicate in written and oral format the considerations for developing an assay against a drug target and for conducting a high throughput screen against that target
- **CLO 5:** Be able to explain verbally the clinical trials process and how it is conducted

ELECTIVE COURSE

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

Experimental Methods in Molecular and Cell Biology

Year 2 and plus, 2 units (EM)
Course Director: Dr. Andrei Osterman
This new elective course introduces students to the basic underlying principles of experimental methods commonly used in Molecular and Cell Biology.

Upon successful completion of this program, students will be able to:
CLO1: Choose appropriate methods to address specific biological tasks
CLO2: Reasonably assess expectations and limitations of each method
CLO3: Relationally modify published protocols for a specific task
CLO4: Critically evaluate the results obtained by themselves and others.

The course will include up to 12 introductory lectures led by Sanford Burnham Prebys faculty and researchers with extensive hands-on experience of the featured methods, as well as discussions and interactive workshops. Students will be introduced to a range of modern experimental techniques associated with proteins, nucleic acids and whole cells/tissues. An emphasis will be placed on conventional and targeted methods rather than high-throughput -*omics* platforms which each deserve a separate course.

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.

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.

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, regulation, and genetic approaches, using animal models (mainly flies, fish, and mice), congenital diseases, birth defects, etc. The student will learn: (1) The variety of mutations that can occur and what we can learn from them, (2) Forward and reverse genetic approaches to gene discovery and characterization, (3) Genetic technologies available in in vivo models: their potential and limitations.

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.

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.

Promises and Challenges of Gene Therapy
Dr. Jose Luis Millan
Students will familiarize themselves and will be able to discuss the various approaches being explored for ex vivo and in vivo gene therapy, their relative advantages, and potential risks as they pertain to rare diseases with a focus on our ongoing research to optimize gene therapy for hypophosphatasia.

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 an emphasis on their use as novel (nano) carriers for active agents.

What Cells Look Like
Dr. Nigel Calcutt, *offsite at 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: (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.

Tutorial Portfolio 2025-2026					
Tutorial Title	**Tutorial Instructor**	**Fall 2025**	**Winter 2026**	**Spring 2026**	**Summer 2026**
Cell Adhesion and the Extracellular Matrix	Dr. Yu Yamaguchi			X	
Cell-Cell Communication	Dr. Giovanni Paternostro	X	X		X
Cellular Stress Responses	Dr. Caroline Kumsta	X			
Developmental Genetics	Dr. Duc Dong			X	
Diversity and Representation in Biomedical Sciences	Dr. Svasti Haricharan		X		
Hallmarks of Aging	Dr. Caroline Kumsta		X		
Promises and Challenges of Gene Therapy	Dr. Jose Luis Millan				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	X	X	
Use of Extracellular Vesicles in Bionanomedicine	Dr. Massimo Bottini		X		
What Cells Look Like*	Dr. Nigel Calcutt	X	X		

**Offsite at UCSD*

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. Each student is 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 disciplinary action. 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 held at a Southern California location. 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

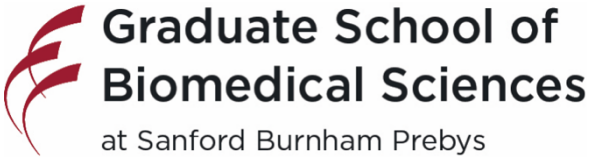
The Responsible Conduct of Scientific Research offers first-year graduate students with an overview of the nine Responsible Conduct of Research (RCR) Core Areas as outlined by the Office of Research Integrity (ORI). A special emphasis is placed on Sanford Burnham Prebys policies and best practices, providing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

OETIS WORKSHOPS & EVENTS

The Office of Education, Training, and International Services (OETIS) 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.

GSBS Co-Curricular Guide
AY2025 - 2026

Fall Quarter	**September 2025** Annual Biomedical Research Symposium Innovators & Entrepreneurs	**October 2025** Responsible Conduct of Research Emerging Topic Presentation Best Practices for Scientific Record Keeping	**November 2025** Decoding Single-Cell Biology: AI-Driven Insights into Gene Regulation and Disease International Education Week	**December 2025** Innovators & Entrepreneurs How to Write a Review Article
Winter Quarter	**January 2026** Leveraging Core Resources Grant Writing Workshop Series	**February 2026** Grant Writing Workshop Series	**March 2026** Grant Writing Workshop Series	
Spring Quarter	**April 2026** Responsible Conduct of Research Emerging Topic Presentation	**May 2026** GSBS Annual Retreat Career Development Workshop		
Summer Quarter	**June 2026**	**July 2026** Manuscript Writing Workshop	**August 2026** Career Exploration & Speed Networking Event	



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