BIOMEDICAL SCIENCES & BIOTECHNOLOGY (MS)

Biomedical Sciences & Biotechnology Overview

The Master's program in Biomedical Sciences and Biotechnology (BSBT) provides comprehensive education and training to prepare students for careers in research and research-related jobs in academia or industry and for further study in graduate or professional programs.

The BSBT Program was designed and is recognized by the National Professional STEM Master's Association (NPSMA) as a Professional STEM Master's Program (PSM), the first such program in the CU system. The program extends student knowledge beyond core STEM disciplines of biomedical sciences and biotechnology by requiring training in scientific writing, project management, business, and regulatory affairs.

Structural Biology Track Overview

The Structural Biology and Biochemistry track will provide students with graduate level training in structural biology, biophysics biochemistry with an emphasis on laboratory research. Students will acquire a solid foundation and specialized skills in biomedical, biophysical, and structural sciences that will be preparation for further education in graduate and professional programs as well as a career in academic research or industry. The curriculum includes 38 units of core course work, electives and participation in cutting-edge research in the laboratory of an STBB faculty member. Students will demonstrate original investigation showing critical judgment, as well as familiarity with tools and methods of research, through preparation of a dissertation that will be defended prior to obtaining the degree.

Admission Requirements

General Track Admission Requirements

- A bachelor's degree with a minimum GPA of 3.0
- Official General GRE or MCAT (both optional)
- Complete transcripts of undergraduate work and any previous graduate work
- A completed application to Graduate Studies
- Three academic letters of recommendation
- Letter of intent
- Training in biology, biochemistry, chemistry, biological chemistry, biophysics
- To apply for admission applicants must submit the following:

  Online Graduate School application

- Personal Statement: A one-page personal statement describing the applicant's career goals and purpose for studying biomedical sciences and biotechnology
- Resume: The applicant's current resume or curriculum vitae, including professional work/practice since graduating with a bachelor's degree (or equivalent).
- Personal statement.
- Three recommendation letters from people who know your professional, academic and/or personal achievements or qualities well.
- Application Fee: A nonrefundable application fee of $50.00 (U.S. dollars). Checks or money orders should be made payable to the University of Colorado.

  Transcripts: Official transcripts from all post-secondary colleges and/or universities should be sent directly to:

- Electronic Transcripts should be sent to: graduate.school@cuanschutz.edu (preferred)
- If sending a physical transcript, please mail to:
  University of Colorado Anschutz Medical Campus
  Graduate School
  Mail Stop C296
  Fitzsimons Building, C5000
  13001 E. 17th Place
  Aurora, CO 80045

  International students must meet ALL of the requirements above and those required by International Admissions.

Structural Biology Track Admission Requirements

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Curriculum

The Professional STEM Master's Program in Biomedical Sciences and Biotechnology requires a total of 38 credits that full-time students can earn in two years. However, students can also enroll part-time. Enrollment for a minimum of 5 credits is required for financial aid eligibility.

In addition to the science courses, in the General BSBT Program, students must enroll in professional development courses (Plus Courses) such as biomedical entrepreneurship, project management, and regulatory affairs. These Plus Courses provide additional training that employers inside and outside academia highly value.

The mandatory internship requires students to apply their base science and professional training in a hands-on, real-world setting. In consultation with the Program Director, students choose an internship that suits their future career aspirations. For example, students interested in a research career can pursue an internship in an academic lab or a company. Students can also intern in a biotech business setting, regulatory affairs, or technology transfer. Employers inside and outside academia often view the internship as an extended interview, and after graduation, quite a number of our graduates stayed at their internship site for employment. Some students have used our program successfully as a stepping stone towards medical or DO school or a PhD program.

The BSBT-PSM Program requires 38 credits for graduation, and graduate students must maintain an overall GPA of at least 3.0 ("B"). Courses with a grade of "C" are not accepted for graduation.

General Track

First Year

Year 1

Fall		**Hours**
BSBT 6072	Foundations in Biochemistry	1.5
BSBT 6073	Foundations in Molecular Biology	1.5
BSBT 6074	Foundations in Cell Biology	1.5
BSBT 6075	Foundations in Genetics	1.5
	Hours	**6**
Spring		
BSBT 6067	Statistics for Biomedical Sciences	2
BSBT 6071	Introduction to R Programming	1
BSBT 6806	Communication Skills	3
	Hours	**6**
Summer		
BSBT 6065	Case Studies in Responsible Conduct of Research	1
	Hours	**1**
	Total Hours	**13**

Second Year

Year 2

Fall		**Hours**
BSBT 6804	Bioinnovation Regulations	3
ENGL 5175	Writing in the Sciences	3
PHSC 7330	Development of Drugs and Biologics	3
	Hours	**9**
Spring		
BSBT 6061	Project Management	2
BSBT 6801	Biomedical Entrepreneurship	3
BSBT 6939	Internship - Technology and Innovation Section 001	3-6
	Hours	**8-11**
	Total Hours	**17-20**

Structural Biology Track

First Year

Year 1

Fall		**Hours**
BSBT 6072	Foundations in Biochemistry	1.5
BSBT 6073	Foundations in Molecular Biology	1.5
BSBT 6074	Foundations in Cell Biology	1.5
BSBT 6075	Foundations in Genetics	1.5
BSBT 6076	Research Explorations	1
STBB 7660	Structure Seminar	1
BMSC 7810	Core Topics in Biomedical Science Section 001; Core Topics A	2
	Hours	**10**
Spring		
STBB 7608 or STBB 7609	Molecular Interactions or Biophysics & Spectroscopy	3
BSBT 6068	Laboratory Research in Structural Biology	1-6
STBB 7631	Molecular Structure A	1.5
BSBT 6076	Research Explorations	1
	Hours	**6.5-11.5**
Summer		
BSBT 6065	Case Studies in Responsible Conduct of Research	1
	Hours	**1**
	Total Hours	**17.5-22.5**

Second Year

Year 2

Fall		**Hours**
STBB 7631	Molecular Structure A Section 004	1.5
STBB 7660	Structure Seminar	1
BSBT 6068	Laboratory Research in Structural Biology	1-6
	Hours	**3.5-8.5**
Spring		
BSBT 6068	Laboratory Research in Structural Biology	1-6
BSBT 6950	Laboratory Thesis Research	1-6

STBB 7660	Structure Seminar	1
	Hours	**3-13**
	Total Hours	**6.5-21.5**

Learning Objectives

Learning and Training Goals

Upon successful completion of their studies, students enrolled in the Biomedical Sciences and Biotechnology Master's Program will be able to:

- Apply principles of experimental design and problem solving in the biomedical sciences
- Apply statistical tools for data composition, mining and analysis
- Employ state-of-the-art techniques in biomedical sciences
- Design strategies for rational drug design
- Conduct research in an ethical manner
- Engage in critical analysis of the scientific literature
- Apply the principles of project management
- Understand and operate in the regulatory environment of life science innovation
- Analyze the process of biomedical entrepreneurship in academic, government, and corporate settings
- Write a well-supported, well-reasoned scientific or technical paper

Upon successful completion of their studies, students enrolled in the Biomedical Sciences Graduate Certificate program will be able to:

1. Apply principles of experimental design and problem solving in four focus areas of biomedical sciences.
2. Employ basic tools of R programming.
3. Classify data and use statistical tools to test hypotheses.
4. Recognize and manage ethical challenges related to the responsible conduct of research.

Courses

BSBT 6061 - Project Management (2 Credits)
Provides training in initiating, executing & closing a project, including the management of scope, time, cost, human resources, communication, risk and more. Highly interactive intensive course prepares students for Certified Project Management exam (internationally recognized certification). Taught by Project Management Professional.
Grading Basis: Letter Grade
Typically Offered: Fall, Spring, Summer.

BSBT 6065 - Case Studies in Responsible Conduct of Research (1 Credit)
Anyone conducting research using federal funding must study RCR. You'll learn expectations and regulations that permeate science. You'll understand consequences of violations to individuals and society. We'll explore misconduct through interactive video, written and video case studies, and other engaging activities.
Grading Basis: Letter Grade
Typically Offered: Fall, Spring, Summer.

BSBT 6067 - Statistics for Biomedical Sciences (2 Credits)
Learn how and when to apply statistical procedures to answer scientific questions relevant to biomedicine, and how to critically assess statistical data for validity.
Grading Basis: Letter Grade
Typically Offered: Fall, Spring, Summer.

BSBT 6068 - Laboratory Research in Structural Biology (1-6 Credits)
The Course BSBT 6068, Laboratory Research, with allow graduate students to engage in laboratory research training in the biomedical sciences with focus on structural biology.
Grading Basis: Letter Grade
Repeatable. Max Credits: 15.
Typically Offered: Fall, Spring, Summer.

BSBT 6070 - Mini-Research Rotations (1-3 Credits)
The Course BSBT 6070, Mini-Research Rotations, with allow graduate students to learn in three different laboratories about research in immunology and microbiology.
Grading Basis: Letter Grade with IP
Typically Offered: Fall, Spring.

BSBT 6071 - Introduction to R Programming (1 Credit)
Introduction to the statistical programming language R geared primarily to biomedical science students with little to no previous programming experience. Basic features of R as a programming language and as scientific computing platform. Basics of data cleaning, visualization, and analysis.
Grading Basis: Letter Grade
Typically Offered: Spring.

BSBT 6072 - Foundations in Biochemistry (1.5 Credits)
This short course provides a condensed and fast-paced overview of the fundamentals in biochemistry including research strategies and techniques. The course aims to enhance the students' ability to engage in critical scientific reasoning and problem-solving and to prepare students for the scientific analyses and discussions.
Grading Basis: Letter Grade
Typically Offered: Fall.

BSBT 6073 - Foundations in Molecular Biology (1.5 Credits)
This short course provides a condensed and fast-paced overview of the fundamentals in molecular biology including research strategies and techniques. The course aims to enhance the students' ability to engage in critical scientific reasoning and problem-solving and to prepare students for the scientific analyses and discussions.
Grading Basis: Letter Grade
Typically Offered: Fall.

BSBT 6074 - Foundations in Cell Biology (1.5 Credits)
This short course provides a condensed and fast-paced overview of the fundamentals in cell biology including research strategies and techniques. The course aims to enhance the students' ability to engage in critical scientific reasoning and problem-solving and to prepare students for the scientific analyses and discussions.
Grading Basis: Letter Grade
Typically Offered: Fall.

BSBT 6075 - Foundations in Genetics (1.5 Credits)
This short course provides a condensed and fast-paced overview of the fundamentals in genetics including research strategies and techniques. The course aims to enhance the students' ability to engage in critical scientific reasoning and problem-solving and to prepare students for the scientific analyses and discussions.
Grading Basis: Letter Grade
Typically Offered: Fall.

BSBT 6076 - Research Explorations (1 Credit)
This course allows for exploration of SBB research labs in a "mini-rotation" format, through meeting faculty, reading literature and participating in lab group meetings and research in order to choose a research lab and prepare a short research proposal.
Grading Basis: Letter Grade
Typically Offered: Fall, Spring.

BSBT 6801 - Biomedical Entrepreneurship (3 Credits)
The course addresses the essential elements of bioscience and health innovation and entrepreneurship. Prerequisites: An undergraduate degree in science, technology, business, engineering or math. Cross-listed with ENTP 6801
Grading Basis: Letter Grade
A-GRAD Restricted to graduate students only.
Typically Offered: Spring.

BSBT 6804 - Bioinnovation Regulations (3 Credits)
This course is designed to familiarize biomedical scientists and those interested in the business of science with the fundamentals of U.S. and international regulatory affairs regarding drug discovery and medical devices. Focus is the development of products, such as drugs, devices, diagnostic tests, and health information software, to receive U.S. and international regulatory clearance or approval for commercialization.
Grading Basis: Letter Grade
Typically Offered: Fall.

BSBT 6805 - Bioinformatics (4 Credits)
This course will simultaneously introduce students to coding principles (using R) applied to common problems in bioinformatics and data analysis. To this end, students will learn how to import high-throughput data into R, pre-process that data to account for technical anomalies resulting from the acquisition modality (e.g., RNA-Seq, ChIP-Seq), and perform a sequence of statistical analysis (e.g., ANOVA) and data visualization (e.g., heatmaps). At the completion of this course, students will be equipped with coding templates in R that they can apply to data analysis for their own research purposes. Students will also be exposed to more advanced principles of data analysis, such as training machine learning algorithms. These include unsupervised and supervised algorithms, which are commonly used for general data exploration and training diagnostic/prognostic models, respectively. Prereq: • Mathematical Foundations: Students are expected to have a solid understanding of calculus and matrix algebra. These mathematical principles are essential for comprehending common data analysis techniques used in bioinformatics. • Programming Skills: Coding experience in any programming language is preferred but not required. The course will teach bioinformatics and coding concepts simultaneously, primarily using R as the programming language.
Grading Basis: Letter Grade
Typically Offered: Spring.

BSBT 6806 - Communication Skills (3 Credits)
Position yourself for success biomedical research and industry careers where effective communication is essential. Learn and practice the fundamentals of effective public speaking, presenting, interviewing, and personal branding. This is a graduate level course designed for individuals in research and industry fields who are looking to refine their communication skills.
Grading Basis: Letter Grade
Typically Offered: Spring.

BSBT 6939 - Internship - Technology and Innovation (3-6 Credits)
The internship provides hands-on learning opportunities for graduate students in institutions related to technology/biotechnology, computer science, engineering, innovation and entrepreneurship. Requisite: Enrollment with permission only. Instructor consent required.
Grading Basis: Letter Grade with IP
Repeatable. Max Credits: 6.
A-GRAD Restricted to graduate students only.
Additional Information: Report as Full Time.
Typically Offered: Fall, Spring, Summer.

ENGL 5175 - Writing in the Sciences (3 Credits)
Provides rhetorical analyses of scientific discourse and student practice in writing research reports and proposals. Restriction: Restricted to students at the graduate level (including non-degree and Anschutz Medical Campus programs). Cross-listed with ENGL 4175. Max hours: 3 Credits.
Grading Basis: Letter Grade
Restriction: Restricted to students at the graduate level (including non-degree and Anschutz Medical Campus programs).

BMSC 7810 - Core Topics in Biomedical Science (2 Credits)
Sections focus on different core topics in biomedical science, and will address subject areas such as protein structure and function, neurobiology, embryology, stem cell research, and cancer biology. Students can enroll in multiple Core Topic Courses topics in one semester. Previously offered as IDPT 7810.
Grading Basis: Letter Grade
Repeatable. Max Credits: 20.
AMC-PHD PhD Students only
Typically Offered: Fall.

PHSC 7330 - Development of Drugs and Biologics (3 Credits)
A survey course designed to introduce students to pharmacokinetic and pharmacodynamics principals used in drug research and development by faculty of the Skaggs School of Pharmacy, Department of Pharmaceutical Sciences. The Phoenix Winnonlin Computer software, is used to complete homework. Offered in Fall only in even-numbered years. Crosslisted with TXCL 7330.
Grading Basis: Letter Grade
A-GRAD Restricted to graduate students only.
Typically Offered: Fall.

STBB 7608 - Molecular Interactions (3 Credits)
Provides chemical/physical basis for protein structure, folding, function & stability; presents methods/principles of protein/peptide purification & enzyme catalysis including electron transfer & mutagenesis. The role of molecular dynamics & use of molecular simulations in the investigations of protein-ligand/protein-protein interactions. Cross-listed with PHSC 7608.
Grading Basis: Letter Grade
A-GRAD Restricted to graduate students only.
Typically Offered: Spring.

STBB 7609 - Biophysics & Spectroscopy (1.5 Credits)
This course aims to provide the students with a deep understanding of the application of different biophysical techniques to study interactions of biomolecules with each other or with small molecules. The course will supply the students with the needed tools to be able to design their own biophysical experiments to tackle a particular question.
Grading Basis: Letter Grade
A-GRAD Restricted to graduate students only.
Typically Offered: Spring.

STBB 7631 - Molecular Structure A (1.5 Credits)
Gain an in-depth understanding of the underlying principles of an NMR experiment, so that student can turn NMR theory into NMR practice for their research.
Grading Basis: Letter Grade
A-GRAD Restricted to graduate students only.
Typically Offered: Fall.

STBB 7660 - Structure Seminar (1 Credit)
Seminar series provides a forum for the presentation of scientific experiments and information in structural biology by faculty, postdoctoral fellows and graduate students.
Grading Basis: Letter Grade
A-GRAD Restricted to graduate students only.
Typically Offered: Fall, Spring.

PMED 6010 - Foundations in Personalized Health (3 Credits)
PMED6010 introduces students to the field of personalized medicine and prepares students to integrate this field into a variety of health-related professions. Students will gain the foundational knowledge to successfully apply personalized medicine approaches to scientific research and clinical care.
Grading Basis: Letter Grade
A-GRAD Restricted to graduate students only.
Typically Offered: Fall.

PMED 6110 - Pharmacogenomics (3 Credits)
PMED6110 introduces students to pharmacogenetics, which refers to how genetic factors influence drug metabolism and dosing. Students will gain the foundational knowledge to use pharmacogenetics in scientific research and clinical care. Co-Requisite - PMED 6010.
Grading Basis: Letter Grade
A-GRAD Restricted to graduate students only.
Typically Offered: Fall.

PMED 6210 - Multi-Omic Approaches in Personalized Medicine (3 Credits)
PMED6210 introduces students to cutting-edge concepts, technologies, analytic methods, and databases for a wide-range of 'omics approaches that form the foundation of personalized medicine. Critical evaluation of literature utilizing 'omics methods for personalized medicine will also be emphasized. Requisite: PMED 6010.
Grading Basis: Letter Grade
A-GRAD Restricted to graduate students only.
Typically Offered: Spring.

PMED 6910 - Applications and Challenges in Personalized Medicine (3 Credits)
PMED6910 is the capstone experience for students enrolled in the Personalized and Genomic Medicine Graduate Certificate. Students will expand their knowledge of personalized medicine through exposure to real-world applications and in-depth research into the field. Requisite: PMED 6010.
Grading Basis: Letter Grade
A-GRAD Restricted to graduate students only.
Typically Offered: Spring.

Policies

Please refer to the Graduate School Policies page (http://catalog.ucdenver.edu/cu-anschutz/schools-colleges-programs/graduate-school/#policiestext).

Contact Us

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