Computational Bioscience (PhD)

Overview

The program was founded and is directed by Professor Lawrence Hunter, founder of the International Society for Computational Biology, and the popular ISMB and PSB conferences. The CPBS Program is globally recognized for its research and teaching of computational biology and bioinformatics at the University of Colorado’s Anschutz Medical Campus. The Program is designed to produce graduates with depth in computational methods and molecular biomedicine, an intimate familiarity with the science and technology that synthesizes the two, and the skills necessary to pioneer novel computational approaches to significant biomedical questions.

The Computational Bioscience Program of the University Of Colorado School Of Medicine is dedicated to training computational biologists who aspire to achieve excellence in research, education and service, and who will apply the skills they learn toward improving human health and deepening our understanding of the living world. The Computational Bioscience Program provides graduates with the foundation for a lifetime of continual learning. Our curriculum integrates training in computation and biomedical sciences with student research and teaching activities that grow increasingly independent through the course of the program. Our graduates are able to do independent computational bioscience research, to collaborate effectively with other scientists, and to communicate their knowledge clearly to both students and the broader scientific community.

Admissions Requirements

To apply for admission applicants must submit the following:

- Online Graduate School application
- Personal Statement: A roughly one-page personal statement describing the applicant’s career goals and purpose for seeking a Computational Bioscience PhD
- Resume: The applicant’s current resume or curriculum vitae, including professional work/practice since graduating with a bachelor’s degree (or equivalent).
- Past Work Statement
- Three recommendations: to be completed by people who know your professional, academic and/or personal achievements or qualifications well. As such, references must be from professional contacts, such as employers, supervisors, former faculty, preceptors, or professional colleagues. References from clergy, family members, friends or politicians will not be accepted.
- Application Fee: A nonrefundable application fee of $50.00 (U.S. dollars) for domestic applicants. Checks or money orders should be made out to the University of Colorado.
- Interview: After the application is complete a telephone or video interview will be arranged with the applicant and around 6 faculty members. This interview will afford the program the opportunity to understand the needs of the applicant and for the candidate to ask questions. The interview process is designed to assess the applicant’s knowledge of the profession, communication, and ability to perform in a positive, professional manner when working with others. To be considered for admission, applicants must participate in the interview process.

Degree Requirements

First Year

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Year 1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fall</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BMSC 7806</td>
<td>Core I: Foundations in Biomedical Sciences</td>
<td>6</td>
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<tr>
<td>BMSC 7810</td>
<td>Core Topics in Biomedical Science Core Topics A</td>
<td>1-6</td>
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<tr>
<td>IDPT 7850</td>
<td>Independent Study in Bioethics, Medical Humanities or Health Law Core Topics B</td>
<td>1-6</td>
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<tr>
<td>CPBS 7711</td>
<td>Methods and Tools in Biomedical Informatics</td>
<td>4</td>
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<tr>
<td>CPBS 7605</td>
<td>Ethics in Bioinformatics</td>
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<td>Spring</td>
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<td>CPBS 7712</td>
<td>Research Methods in Biomedical Informatics</td>
<td>4</td>
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<td>CPBS 7605</td>
<td>Ethics in Bioinformatics Section 001</td>
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<td>Ethics in Bioinformatics Section 0V3</td>
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<tr>
<td>Summer</td>
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<tr>
<td>CPBS 8990</td>
<td>Doctoral Thesis</td>
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<td>Total Hours</td>
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Second Year

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<tr>
<td>Fall</td>
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<tr>
<td>BIOS 6601</td>
<td>Applied Biostatistics I</td>
<td>3</td>
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<td>or take 1 of the following courses:</td>
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<tr>
<td>BIOS 6611</td>
<td>Biostatistical Methods I</td>
<td></td>
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<tr>
<td>BIOS 6631</td>
<td>Statistical Theory I</td>
<td></td>
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<tr>
<td>CPBS 7605</td>
<td>Ethics in Bioinformatics</td>
<td>1</td>
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<td></td>
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<tr>
<td>Spring</td>
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<tr>
<td>CPBS 7605</td>
<td>Ethics in Bioinformatics</td>
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<td></td>
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</table>
Computational Bioscience (PhD)

**Learning Objectives**

**Educational Goals and Objectives**

Knowledge Goals - Graduates demonstrate their knowledge of core concepts and principles of computational bioscience, and the ability to apply computation to gain insight into significant biomedical problems. This knowledge includes mastery of the fundamentals of biomedicine, statistics and computer science, as well as proficiency in the integration of these fields. Graduates contribute to the discovery and dissemination of new knowledge.

Knowledge Objectives

1. Demonstrate knowledge of the scientific principles that underlie the current understanding of molecular biology, statistics and computer science.
2. Demonstrate an ability to productively integrate knowledge from disparate fields to solve problems in biomedicine using computational methods.
3. Demonstrate knowledge of the types and sources of data most commonly used in computational bioscience, including knowledge of all major public data repositories.
4. Demonstrate the knowledge of the classes of algorithms most often applied in computational bioscience, and their domains of applicability.
5. Demonstrate an understanding of the principles and practice of the scientific method as applied in computational bioscience, including experimental design, hypothesis testing, and evaluation of computational systems.

Communication Skills - Communication Skills Goals - Graduates demonstrate interpersonal, oral and written skills that enable them to interact productively with scientists from both biomedical and computational domains, to clearly communicate the results of their work in appropriate formats, and to teach others computational bioscience skills. Graduates are able to bridge the gap between biomedical and computational cultures.

Communication Skills Objectives

1. Communicate effectively, both orally and in writing, in an appropriate range of scientific formats, including formal presentations, collaborative interactions, and the critique of others’ work.
2. Demonstrate familiarity with both biomedical and computational modes of expression, and be able to communicate clearly across disciplinary boundaries.
3. Demonstrate commitment and skill in teaching to and learning from students, colleagues, and other members of the scientific community.

**Self-Directed and Life Long Learning Skills** - Self-Directed and Life Long Learning Goals - Graduates demonstrate habits and skills for self-directed and life-long learning, and recognize that computational bioscience is a rapidly evolving discipline. Our focus is on the development of adaptive, flexible and curious scientists able to comfortably assimilate new ideas and technologies during the course of their professional development.

Self-Directed and Life Long Learning Skills Objectives 1. Recognize the need to engage in lifelong learning to stay abreast of new technologies and scientific advances in multiple disciplines. 2. Locate, evaluate and assimilate relevant new knowledge and techniques from a wide variety of sources.

**Courses**

BIOS 6606 - Statistics for the Basic Sciences (3 Credits)
This course is designed for those wishing to obtain a basic understanding of statistics and its application in biological research. Students will develop statistical literacy and an ability to perform basic statistical analyses, basic graphical statistics, data summarizations, and estimation and inference using statistical software. Restrictions: Enrollment in UCD-AMC graduate program or permission of the instructor.
Grading Basis: Letter Grade
A-PUBH 1 Graduate students and public health certificate students only.
Typically Offered: Fall.

BIOS 6611 - Biostatistical Methods I (3 Credits)
This first course in applied statistics covers basic descriptive methods and probability; parametric and nonparametric inference for the one- and two-sample location problem; ANOVA, ANCOVA, and multiple linear regression. Matrix notation, R, and SAS are used. Prerequisite: differential calculus or permission of instructor.
Grading Basis: Letter Grade
A-PUBH BIOS
Typically Offered: Fall.
BIOS 6631 - Statistical Theory I (3 Credits)
This course presents an introductory coverage of the theory of discrete and continuous random variables and applications to statistical problems. Topics include probability theory, transformations and expectations, common families of distributions, multiple random variables, and properties of a random sample. Prereq: Differential and integral calculus.
Grading Basis: Letter Grade
A-PUBH1 Graduate students and public health certificate students only. Typically Offered: Fall.

BMSC 7806 - Core I: Foundations in Biomedical Sciences (6 Credits)
Course will focus on the fundamental principles of biomedical sciences. Lectures and recitations/discussions will primarily address the basics of molecular biology, biochemistry, genetics, cell biology and energetic principles. Course is typically limited to biomedical science PhD and BSBT MS students. Previously offered as IDPT 7806
Grading Basis: Letter Grade
Repeatable. Max Credits: 6. Typically Offered: Fall.

BMSC 7810 - Core Topics in Biomedical Science (1-6 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.

CPBS 7605 - Ethics in Bioinformatics (1 Credit)
Discussions of professional conduct, social implications of research and questions raised by biomedical research, with an emphasis on topics relevant to computational biologists. Active student participation is required. Offered every other year.
Grading Basis: Letter Grade
Typically Offered: Every other.

CPBS 7711 - Methods and Tools in Biomedical Informatics (4 Credits)
An introduction to the theory and practice of bioinformatics and computational biology. Topics include: the analysis of macromolecular sequences, structures, gene expression arrays, proteomics, and management of the biological literature. Prerequisites: Permission of instructor. Crosslisted: PHCL 7611 (non-sponsor).
Grading Basis: Letter Grade
A-GRAD Restricted to graduate students only.
Typically Offered: Fall.

CPBS 7712 - Research Methods in Biomedical Informatics (4 Credits)
The CPBS faculty members will present lectures on the research currently being conducted in their laboratories. Students will plan, execute and report on their own research project. This course is beginning transition from well-educated students to independent researchers. Prerequisites: Permission of Instructor. Crosslisted: PHCL 7612 (non-sponsor).
Grading Basis: Letter Grade
A-GRAD Restricted to graduate students only.
Typically Offered: Spring.

CPBS 8990 - Doctoral Thesis (1-10 Credits)
Doctoral Thesis work in Computational Bioscience. Prerequisites: Permission of instructor.
Grading Basis: Letter Grade with IP
Repeatable. Max Credits: 10.
A-GRAD Restricted to graduate students only.
Additional Information: Report as Full Time.
Typically Offered: Fall, Spring, Summer.

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

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