CURRICULUM IN BIOINFORMATICS AND COMPUTATIONAL BIOLOGY (GRAD)

Modern biology, in this postgenome age, is being greatly enriched by an infusion of ideas from a variety of computational fields, including computer science, information science, mathematics, operations research, and statistics. In turn, biological problems are motivating innovations in these computational sciences. There is a high demand for scientists who can bridge these disciplines. The goal of the Curriculum in Bioinformatics and Computational Biology (BCB) is to train such scientists through a rigorous and balanced curriculum that transcends traditional departmental boundaries.

Incoming students are expected to matriculate from a broad range of disciplines; thus, it is important to ensure that all students have a common foundation on which to build their BCB training. The first year is dedicated to establishing this foundation and training all students with a common set of core BCB courses. BCB students will also participate in three laboratory research rotations their first year and ultimately join a laboratory at the end of those rotations. Research work is done in the laboratory facilities of the individual faculty member and is supported primarily by faculty research grants.

Curriculum faculty have appointments in 18 departments in the School of Medicine, School of Dentistry, Gillings School of Global Public Health, Eshelman School of Pharmacy, School of Information and Library Science, and the College of Arts and Sciences. This level of diversity allows students a broad range of research opportunities.

Requirements for Admission for Graduate Work

Ideal BCB candidates should have an undergraduate degree in a biological, physical, mathematical, or computational science. They must apply to the program through a unified application program known as the Biological and Biomedical Sciences Program (BBSP). Students apply for graduate study in the biological or biomedical sciences at UNC–Chapel Hill. Students interested in any of the BBSP research areas apply to BBSP; and those whose application portfolio places them highest on the admission list are asked to visit Chapel Hill for interviews. Students who are ultimately admitted to UNC–Chapel Hill make no formal commitment to a Ph.D. program. After completing their first year of study students leave BBSP, join a thesis laboratory, and matriculate into one of 14 participating Ph.D. programs. During their first year BBSP students are part of small, interest-based groups led by several faculty members. These groups meet frequently and provide a research community for students until they join a degree-granting program. Students are encouraged to apply as early as possible, preferably before December 1. (Applicants seeking a master's degree are not considered for admission.)

Financial Aid

Stipends for predoctoral students are available from an NIH predoctoral training grant and from the University. Tuition, student fees, and graduate student health insurance are also covered by the training grant and the University.

In addition to the dissertation requirements of The Graduate School (four full semesters of credit including at least six hours of doctoral dissertation, a written preliminary examination, an oral examination and a dissertation), students in the Curriculum in Bioinformatics and Computational Biology must meet the following requirements:

- complete all five of the BCB core courses (BCB 715, 716, 717, 720, and 722)
- complete twelve hours of elective courses (as determined by student and thesis advisor); at least 9 hours must be computational
- participate in the BCB Colloquium as attendees during the first and second years
- act as teaching assistant for one of the BCB modules in Year 2
- attend BCB Student Seminars in Years 2 and 3; present in BCB Student Seminars beginning in Year 3 until graduation
- participate in BCB Grant Writing course in Year 2
- attend BCB sponsored special seminars and new student symposium
- attend the BCB annual retreat; present posters or talks

Students are required to rotate through at least three laboratories before choosing a thesis advisor. The advisor or co-advisor must be from BCB Core Faculty list. It is strongly recommended that students attend national meetings in order to better understand how their research fits with progress in their field.

Professors

Shawn Ahmed, Genetics and Biology
Jim Bear, Cell Biology and Physiology
Kerry Bloom, Biology
Charles Carter, Biochemistry and Biophysics
Jeff Dangl, Biology
Ian Davis, Genetics and Pediatrics
Henrik Dohlman, Pharmacology; Biochemistry and Biophysics
Timothy Elston, Pharmacology and Computational Medicine
Gregory Forest, Math
Terry Furey, Genetics and Biology
Amy Gladfelter, Biology
Shawn Gomez, Biomedical Engineering
Klaus Hahn, Pharmacology and Medicinal Chemistry
Corbin Jones, Biology and Genetics
Brian Kuhlmans, Biochemistry and Biophysics
Alain Laederach, Biology
Yun Li, Genetics and Biostatistics
Yufeng Liu, Statistics & Operations Research, Biostatistics, and Genetics
Terry Magnuson, Genetics
Steve Marron, Statistics & Operations Research
William Marzluff, Biochemistry & Biophysics
Karen Mohlke, Genetics
Fernando Pardo-Manuel de Villena, Genetics
Charles Perou, Genetics and Pathology & Laboratory Medicine; Computational Medicine
Jan Prins, Computer Science
Jack Snoeyink, Computer Science
John Sondek, Pharmacology, and Biochemistry & Biophysics
Brian Strahl, Biochemistry & Biophysics
Alex Tropsha, Chemical Biology & Medicinal Chemistry
William Valdar, Genetics
Kevin Weeks, Chemistry
Mark Zylka, Neuroscience Center; Cell Biology & Physiology
**Associate Professors**

J. Mauro Calabrese, Pharmacology; Lineberger Comprehensive Cancer Center  
Boye Griffith, Mathematics; Biomedical Engineering  
Erin Heinzen, School of Pharmacy and Genetics  
Bradley Hemminger, School of Information and Library Science  
Samir Kelada, Genetics  
Sam Lai, School of Pharmacy  
Amy Shaub Maddox, Biology  
Paul Maddox, Biology  
Adrian Marchetti, Marine Sciences  
Dan McKay, Biology and Genetics  
Leonard McMillan, Computer Science  
Jeremy Purvis, Genetics; Computational Medicine  
Shehzad Sheikh, Genetics and Medicine  
Todd Vision, Biology; School of Information and Library Science

**Assistant Professors**

Elizabeth Brunk, Pharmacology and Chemistry  
Brad Dickerson, Biology  
Daniel Dominguez, Pharmacology  
Jill Dowen, Biochemistry & Biophysics; Biology  
Marty Ferris, Genetics  
Hector Franco, Genetics; Lineberger Cancer Center  
Flavio Frohlich, Psychiatry, Cell Biology and Physiology, Biomedical Engineering, Neurology  
Katherine Hoadley, Genetics; Lineberger Cancer Center  
Yuchao Jiang, Biostatistics & Genetics  
Daphne Klotsa, Applied Physical Sciences  
Wesley Legant, Biomedical Engineering and Pharmacology  
Mike Love, Biostatistics & Genetics  
Ehsan Nazockdast, Applied Physical Science  
Adam Palmer, Pharmacology  
Doug Phanstiel, Cell Biology & Physiology  
Jesse Raab, Genetics  
Laura Raffield, Genetics  
Christoph Rau, Genetics; Computational Medicine  
Alexander Rubinsteyn, Genetics  
Daniel Schrider, Genetics  
Jeremy Simon, Genetics; Neuroscience Center  
Natalie Stanley, Computer Science  
Jason Stein, Genetics; Neuroscience Center  
Benjamin Vincent, Medicine, Division of Hematology/Oncology  
Jeremy Wang, Genetics  
Hyeyung Won, Genetics  
Di Wu, Periodontics, School of Dentistry; Biostatistics  
Anthony Zannas, Psychiatry and Genetics

**BCB**

**Graduate-level Courses**

BCB 701. **Genome Sciences Seminar Series. 1 Credits.**  
Open to bioinformatics students only. Diverse but current topics in all aspects of bioinformatics. Relates new techniques and current research of notables in the field of bioinformatics.

**Rules & Requirements**
Repeat Rules: May be repeated for credit.  
Grading Status: Letter grade.

BCB 702. **Genome Sciences Seminar Series. 1 Credits.**  
Open to bioinformatics students only. Diverse but current topics in all aspects of bioinformatics. Relates new techniques and current research of notables in the field of bioinformatics.

**Rules & Requirements**
Repeat Rules: May be repeated for credit.  
Grading Status: Letter grade.

BCB 710. **Bioinformatics Colloquium. 1 Credits.**  
The goal of this course is to expose students to the research interests of BCB faculty and to provide an opportunity for students to present their own work and receive input from their peers and faculty.

**Rules & Requirements**
Grading Status: Letter grade.

BCB 712. **Databases, Metadata, Ontologies, and Digital Libraries for Biological Sciences. 1 Credits.**  
Course introduces the basic information-science methods for storage and retrieval of biological information.

**Rules & Requirements**
Grading Status: Letter grade.

BCB 715. **Mathematical and Computational Approaches to Modeling Signaling and Regulatory Pathways. 1 Credits.**  
The course provides an introduction to the basic mathematical techniques used to develop and analyze models of biochemical networks. Both deterministic and stochastic models are discussed.

**Rules & Requirements**
Grading Status: Letter grade.

BCB 716. **Sequence Analysis. 1 Credits.**  
This module is designed to introduce students to concepts and methods in the comparative analysis of nucleic acid sequences using state of the art sequencing platforms. Course topics will include sequence alignment, genome assembly, and computational details of contemporary protocols for DNA and RNA sequencing.

**Rules & Requirements**
Grading Status: Letter grade.

BCB 717. **Structural Bioinformatics. 1 Credits.**  
Course introduces methods and techniques for protein modeling.

**Rules & Requirements**
Grading Status: Letter grade.

BCB 718. **Computational Modeling Laboratory. 1 Credits.**  
This course provides a practical introduction to computational modeling of cellular systems. We will focus on how to choose and implement different modeling techniques-deterministic, stochastic, and inferred-to describe the same biological phenomenon. Although no formal mathematical or computational background is required, the course will involve a fair amount of programming in MATLAB.

**Rules & Requirements**
Grading Status: Letter grade.
BCB 720. Introduction to Statistical Modeling. 3 Credits.
This course introduces foundational statistical concepts and models that motivate a wide range of analytic methods in bioinformatics, statistical genetics, statistical genomics, and related fields. Students are expected to know single-variable calculus, be familiar with matrix algebra, and have some programming experience.

Rules & Requirements
Grading Status: Letter grade.

BCB 722. Population Genetics. 1 Credits.
This course will cover methods of inferring/estimating natural selection, including the Dn/Ds ratio, the McDonald-Kreitman test, and the Poisson Random Field model. The course will feature discussions of high-profile publications that describe the application of these methods to yield insights into the forces that have shaped organismal evolution.

Rules & Requirements
Grading Status: Letter grade.

BCB 723. Topics in Statistical Genetics and Genomics. 1 Credits.
This module introduces selected concepts and techniques in statistical genetics and genomics.

Rules & Requirements
Grading Status: Letter grade.

BCB 725. Introduction to Statistical Genetics. 3 Credits.
Covers statistical methods for the analysis of family and population-based genetic data. Topics include classical linkage analysis, population-based and family-based association analysis, haplotype analysis, genome-wide association studies, basic principles in population genetics, imputation-based analysis, pathway-based analysis, admixture mapping, analysis of copy number variations, and analysis of massively parallel sequencing data.

Rules & Requirements
Grading Status: Letter grade.

BCB 730. Fundamentals of Quantitative Image Analysis for Light Microscopy. 1 Credits.
This course is a practical introduction to quantitative analysis of light microscopy images. During the class students will follow tutorials that will guide them through common tasks in analysis of biological images. They will be introduced to basic concepts of image processing like image registration, filtering, object detection etc.

Rules & Requirements
Grading Status: Letter grade.

BCB 784. Introduction to Computational Biology. 3 Credits.
Molecular biology, sequence alignment, sequence motifs identification by Monte Carlo Bayesian approaches, dynamic programming, hidden Markov models, computational algorithms, statistical software, high-throughput sequencing data and its application in computational biology.

Rules & Requirements
Requisites: Prerequisites, BIOS 661 and 663; Permission of the instructor for students lacking the prerequisites.
Grading Status: Letter grade.
Same as: BIOS 784.

BCB 785. Statistical Methods for Gene Expression Analysis. 3 Credits.
Clustering algorithms, classification techniques, statistical techniques for analyzing multivariate data, analysis of high dimensional data, parametric and semiparametric models for DNA microarray data, measurement error models, Bayesian methods, statistical software, sample size determination in microarray studies, applications to cancer.

Rules & Requirements
Requisites: Prerequisites, BIOS 661 or 673, and 663; Permission of the instructor for students lacking the prerequisites.
Grading Status: Letter grade.
Same as: BIOS 785.

BCB 850. Training in Bioinformatics and Computational Biology Teaching. 3 Credits.
Principles of bioinformatic and computational biology pedagogy. Students are responsible for assistance in teaching BCB and work under the supervision of the faculty, with whom they have regular discussion of methods, content, and evaluation of performance.

Rules & Requirements
Repeat Rules: May be repeated for credit.
Grading Status: Letter grade.

BCB 870. Writing Fellowship Proposals. 1 Credits.
Provides practical experience to predoctoral students in writing fellowship proposals, using the NIH F31 as a template. Students will have weekly writing assignments, with feedback given by students and faculty. Open to 2nd and 3rd year students in the Curriculum or by permission of the instructor.

Rules & Requirements
Grading Status: Letter grade.
Same as: GNET 870.

BCB 888. Responsible Conduct of Research. 1 Credits.
Classroom-based graduate level course covering critical topics for ethical and responsible conduct of experimental research. There are both classroom lecture, workshop-type discussion components, in addition to assigned outside of class readings. Case studies and hypothetical situations involving the most likely scenarios confronting graduate students will be covered, these topics include: mentor and mentee relationships, publication authorship, collaboration, peer review, conflicts of interest, intellectual property, plagiarism, data acquisition and data processing. Restricted to students in good standing as a graduate student at UNC; In the unlikely event that classroom space is limited, preference will be given to graduate students who have previously received external federal funding sources and may require a refresher course in RCR.

Rules & Requirements
Repeat Rules: May be repeated for credit. 2 total credits. 1 total completions.
Grading Status: Letter grade.
Same as: BIOC 888.

BCB 891. Special Topics. 1-3 Credits.
Advance topics in current research in statistics and operations research.

Rules & Requirements
Repeat Rules: May be repeated for credit; may be repeated in the same term for different topics.
Grading Status: Letter grade.
Same as: MATH 891, GNET 891.
BCB 899. Special Topics in Bioinformatics and Computational Biology. 1-6 Credits.
Special topics course in the Bioinformatics and Computational Biology Curriculum. Topics will vary.

Rules & Requirements
Repeat Rules: May be repeated for credit. 9 total credits. 9 total completions.
Grading Status: Letter grade.

BCB 905. Research in Bioinformatics and Computational Biology. 1-8 Credits.
Credit awarded to students for research in bioinformatics and computational biology.

Rules & Requirements
Repeat Rules: May be repeated for credit.
Grading Status: Letter grade.

BCB 993. Master's Research and Thesis. 3 Credits.
Students are not accepted for master's program.

Rules & Requirements
Repeat Rules: May be repeated for credit.

BCB 994. Doctoral Research and Dissertation. 3 Credits.
Credit for work done towards doctorate.

Rules & Requirements
Repeat Rules: May be repeated for credit.

Contact Information
Curriculum in Bioinformatics and Computational Biology
Visit Program Website (http://bcb.unc.edu)

Director
William Valdar
william.valdar@unc.edu

Associate Director
Timothy Elston
timothy_elston@med.unc.edu

Student Services Manager
Jonathon Cornett
jcornett@email.unc.edu