

Computational & Systems Biology, PhD

Degree Requirements

Computational & Systems Biology

The Computational and Systems Biology Program is a graduate training program at WashU, housed under the Roy and Diana Vagelos Division of Biology and Biomedical Sciences (DBBS).

The goal of the Computational and Systems Biology Program is to train the next generation of scientists in technology intensive, quantitative, systems level approaches to molecular biology. We aim to graduate students who are as comfortable operating the latest high-end instrumentation as they are manipulating the mathematical formalisms that are required to make sense of their data. It is our hope that the students who join the Computational and Systems Biology Program will apply these approaches to unravel the complex genetic circuits that control the cell and to understand the genetics of human disease.

Technological advances are having a major impact on molecular biology. Advances in experimental techniques mean that large amounts of sequence, expression, and localization data are now routinely gathered by individual investigators. In addition, terabytes of these kinds of data are stored in various public and private databases. Concurrently, access to large scale computing resources has become more and more common in molecular biology laboratories. Students in the Computational and Systems Biology Program will learn to leverage these advances in both experimental and computational resources.

Some of the general areas in which faculty work include the following:

- Large-scale genetic network analysis and reconstruction
- Technology development for high-throughput collection of genetic and biochemical data
- Molecular modeling of genetic regulatory circuits
- Real time, single cell analyses of genetic regulatory circuits
- Specificity and evolution of DNA-protein interactions
- Algorithm development for comparison of DNA, RNA, and protein sequences
- Synthetic biology
- Human microbiome and other health-relevant microbial communities
- Complex trait analysis
- Population genetic analysis of genetic variation
- Functional genomic approaches to disease gene identification

To earn a PhD at within the Roy and Diana Vagelos Division of Biology and Biomedical Sciences at Washington University, a student must complete all courses required by their department; maintain satisfactory academic progress; pass the qualifying examination; complete all requirements for doctoral candidacy; create a Research Advisory Committee (RAC); submit a Title, Scope, and Procedure Form; fulfill residence and Mentored Experience Requirements; write, defend, and submit a dissertation; and apply for program completion (graduation) via Workday Student.

Program Requirements

- **Total Units Required:** 36 units
- **Degree Length:** Seven years
 - Students are expected to maintain satisfactory academic progress in accordance with academic milestones. Students entering their seventh year in the program will receive a warning letter in regards to reaching their stated degree length. Students entering their eighth year in the program will be required to obtain permission from the Associate Dean of Graduate Education. Across DBBS programs, the average time to degree is 5.6 years.
 - **Note:** Students must be enrolled in 9 graduate credits each semester to retain full-time status. As students complete their coursework, if enrolled in fewer than 9 graduate credits, they must enroll in a specific Biology & Biomedical Sciences research graduate course to maintain full-time status. Prior to completing 36 credit units, student will enroll in BBS 5900 Research for research credit; after completing 36 credit units, students will enroll in BBS 9000 Full-Time Graduate Research/Study, which will show 0 credit units but fulfills full-time status. Students should follow advising instructions to ensure proper enrollment prior to Add/Drop.
 - Continued support is guaranteed for the duration of the student's graduate studies, provided that the student maintains satisfactory progress toward completion of the degree.
 - **Grade Requirement:** Required courses generally consist of four to nine courses in areas fundamental to the student's program. Students are expected to maintain a B average in graduate courses.

Required Courses

DBBS Required Courses

- BBS 5098 Graduate Research Fundamentals
- BBS 5011 Ethics & Research Science

Program Required Courses

- CSE 5807 Algorithms for Computational Biology
- BBS 5488 Genomics

Three Advanced Electives

In consultation with their advisor, students choose a minimum of three advanced electives or special topics of at least 3 credit units each. Students may substitute one of these three elective requirements by combining multiple 1- and 2-credit courses totaling at least 3 credits. To pursue this substitution option, students must submit a petition in advance to the Program Directors for each 1- or 2-credit course that they wish to substitute with a brief rationale. Because students will be expected to demonstrate substantive command of molecular biology, applied mathematics, and computer science in their qualifying exam, the advanced electives will typically be chosen in areas in which the student does not feel adequately prepared or will emphasize areas of primary interest for the student. The interdisciplinary nature of the program allows considerable flexibility in choosing these courses, depending upon the student's needs. Common choices for these electives include the following:

- BBS 5014 Biotech Industry Innovators
- BBS 5312 Macromolecular Interactions
- BBS 5357 Chemistry and Physics of Biomolecules
- BBS 5483 Human Genetic Analysis
- BBS 5491 Advanced Genetics
- SDS 5210 Statistical Computation
- SDS 5010 Probability
- SDS 5020 Mathematical Statistics
- CSE 5104 Data Mining
- SDS 5480 Topics in Statistics : Machine Learning Methods in Biological Sciences
- INFO 5558 Applications of Deep Neural Networks
- MSB 5555 Computational Statistical Genetics
- BBS 5910 Nano Topics in Biology and Biomedical Sciences

Three Semesters of Journal Clubs

Students are required to register for three semesters of journal clubs. First-year students must enroll in BBS 5496 Seminar in Computational Molecular Biology for two semesters and then may choose another journal club or seminar to fulfill their third semester, as long as it has a presentation requirement. Students may take BBS 5496 Seminar in Computational Molecular Biology for a third time to fulfill the final requirement, if interested.

Laboratory Rotations

Selecting a thesis advisor is the most important decision a student makes in graduate school. To help each student make an informed, thoughtful choice, the Division builds in flexibility to explore options. Students usually participate in three lab rotations during their first year. Additional rotations can be arranged, and rotation lengths are flexible. Students usually begin their thesis research by the end of their first year.

Scientific Scholarship

Keeping abreast of scientific developments is critical for faculty and students alike. The Division offers many ways to stay current. More than 15 weekly biology seminars provide excellent opportunities to meet outstanding scientists from outside Washington University. Several annual symposia bring internationally recognized speakers to campus. Journal clubs meet weekly for students, postdoctoral fellows and faculty to present and discuss current scientific literature. A number of Interdisciplinary Research Pathways allow students to enhance their PhD program. Program retreats allow for informal interaction among students and faculty. The Division also provides funds for each student for professional development.