BIOINFORMATICS AND GENOMICS

Degree Requirements

Master of Science (M.S.)

Requirements listed here are in addition to Graduate Council policies listed under GCAC-600 Research Degree Policies. (https://gradschool.psu.edu/graduate-education-policies/)

For master's degree, a minimum of 30 credits at the 400, 500, 600, or 800 level and a 3.0 overall GPA are required. At least 18 credits in the 500 and 600 series combined (thesis option) or 500 series alone (internship plus scholarly paper option) must be included in the program. As part of the application to the graduate program, students will indicate their preference for completing either a thesis or an internship plus a scholarly paper as part of their M.S. training. Approval of the thesis option is contingent on a BG faculty member agreeing to serve as the thesis adviser.

Required courses for all BG master's degree students are:

Code	Title	Credits
Required Courses		
BGEN 551	Genomics	3
MCIBS 554	Foundations in Data Driven Life Sciences	3
Choose one of the following:		3
STAT 500	Applied Statistics	
STAT 501	Regression Methods	
STAT 502	Analysis of Variance and Design of Experiments	
STAT 555	Statistical Analysis of Genomics Data	3
BMMB 852	Applied Bioinformatics	2
BIOL 405	Molecular Evolution	3
BGEN 541	Critical Analysis of Bioinformatics and Genomics Research Topics	3
BGEN 590	Colloquium	1
MCIBS 591	Ethics, Rigor, Reproducibility and Conduct of Research in the Life Sciences	2
Electives		
At least one elective credit must be chosen from a list of approved classes maintained by the graduate program office.		1
Culminating Experience		
Students choosing the M.S. with thesis option must complete original laboratory research (a minimum of 6 credits of BGEN 600) that culminates in a thesis. The thesis must be accepted by the advisers and/or committee members, the head of the graduate program, and the Graduate School, and the student must pass a thesis defense.		
BGEN 600		6
Students choosing the M.S. with internship plus scholarly paper option must complete independent study (non-thesis research, BGEN 596) and an internship (BGEN 595). Acceptance by the program chair of a scholarly paper reporting results from an original research project is required to fulfill the culminating experience. The internship is separate from the research project and data from the internship are not required for the scholarly paper.		
BGEN 596	Individual Studies	4
BGEN 595	Internship	2
Total Credits		**30**

Program Options described below for the Ph.D. degree are not offered for the M.S. degree.

Doctor of Philosophy (Ph.D.)

Requirements listed here are in addition to Graduate Council policies listed under GCAC-600 Research Degree Policies. (https://gradschool.psu.edu/graduate-education-policies/)

For the Ph.D., a minimum of 35 credits is required. During the first year of study, Ph.D. students are required to take 22 credits of core required courses. Subsequently, 13 credits of elective courses are also required:

Code	Title	Credits
Core Required Courses		
BGEN 551	Genomics	3
MCIBS 554	Foundations in Data Driven Life Sciences	3
BGEN 541	Critical Analysis of Bioinformatics and Genomics Research Topics	3
BGEN 590	Colloquium	1
MCIBS 591	Ethics, Rigor, Reproducibility and Conduct of Research in the Life Sciences	2
BMMB 852	Applied Bioinformatics	2
STAT 555	Statistical Analysis of Genomics Data	3
Choose one of the following:		3
BIOL 405	Molecular Evolution	
BIOL 428	Population Genetics	
BIOL 460	Human Genetics	
BGEN 596	Individual Studies (representing three Research Rotations)	2
Electives		
Elective credits chosen from a list of approved courses maintained by the graduate program office		13
Total Credits		**35**

Depending on the student's prior background, STAT 500, STAT 501, or STAT 502 may also be required.

Each candidate for the Ph.D. degree must fulfill written and spoken English communication requirements that are satisfied by preparing written and oral reports describing the laboratory rotations during the first year.

At the end of the first year, continuation in the Ph.D. program is determined by performance in course work, laboratory rotations, and the BG Graduate Program Qualifying Examination. Students join their research laboratory by the end of the second semester of the first year.

The Ph.D. committee is formed following entry into the dissertation laboratory, and must comply with all Graduate Council requirements (http://gradschool.psu.edu/graduate-education-policies/gcac/gcac-600/phd-dissertation-committee-formation/). Students may consider joint co-advisers, each representing a different area of expertise within the field of bioinformatics and genomics.

During the second year, students may take additional courses in consultation with the Ph.D. committee. Students may select an option area in which they conduct research and take additional courses

specified by the Option (see below). Students are not required to choose an Option. Additionally, students will complete a Teaching Experience, which may be fulfilled by serving as a Teaching Assistant for an undergraduate course or a Student Instructional Assistant for a graduate course, the development of content for and delivery of a comprehensive bioinformatics and genomics training workshop, or other pedagogy-related training and practical experience as approved by the program chair.

Ph.D. students must pass a comprehensive examination; to maintain satisfactory progress in the program this should take place by the end of the fifth semester of enrollment. The written portion of the comprehensive examination is in the format of a grant application. As part of this examination, the candidate also gives an oral presentation of this proposal to their Ph.D. committee.

A dissertation must be prepared and defended by each Ph.D. student. Students must present their dissertation in accordance with Graduate Council and Graduate School guidelines as described in the THESIS GUIDE: Requirements for the Preparation of Master's Theses and Doctoral Dissertations (http://www.gradschool.psu.edu/current-students/etd/thesisdissertationguidepdf/). To earn the Ph.D. degree, the dissertation must be accepted by the Ph.D. committee, the head of the graduate program, and the Graduate School and the student must pass a final oral examination (the dissertation defense).

The final examination of the doctoral candidate is an oral examination administered and evaluated by the entire Ph.D. committee. It consists of an oral presentation of the dissertation by the candidate and a period of questions and responses. These will relate in large part to the dissertation, but may cover the candidate's entire program of study, because a major purpose of the examination is also to assess the general scholarly attainments of the candidate. The portion of the examination in which the dissertation is presented is open to the University community and the public; therefore, it is expected that the examination will take place at University Park or the Hershey campus. It is expected that the Ph.D. candidate will have at least one paper submitted for publication in a major peer-reviewed scientific journal prior to the final oral examination.

Ph.D. students in Bioinformatics and Genomics may enroll in one of two options, but are not required to do so.

Option in Algorithms and Computation

Students are admitted to the Option in Algorithms and Computation after successfully completing:

1. the first year of the IGDP in BG;
2. three research rotations, of which at least two must be with faculty affiliated with the Algorithms and Computation Option; and
3. the qualifying examination.

During the second year, Ph.D. students choosing this option will be required to take:

Code	Title	Credits
CSE/BMMB 566	Algorithms and Data Structures in Bioinformatics	3
CMPSC 465	Data Structures and Algorithms	3
or CSE 565	Algorithm Design and Analysis	
Two courses from a list of prescribed electives which includes but is not limited to the following:		6
CMPSC 431W	Database Management Systems	
CMPSC 450	Concurrent Scientific Programming	
CSE 557	Concurrent Matrix Computation	
CMPSC 464	Introduction to the Theory of Computation	
CSE 583	Pattern Recognition and Machine Learning	
CSE 562	Probabilistic Algorithms	
CMPEN 455	An Introduction to Digital Image Processing	
CMPEN 454	Fundamentals of Computer Vision	
CHE 512	Optimization and Biological Networks	
Total Credits		**12**

Option in Statistical Genomics

Students are admitted to the Option in Statistical Genomics, after successfully completing:

- the first year of the IGDP in BG;
- three research rotations, of which at least two must be with faculty affiliated with the Statistical Genomics Option; and
- the qualifying examination.

During the second year, Ph.D. students choosing this option will be required to take:

Code	Title	Credits
STAT 501	Regression Methods	3
or STAT 511	Regression Analysis and Modeling	
STAT 557	Data Mining I	3
Two courses from a list of prescribed electives which includes but is not limited to the following:		6
STAT 414	Introduction to Probability Theory	
STAT 415	Introduction to Mathematical Statistics	
STAT 416	Stochastic Modeling	
STAT 502	Analysis of Variance and Design of Experiments	
STAT 504	Analysis of Discrete Data	
STAT 505	Applied Multivariate Statistical Analysis	
STAT 540	Statistical Computing	
Total Credits		**12**