Entrance requirements, program descriptions, degree requirements and other program policies for the CBQG SM at Harvard.

www.hsph.harvard.edu/sm-computational-biology
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1 Introduction

This handbook describes the Master’s Degree Program in Computational Biology and Quantitative Genetics offered by the Departments of Biostatistics and Epidemiology at Harvard University. The SM program provides students with the rigorous quantitative training and essential skills needed to successfully meet the challenges presented by large-scale public health data – “Big Data” – in biomedical research. The program is designed to prepare students for a career as a bioinformatics analyst or bioinformatics engineer in universities and hospitals, research organizations, and the pharmaceutical and biotechnology industries. It can also provide the foundation for further doctoral studies.

The sections of this handbook include information and regulations concerning entrance requirements, program descriptions, degree requirements, and other program policies. Policies and official requirements of the School of Public Health are set forth in the Harvard T. H. Chan School of Public Health Student Handbook (http://www.hsph.harvard.edu/student-handbook/). Each graduate student is responsible for general knowledge of, and adherence to, the policies and requirements of the degree program in which the student is enrolled. Additional program information is available at the website https://www.hsph.harvard.edu/sm-computational-biology/program/. Vitally important for our community is that all members demonstrate respect for each other and our discipline. For all members of the community, respect is demonstrated by attending all scheduled classes or meetings, and arriving on time, fully prepared, and ready to participate.

This handbook was prepared by the Program Director and approved by the Executive Committee of the Program in Computational Biology and Quantitative Genetics. The Program Director is responsible for reviewing the student’s program of study, and has the authority to consider exceptions to the rules and regulations established by the Executive Committee. Recommendations of the Program Director are forwarded to the Executive Committee for final approval. Both the Program Director and the Executive Committee welcome suggestions and comments.
Program Leadership and Administration

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Master of Science in Computational Biology and Quantitative Genetics
    Department of Biostatistics
    Department of Epidemiology
2 Master of Science in Computational Biology and Quantitative Genetics

This 80-credit program, offered jointly by the Departments of Biostatistics and Epidemiology, is designed to provide students with:

- The biological background needed to understand and interpret data
- A bioinformatics background providing familiarity with essential tools and data resources
- Computational skills used to analyze and manage “Big Data”
- Statistical skills required to appropriately analyze large quantitative datasets
- Epidemiological skills necessary for the design, conduct, and analysis of experiments

The SM in Computational Biology and Quantitative Genetics is intended as a terminal professional degree which will enable you to launch your career in bioinformatics. It can also provide the foundation for further doctoral studies in biostatistics, epidemiology, computational biology, and other related fields.

Students will receive training in quantitative methods, including linear and logistic regression, survival analysis, longitudinal data analysis, statistical computing, clinical trials, statistical consultation and collaboration, and epidemiology. Students will also gain a strong foundation in modern molecular biology and genetics, computer programming, the use and application of tools for analysis of genomic data, methods for integrative analysis, and meta-analysis of genes and gene function.

2.1 Core Competencies

This Master of Science program is designed to provide students with the essential skills and competencies they will need to be key contributors in research projects involving the large, complex genomic datasets that are becoming increasingly common in all areas of biomedical, biological, and public health research.

2.2 Admissions Procedures and Requirements

2.2.1 Harvard T.H. Chan School of Public Health Requirements

Application for admission to the SM program is available online on the Admissions Office website (http://www.hsph.harvard.edu/admissions/admissions/how-to-apply/application-requirements/). For information on general requirements for admission, contact the Admissions Office by phone (617/432-1031) or through their website (http://www.hsph.harvard.edu/admissions/).

2.2.2 Program Requirements

All candidates for admission to the SM in Computational Biology and Quantitative Genetics program should have successfully completed the following:

- An undergraduate degree in mathematical sciences or allied fields (e.g., biology, psychology, economics),
- Calculus through partial differentiation and multivariable integration,
- One semester of linear algebra or matrix methods,
- Either a two-semester sequence in probability and statistics or a two-semester sequence in applied statistics,
- At least one semester of training in biology, with some familiarity with molecular biology and genetics.
In addition, applicants are encouraged to have completed other courses in quantitative areas and in areas of application in the biological sciences. Practical knowledge of computer scripting and programming as well as experience with a statistical computing package such as R is highly desirable. Additional research or work experience is beneficial, but not required. Applicants should show excellence in written and spoken English.

Evidence that these requirements have been fulfilled should form part of the application.

2.3 Advising and Degree Program Approval

2.3.1 Academic Advisor

All entering students are assigned an academic advisor to help plan course loads and explain program requirements. At the earliest possible date, the student and the academic advisor will develop a program of study. Should a student wish to change his/her academic advisor, he or she is encouraged to discuss this with the Program Director. In addition, SPH provides services for all students with clinically documented learning and/or physical disabilities.

2.3.2 Departmental Approval of Program

The Master’s Degree program plan must be submitted to the student’s academic advisor and the Program Director for approval, using the Master’s Degree Program form provided. This plan should be submitted at least one semester prior to your expected graduation date.

2.3.3 Epidemiology Requirement

The School of Public Health requires that Master’s students must successfully pass one epidemiology course. The program requires that EPI 201 be taken to satisfy this requirement.

2.3.4 Research Ethics Requirement

Students must satisfy a research ethics requirement by completing a course in responsible conduct of research or by completing an online training course during the first year in the program. Students who feel they have already completed an equivalent training program must submit adequate documentation to, and receive approval from, the Program Director during the first semester in residence.

2.4 Satisfactory Progress Requirements

For students in the program, a minimum of 55 ordinal credits is required. In addition, SPH students must remain in good academic standing, must complete program requirements within the designated time to degree, and must maintain a cumulative average of 2.70 or above. All ordinal grades for courses used to satisfy program requirements specified in Section 2.5.1 must be at the level of B- or higher. Courses taken on a pass/fail basis cannot be used to satisfy ordinally graded program requirements.

A detailed presentation of SPH’s regulations for Master’s students is found at http://www.hsph.harvard.edu/student-handbook/. All Master’s students and their advisors should make sure that SPH and CBQG program requirements are met according to schedule.

2.5 Degree Requirements

A minimum of 55 credits of coursework is required for the SM in Computational Biology and Quantitative Genetics. Students with prior equivalent background to any of the required courses or strong reasons to take a different course can request permission from the Program Director for a substitution of one or more of the required courses. Students should submit a degree program form to the Program Director least one semester prior to your expected graduation date.
2.5.1 Course Requirements for the SM2 Degree

Fifty-five credits of ordinally graded courses must be taken for the two-year degree. This includes a 17.5 credit ordinally graded core curriculum consisting of:

- BIO 211 Regression and Analysis of Variance in Experimental Research (5 credits)
- BIO 222 Basics of Statistical Inference (5 credits)
- BIO 292 Introductory Genomics & Bioinformatics for Health Research (2.5 credits)
- EPI 201 Introduction to Epidemiology Methods I (2.5 credits)
- EPI 249 Molecular Biology for Epidemiologists (2.5 credits)

An additional ten credits comprised of all courses in either one of the two following tracks:

**Statistical Genetics Track**

- BIO 227 Introduction to Statistical Genetics (2.5 credits)
- EPI 293 Analysis of Genetic Association Studies (2.5 credits)
- EPI 507 Genetic Epidemiology (2.5 credits)
- EPI 511 Advanced Population and Medical Genetics (2.5 credits)

**Computational Biology Track**

- BIO 508 Genomic Data Manipulation (5 credits)
- BIO 512 Introduction to Computational Biology and Bioinformatics (5 credits)

A minimum of 17.5 additional credits will come from the alternative track or the following list of elective courses:

- BIO 210 The Analysis of Rates and Proportions (5 credits)
- BIO 212 Survey Research Methods in Community Health (2.5 credits)
- BIO 214 Principles of Clinical Trials (2.5 credits)
- BIO 223 Applied Survival Analysis (5 credits)
- BIO 226 Applied Longitudinal Analysis (5 credits)
- BIO 230 Probability Theory and Applications I (5 credits)
- BIO 231 Statistical Inference I (5 credits)
- BIO 232 Methods I (5 credits)
- BIO 233 Methods II (5 credits)
- BIO 257 Advanced Statistical Genetics (2.5 credits)
- BIO 287 Public Health Surveillance (2.5 credits)
- BIO 510 Programming I (2.5 credits)
- BIO 513 Advanced Computational Biology and Bioinformatics (5 credits)
- BIO 514 Introduction to Data Structures and Algorithms (5 credits)
- BIO 515 Measurement Error and Misclassification (2.5 credits)
- BIO 516 Inferential Methods in Infectious Diseases (2.5 credits)
- BIO 519 Mathematical Modeling of Cancer (2.5 credits)
- BIO 521 Introduction to Social and Biological Networks (2.5 credits)
- BIO 523 Statistical & Quantitative Methods for Pharmaceutical Regulatory Services (2.5 credits)
- EPI 202 Elements of Epidemiologic Research: Methods 2 (2.5 credits)
- EPI 203 Study Design in Epidemiologic Research (2.5 credits)
- EPI 204 Analysis of Case-Control and Cohort Studies (2.5 credits)
- EPI 221 Pharmacoepidemiology (2.5 credits)
- EPI 222 Genetic Epidemiology of Diabetes (5 credits)
- EPI 271 Propensity Score Analysis (1.25 credits)
- EPI 288 Data Mining and Prediction (2.5 credits)
- EPI 289 Causal Inference (2.5 credits)
2.5.2 Collaborative Research Thesis

The Collaborative Research Thesis provides students with valuable real-world experience doing research in Boston’s premier biomedical institutions. Students are mentored by a member of the program faculty or other affiliated quantitative scientist working in clinical and epidemiologic research projects at SPH, Harvard University, or a Harvard-affiliated hospital. In many cases, students may instead choose to undertake their thesis work in an industry setting; our faculty have many ties to the biotech world and can help arrange appropriate research projects. A link to a list of possible thesis advisors is provided here, although this list should not prevent you from exploring other potential advisors. Students may also ask their academic advisor or the Program Director about possibilities for thesis research.

A student must complete a 10-20 credit ordinarily graded CBQG Collaborative Research Thesis (CBQG 325), normally undertaken during the fourth semester, after the required core course work has been completed. This will typically involve data analysis for a research project under the direction of one or more mentors. Students should notify the Manager of Academic Services in Biostatistics about their thesis advisor choice by the end of their first academic year. Students with a more extensive background may be permitted to undertake their thesis research during the summer following their second semester, and complete the entire program in as little as 16 months. Once a thesis advisor is chosen, and a research project has been decided, the student should submit a Thesis Proposal for approval to the Program Director.

In this Collaborative Research Thesis, a student will perform activities related to the design, conduct, and analysis of research studies with a focus on data analysis and scientific presentation. The student will carry out an extensive data analysis with the goal of addressing a relevant question requiring the use of methods in computational biology or quantitative genetics. Usually these projects will involve interacting with a group of people with varied disciplinary backgrounds. The student will then write a Master’s thesis of approximately 20-25 double-spaced pages excluding tables, figures, and references that describes the medical or public health problem of interest, describes the analytical methods used and their appropriateness, summarizes the data analyses, and provides a scientific interpretation of the data, in a standard scientific writing style. The student will also orally present this work in a seminar of approximately 30 minutes in length. The Master’s thesis and oral presentation will primarily be the work of the student, with only advisory input from the mentor(s). The Master’s thesis and oral presentation will be evaluated by a review committee consisting of three members. The members will include the student’s Practicum mentor(s), the Program Director, and other Biostatistics faculty members or surrogates as needed (potentially including the student’s academic advisor). The student will submit a Thesis Committee Nomination form before scheduling the thesis defense. The thesis defense should be scheduled by completing a scheduling form and submitting it to the Manager of Academic Services in Biostatistics at least three weeks in advance of the defense date. The Master’s thesis must be submitted to the review committee at least two weeks prior to the oral presentation. A written evaluation will be provided to the student after the thesis defense, and the submission of the Thesis Final Report to the Program Director.
3 PROGRAM FORMS

- CBQG SM2 Degree Program Form
  http://www.hsph.harvard.edu/biostats/publications/cbqg_handbook/SM2_Degree_Form_CBQG.pdf

- Thesis Proposal

- Thesis Final Report

- Thesis Committee Nomination Form

- Thesis Defense Scheduling Form