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1 INTRODUCTION

This handbook describes the academic programs offered by the Department of Biostatistics at Harvard University. The Department offers courses of study leading to the Doctor of Philosophy and Master of Science degrees. Both the Ph.D. and SM programs provide rigorous training in theory and practical experience in statistical and bioinformatics methods used in the biomedical sciences. The Department’s programs are designed to prepare students for careers in the theory and practice of biostatistics and bioinformatics, especially as applied to the biomedical and health sciences. The programs include training in the application and development of methodology, consulting, teaching, and collaboration on a broad spectrum of health-related problems. All students work with faculty on ongoing projects in methodological research and scientific collaboration. About sixty faculty participate in these programs.

The sections of this handbook include information and Departmental regulations concerning entrance requirements, program descriptions, degree requirements, and other Departmental policies. The Ph.D. Program is overseen by the Graduate School of Arts and Sciences, whereas the SM degree is governed by the School of Public Health. Policies and official requirements of the Graduate School of Arts and Sciences are set forth in the Graduate School of Arts and Sciences Handbook (http://www.gsas.harvard.edu/gsas_handbook.php). Policies and official requirements of the School of Public Health are set forth in the Harvard School of Public Health Catalog (http://www.hsph.harvard.edu/academics/catalog/) and the Harvard School of Public Health Student Handbook (http://www.hsph.harvard.edu/academics/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 departmental information is available at http://www.hsph.harvard.edu/departments/biostatistics/.

This handbook was prepared by the Director of Graduate Studies and approved by the Faculty of the Department of Biostatistics. The Director of Graduate Studies 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 Department. The recommendations of the Director of Graduate Studies are forwarded to the Department Chair for final approval. Any suggestions or comments should be addressed to the Director of Graduate Studies.
THE DOCTOR OF PHILOSOPHY PROGRAM

The Ph.D. program in Biostatistics trains students in the areas of probabilistic and statistical theory, biostatistical and bioinformatics methods, statistical computation and algorithm development, the ability to collaborate and communicate effectively with scientists in related disciplines, and the ability to teach biostatistics and bioinformatics effectively to general or specialized audiences. The Ph.D. program includes training in the development of methodology, consulting, teaching, and collaboration on a broad spectrum of health-related problems.

All Ph.D. students work with faculty on ongoing projects in methodological research and scientific collaboration. Faculty and students conduct methodologic research in Bayesian inference, bioinformatics, causal inference, clinical trials, computational biology, data analysis, decision sciences, experimental design, health policy, multivariate and longitudinal studies, quantitative genomics, sequential methods, spatial statistics, statistical computing, statistical genetics, stochastic processes, and survival analysis, among other areas. Areas of application include biology, cancer, clinical research, computational biology, the environment, epidemiology, genetics, health disparities, HIV/AIDS, infectious diseases, neurology, and psychiatry, among other areas. Collaborative activities include coordination of national and international clinical trials, participation in studies of potential environmental hazards, collaboration on novel genetic and genomic studies, design of health surveys, evaluation of health interventions and medical technologies, and consultation with federal, state, and local agencies.

The Department of Biostatistics offers the Ph.D. in Biostatistics with two areas of interest: Biostatistics and Bioinformatics. Students select the area of interest most appropriate to their background and interests, and satisfy the degree program requirements listed below for their area of interest. Some Ph.D. requirements are common to both areas of interest, while others are specific to the area of interest selected.

The Ph.D. program in Biostatistics prepares students in the following five specific competencies:

1. Applying innovative probabilistic and statistical theory and computing methods to the development of new biostatistical or bioinformatics methodology, publishing of original methodological research, and the solution of public health problems.

2. Providing scientific and biostatistical or bioinformatics leadership in the design, conduct, and analysis of collaborative research studies in medicine and public health.

3. Applying modern statistical and computational methods to effectively analyze complex medical and public health data, including the development of new software for non-standard problems and simulation methods.

4. Collaborating and communicating effectively with research scientists in related disciplines.

5. Teaching biostatistics or bioinformatics effectively to health professionals, research scientists, and graduate students.

2.1 Admissions Procedures and Requirements

2.1.1 Graduate School of Arts and Sciences Requirements

For information on general requirements for admission, see the Graduate School of Arts and Sciences website (http://www.gsas.harvard.edu/prospective_students/admissions_overview.php) or contact the Admissions Office by phone (617/496-6100).

2.1.2 Departmental Requirements

All candidates for admission to the Ph.D. program should have successfully completed calculus through multivariable integration and one semester of linear algebra. Knowledge of a programming language is
also required. Evidence that these requirements have been fulfilled should form part of the application. In addition, all applicants are strongly encouraged to have completed two semesters of calculus-based probability and statistics, two semesters of advanced calculus or real analysis, and a course in numerical analysis. Students with interests in bioinformatics are also encouraged to have completed courses in biology, computational biology, and genetics. Practical knowledge of a statistical computing package such as SAS, Splus, R, Stata, or SPSS is also desirable. Students with interests in bioinformatics should also have knowledge of a scripting language such as Python or Perl and some familiarity with relational databases. From time to time the Department will admit students to the doctoral program without this level of preparation with the understanding that the student will promptly make up any deficiencies, usually by taking additional courses prior to entering the program. In addition, the Department Summer Program, which is held in August, is designed to review basic concepts of probability, statistics, advanced mathematics, and statistical computing prior to the first semester in the Ph.D. program.

2.2 Advising and Degree Program Approval

2.2.1 Academic Advisor

The Department has a Student Advising Committee which provides guidance and assistance to students. In addition, all entering students are assigned an academic advisor to help plan course loads and explain Departmental 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 Director of Graduate Studies. In addition, the Department and GSAS/HSPH provide services for all students with clinically documented learning and/or physical disabilities.

2.2.2 Dissertation Advisor

After the written qualifying examination has been successfully completed, and usually in the fourth semester of study, the doctoral candidate will identify an area of research and a prospective dissertation advisor from the Department. The dissertation advisor assumes the responsibilities of the academic advisor and directs the student’s doctoral research.

2.2.3 Dissertation Committee

After a student has passed the oral qualifying examination, the student, in consultation with the dissertation advisor, nominates a Dissertation Committee to oversee the student’s progress. The Dissertation Committee ordinarily consists of the dissertation advisor, who serves as the chairperson, and two other faculty members. At least two of the Dissertation Committee members must be either members of the Faculty of Arts and Sciences, or of the Department of Biostatistics. The chair should be a member of the Department of Biostatistics. In some cases, a student could have two co-chairs of the Dissertation Committee. The student is responsible for arranging periodic meetings with the Dissertation Committee, and for submitting Dissertation Progress Report forms as required.

2.2.4 Departmental Approval of Program

The final doctoral program plan must be submitted to the Department for approval, on the doctoral Degree Program form provided by the Department. This program must be approved by the student’s faculty advisor and the Director of Graduate Studies. This plan should be submitted by May 15 of the second year.

2.3 Degree Requirements

The Ph.D. Program in Biostatistics trains students in probabilistic and statistical theory; the use of biostatistical and bioinformatics methods in formulating problems, planning studies, conducting analyses, and writing reports; conducting independent methodologic research; providing scientific leadership in collaboration with scientists in related disciplines; and the ability to teach and consult effectively through oral and written communications.
Ph.D. students are expected to take progressively more advanced courses, to prepare for the qualifying exams, and to choose a dissertation advisor and research topic. The student is also expected to participate in the Working Group seminars offered by the Department. These seminars provide background for choosing a dissertation topic, as well as general knowledge of contemporary biostatistical and bioinformatics research.

A detailed presentation of the GSAS’s regulations for doctoral students is found at http://www.gsas.harvard.edu. All doctoral students and their advisors should make sure that GSAS and Departmental requirements are met according to schedule.

Full-time students must register for the equivalent of at least 4 half-courses (20 credits), or the equivalent in TIME, each semester.

2.3.1 Residency

The Graduate School of Arts and Sciences requires that each student have a minimum of two years of full-time study in residence.

2.3.2 Course Requirements

The requirements listed below are minimal requirements for the Ph.D. program in Biostatistics. Each student should, in consultation with his/her advisor, select an area of interest and develop a program of study to best meet his/her individual needs and goals. Each student’s program is reviewed individually, and the final doctoral program must be approved by the Director of Graduate Studies.

The Ph.D. Program in Biostatistics builds on an ordinarily graded core curriculum consisting of:

- BIST 230 Probability Theory and Applications I
- BIST 231 Statistical Inference I
- BIST 232 Methods I
- BIST 233 Methods II

In addition, 35 credits of ordinarily graded Biostatistics courses (http://www.hsph.harvard.edu/biostats/courses/course.html) must be taken from the advanced doctoral core. Students with an area of interest in Biostatistics must select a minimum of 20 of these 35 credits from among BIST 235, 244, 245, 249, 250, and 251. Students with an area of interest in Bioinformatics must select a minimum of 20 of these 35 credits from among BIST 235, 245, 249, 250, 251, 298 (required), 299, BIO 520, and EPI 511.

The advanced doctoral core includes:

- BIST 235 Regression and Analysis of Variance
- BIST 238 Advanced Topics in Clinical Trials
- BIST 244 Analysis of Failure Time Data
- BIST 245 Analysis of Multivariate and Longitudinal Data or STAT 230 Multivariate Statistical Analysis
- BIST 249 Bayesian Methods in Biostatistics or STAT 220 Bayesian Data Analysis
- BIST 250 Probability Theory and Applications II
- BIST 251 Statistical Inference II
- BIO 276 Sequential Analysis
- BIST 298 Introduction to Computational Biology and Bioinformatics
- BIST 299 Advanced Computational Biology and Bioinformatics
- BIO 514 Introduction to Data Structures and Algorithms
- BIO 515 Measurement Error and Misclassification
Other advanced courses in Biostatistics, including many of the special topics courses, and courses at MIT and the Faculty of Arts and Sciences (FAS) that are offered at an advanced level, may also be acceptable. Students are advised to consult with the Director of Graduate Studies to check prior to enrolling in the courses in question. Students are also strongly encouraged to take BIO 509 and BIO 510 to strengthen their statistical computing skills.

All advanced doctoral core courses contributing to the final program should be completed with a grade of B or better.

In addition, the Department requires that students take either EPI 201 or 500 (201 preferred). A student may choose to take EPI 202 and include this course as part of his/her cognate field, if appropriate. Also, incoming Ph.D. students must participate in the “Practicing Public Health” session administered by the HSPH Office for Educational Programs.

2.3.3 Cognate Requirement

The Department requires students to explore in some depth a selected cognate field, a non-quantitative field outside of biostatistics or statistics. Examples of cognate fields include the biology of AIDS or cancer; biophysics; environmental health; epidemiology (e.g., chronic disease epidemiology, environmental and occupational epidemiology, infectious disease epidemiology, molecular epidemiology, psychiatric epidemiology, psychosocial epidemiology); genetics; health policy and management; human development; molecular biology; society and health; or other non-quantitative fields. The cognate field should be complementary to the student’s area of interest in biostatistics or bioinformatics. The courses used to satisfy the cognate requirement should form a coherent set of courses related to the cognate field selected, and should primarily be substantive, rather than quantitative, in nature.

Students must complete 10 credits of ordinarily graded courses in the cognate field. Provided that the inclusion of such courses contributes to the selection of a coherent cognate field, a maximum of 5 credits among BIO 214, BIO 227, BIO 287, BIO 516, RDS 280, RDS 282, EPI 202, EPI 203, EPI 204, EPI 207, EPI 288, EPI 289, or other semi-quantitative courses in epidemiology or other fields will be allowed to count towards the fulfillment of this requirement. Students are advised to consult with the Director of Graduate Studies to check whether certain combinations of courses are appropriate for cognate consideration prior to enrolling in the courses in question.

All cognate field courses contributing to the final program should be completed with a grade of B or better. The selection of courses for the cognate field must be approved by the Director of Graduate Studies.

2.3.4 Consulting Requirement

Students must acquire experience in the planning of experiments and establishing a collaborative interaction with an investigator. To meet this requirement students must take the consulting seminar (BIO 312). A project outside the consulting seminar may be substituted only if approval is obtained from the Director of Graduate Studies.

2.3.5 Teaching Requirement

Students must acquire extensive experience in teaching biostatistics or bioinformatics. To meet this requirement, students ordinarily serve as a teaching assistant (TA) for an average of one 5-credit course in the Department per year in the program.
2.3.6 Research Ethics Requirement

Students must satisfy a research ethics requirement by completing a course in responsible conduct of research (currently HPM 548) during the first year in the program.

2.3.7 TIME and Research Credits

In addition to regular coursework, Ph.D. students may register for TIME as a means of indicating that appropriate independent work is replacing numbered courses. TIME is undertaken with a faculty advisor who must sign the study card. One unit of TIME is the equivalent of one half-course (or 5 HSPH credits). Units of TIME are ungraded. TIME-C is used for course-related work; TIME-R for research-related work; and TIME-T, for teaching-related work. Students may register for TIME-C when independent work is being undertaken that is not specifically indicated in a numbered course. TIME-R may be used to indicate that research work is being undertaken that is not directly related to the student’s dissertation work, or that a student has received a research assistant appointment. TIME-T may be used to indicate that a student has received a teaching assistant appointment.

BIST 350 should be used by Ph.D. candidates who have passed their written qualifying examination and who are working on their dissertation research. Students may register for a maximum of 4 units of BIST 350 per semester, as needed, to maintain full-time status.

2.3.8 Transfer of Coursework

The Department of Biostatistics does not allow courses taken elsewhere to count towards the residency requirement. However, students may occasionally be permitted to use graduate level courses in Biostatistics or related areas taken at other universities to satisfy some Departmental requirements for the Ph.D. degree (e.g., core courses, epidemiology requirement, cognate requirement, consulting requirement). Generally, when core courses are waived, it is not necessary to make up the credit in other biostatistics courses.

To request a waiver of Departmental requirements on the basis of prior coursework, the student must petition the Director of Graduate Studies for approval. The petition should contain a course description and syllabus. An official transcript indicating the grade received must be on file, or submitted with the petition. Each request is considered on an individual basis. All waivers of departmental requirements must be approved by the Director of Graduate Studies.

2.3.9 Examination Requirements

Students must take and pass two qualifying examinations: a written examination and an oral examination.

The Written Examination The written examination is given annually following the fall semester. Students will take the exam for the first time during or before their second year in the doctoral program. Students may be allowed to retake the examination at most once, with Departmental approval.

The exam consists of two parts which are administered in two sessions on different days. Material relevant to the exam is covered in the doctoral core courses of the Biostatistics program (see Section 2.3.2). The exam tests the student’s understanding of probability, statistical inference, and statistical methods. Copies of past examinations are available on request from the Manager of Academic Services.

The written qualifying examination is evaluated by the faculty, who establish the passing score. Students whose scores fall below the passing score are further evaluated based on their performance in coursework, summer projects, and performance as research/teaching assistants. On the basis of this further evaluation, a student whose qualifying exam score is below the passing score may nonetheless be determined to pass the qualifying exam.

The Oral Examination The oral examination assesses the student’s potential to perform research in a chosen field, and examines the student’s knowledge of biostatistics or bioinformatics and his/her cognate field of study. Successful completion of the written examination is a prerequisite for taking the oral examina-
The oral examination should be scheduled within three semesters of passing the written examination or within seven semesters, whichever comes first. In preparation for the oral examination, the student must decide on a specialized topic on which he/she wishes to be examined. In most cases, this specialized topic will be related to the student’s chosen dissertation research area. The student will prepare a written report summarizing the topic and reviewing the relevant literature. This written report must be given to the Oral Examination Committee at least three weeks prior to the examination. The Oral Examination Committee consists of three faculty members, at least one from Biostatistics. At the examination, students will be required to make a short presentation of the chosen topic, and will be examined on the topic by the Committee.

2.3.10 Doctoral Dissertation

The dissertation should be an original contribution to scientific knowledge. It can contribute to a subject matter field through innovative application of existing methodology, can make an original methodologic contribution, or be a combination of the two. Most dissertations consist of material sufficient for three publications. The dissertation topic should be complementary to the student’s area of interest in biostatistics or bioinformatics.

Acceptance of the dissertation is the responsibility of the student’s Dissertation Committee, the Department, and GSAS. When the dissertation is complete, the student defends it to the Dissertation Committee at a public presentation. The defense must be openly publicized and scheduled at least three weeks in advance. Copies of the dissertation should be given to the members of the Dissertation Committee and the Department Chair at least two weeks before the defense.

2.4 Satisfactory Progress Requirements

A doctoral student’s academic standing will be assessed by the Department on a regular basis to ensure that he/she is progressing at an appropriate rate. The Department adheres to the general satisfactory progress requirements as established by the Graduate School of Arts and Sciences and described in Section VI of the GSAS Handbook. Our Department will use the following additional criteria in establishing satisfactory progress.

1. Students in the first year of the Biostatistics doctoral program are expected to complete four core courses (BIST 230, BIST 231, BIST 232, and BIST 233) with a minimum average of B+ and no grade below B.

2. No more than one grade below B in any academic year; satisfactory performance on summer projects and as teaching assistants, research assistants, and/or computing assistants; maintain full time status of 4 half-courses (20 credits) minimum per semester.

3. Students will complete their written qualifying examination by the beginning of the fourth semester. The written exam must be passed by the beginning of the sixth semester.

4. Students will complete their oral qualifying examination within three semesters of passing the written qualifying examination or within seven semesters, whichever comes first, and nominate their Dissertation Committee within one month of passing the oral qualifying exam.

5. Ordinarily, students will complete all course, cognate, and consulting requirements by the end of the sixth semester.


Ordinarily, a student will complete their degree within 3 to 5 years after entering the program.
2.5 Master of Arts

No one is admitted as a candidate for the Master of Arts (AM), only for the Ph.D. Nevertheless, the requirements for the Master’s degree must be satisfied by all students as they move toward the Ph.D. and are expected to be completed by the end of the fourth semester. The AM degree may be granted when these requirements are fulfilled. In addition, the Department may confer a terminal AM degree on students who will not be completing the requirements for the Ph.D. Effectively, a Ph.D. student must complete the specific requirements for the Master of Science degree (described in Section 3.4) in order to satisfy the AM requirements. The Department views one unit of TIME (TIME-C, TIME-R, or TIME-T) as the equivalent of one half-course (or 5 pass/fail HSPH credits). At least 60 ordinal credits are required for the AM degree, which ordinarily includes at least 50 credits of ordinally graded courses from the Master’s core, the doctoral core, or the advanced doctoral core. Upon fulfilling these requirements, students should submit an application for the AM degree to GSAS.

2.6 Joint SD Program

In certain cases, the Department may entertain applications for a joint SD program in Biostatistics from students already enrolled in another HSPH SD program. The student would be required to fulfill the Ph.D. requirements described above, but would follow HSPH doctoral student guidelines. Further information is available from the Director of Graduate Studies.
3 THE MASTER OF SCIENCE PROGRAMS

The Master of Science programs in Biostatistics train students in the basics of statistical theory, biostatistical and bioinformatics methods in planning studies, conducting analyses, and writing reports, the interpretation of numeric data for scientific inference in studies in medicine and public health, and the ability to collaborate and communicate effectively with scientists in related disciplines. Application areas include observational studies, clinical trials, computational biology and quantitative genomics, statistical genetics, and medical and public health research, among other areas.

The Department of Biostatistics offers several Master of Science programs, with the appropriate program dependent on the student’s background and interests. The two-year Master of Science (SM2) degree provides training in statistical theory and a variety of statistical, computational, and bioinformatics methods for application in medicine and public health. Two areas of interest are offered: Biostatistics and Bioinformatics. The SM2 program is appropriate for students considering doctoral level work or Master’s level medical research positions upon completion. The one-year Master of Science (SM1) degree is designed for students with a mathematical and statistical background sufficient to achieve a level of proficiency after one year of study comparable to that obtained in the SM2 program. The 60-credit Master of Science (SM60) degree has an applied emphasis and is designed for students seeking medical research positions in biostatistics upon completion.

All Master of Science programs in Biostatistics prepare students in four specific competencies:

1. Designing research studies in medicine and public health, including study design and population selection, sample size justification, data analysis plans, methods of data acquisition and organization, data management methods, data analysis plans, and protocol development.

2. Analyzing and interpreting quantitative data for scientific inference, including graphical and tabular displays, descriptive statistics, statistical inference, and choice of appropriate statistical software for the data analysis.

3. Using modern computational methods to effectively analyze complex medical and public health data, including regression methods, survival data analysis, bioinformatics, and statistical genetics.

4. Collaborating and communicating effectively with research scientists in related disciplines.

The SM1 and SM2 programs in Biostatistics have a fifth specific competency:

5. Using probabilistic and statistical reasoning and theory to effectively analyze non-standard problems arising in medicine and public health and assisting biostatistical researchers in the conduct of methodologic research.

The SM60 program in Biostatistics also has a fifth specific competency:

5. Disseminating new knowledge in a research discipline through the preparation of written reports of biostatistical analyses, comparison of different statistical methodologies, and oral presentation of results.

Specific program requirements are described below. Some requirements are common to all Master of Science programs, while others are specific to the degree program or area of interest.
3.1 Admissions Procedures and Requirements

3.1.1 Harvard 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/administrative-offices/admissions/application-requirements/). For information on general requirements for admission, see the Harvard School of Public Health Catalog (http://www.hsph.harvard.edu/register/) or contact the Admissions Office by phone (617/432-1031) or through their website (http://www.hsph.harvard.edu/administrative-offices/admissions/).

3.1.2 Departmental Requirements
All candidates for admission to the SM programs should have successfully completed calculus through multivariable integration and one semester of linear algebra. Knowledge of a programming language is also required. Evidence that these requirements have been fulfilled should form part of the application. In addition, applicants are encouraged to have completed courses in probability, statistics, advanced calculus, and numerical analysis. Students with interests in bioinformatics are also encouraged to have completed courses in biology, computational biology, and genetics. Practical knowledge of a statistical computing package such as SAS, Splus, R, Stata, or SPSS is also desirable. Students with interests in bioinformatics should also have knowledge of a scripting language such as Python or Perl and some familiarity with relational databases. From time to time the Department will admit students to the SM program without this level of preparation with the understanding that the student will promptly make up any deficiencies, usually by taking additional courses prior to entering the program.

Students who have a Master’s degree in one of the mathematical sciences or a doctorate in a quantitative field may be qualified for a one-year SM program. To be admitted, applicants must have a mathematical and statistical background sufficient to achieve a level of proficiency after one year of study comparable to that achieved by the two-year program.

3.2 Advising and Degree Program Approval

3.2.1 Academic Advisor
The Department has a Student Advising Committee which provides guidance and assistance to students. In addition, all entering students are assigned an academic advisor to help plan course loads and explain Departmental 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 Director of Graduate Studies. In addition, the Department and HSPH provide services for all students with clinically documented learning and/or physical disabilities.

3.2.2 Departmental Approval of Program
The Master’s program plan must be submitted to the Department for approval, using the Master’s Degree Program form provided by the Department. The program must be approved by the student’s faculty advisor and the Director of Graduate Studies. This plan should be submitted at least one semester prior to the expected graduation date for Master’s students.

3.2.3 Epidemiology Requirement
The School of Public Health requires that Master’s students must successfully pass one Epidemiology course. The Department requires that either EPI 201 or EPI 500 be taken to satisfy this requirement.

3.2.4 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 Director of Graduate Studies during the first semester in residence.

3.3 Satisfactory Progress Requirements

For students in the SM2 program, a minimum of 60 ordinal credits is required. For students in the SM60 program, a minimum of 45 ordinal credits is required. For students in the SM1 program, a minimum of 30 ordinal credits is required. In addition, HSPH 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 Departmental requirements specified in Sections 3.4.1, 3.4.2, 3.5.1, 3.6.1 (depending on your program) must be at the level of B- or higher. Courses taken on a pass/fail basis cannot be used to satisfy ordinally graded Departmental requirements.

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

3.4 Degree Requirements for the Two-Year SM (SM2) in Biostatistics

A total of 80 credits are required for the SM2 program. The SM2 program is aimed at students who are considering doctoral level work in biostatistics, statistics, bioinformatics, or allied fields such as epidemiology, environmental health, or medicine. The SM2 program is also appropriate for students seeking to take more varied and advanced courses but who are considering Master’s level medical research positions upon completion. Two areas of interest are offered: Biostatistics and Bioinformatics. SM2 students will satisfy the course requirements for their selected area of interest.

3.4.1 Course Requirements for the SM2 with Area of Interest in Biostatistics

Students selecting Biostatistics as their area of interest can develop a flexible program in statistical methods, statistical theory, statistical computing, bioinformatics, and health decision sciences, depending on the student’s background and interests. Fifty credits of ordinally graded courses must be taken from the two-year Biostatistics Master’s core, including:

- BIO 210 The Analysis of Rates and Proportions
- BIO 211 Regression and Analysis of Variance in Experimental Research
- BIO 212 Survey Research Methods in Community Health
- BIO 214 Principles of Clinical Trials
- BIO 222 Basics of Statistical Inference
- BIO 223 Applied Survival Analysis and Discrete Data Analysis
- BIO 226 Applied Longitudinal Analysis
- BIO 227 Fundamental Concepts in Gene Mapping
- BIO 230 Probability Theory and Applications I
- BIO 251 Statistical Inference I
- BIO 232 Methods I
- BIO 233 Methods II
- BIO 235 Regression and Analysis of Variance
- BIO 238 Advanced Topics in Clinical Trials
- BIO 249 Bayesian Methods in Biostatistics or STAT 220 Bayesian Data Analysis
- BIO 287 Public Health Surveillance
BIO 507 Introduction to Quantitative Methods for Monitoring and Evaluation
BIO 508 Genomic Data Manipulation
BIO 509 Introduction to Statistical Computing Environments
BIO 510 Programming I
BIO 512 Introduction to Computational Biology and Bioinformatics
BIO 513 Advanced Computational Biology and Bioinformatics
BIO 514 Introduction to Data Structures and Algorithms
BIO 515 Measurement Error and Misclassification
BIO 516 Inferential Methods in Infectious Diseases
BIO 519 Mathematical Modeling of Cancer
BIO 520 Concepts of Modern Statistical Genetics
EPI 511 Advanced Population and Medical Genetics
GHP 261 Models of Complex Systems
ID 271 Advanced Regression: Environmental Epidemiology
ID 542 Methods for Mediation and Interaction
RDS 280 Decision Analysis: Environmental Epidemiology
RDS 282 Economic Evaluation of Health Policy and Program Management
RDS 284 Decision Theory
RDS 285 Decision Analysis Methods
RDS 500 Risk Assessment

Students can then choose electives depending on their background and interests. Students are strongly encouraged to take appropriate training in areas of application such as the biological sciences, biophysics, cancer, computational biology, environmental health, epidemiology, health policy, infectious diseases, international health, nutrition, psychiatry, social health, or other allied fields to prepare them for interdisciplinary collaborative research.

Other advanced courses in Biostatistics, including many of the special topics or Wintersession courses, and courses at MIT and the Faculty of Arts and Sciences (FAS) that are offered at an advanced level, may also be acceptable. Students are advised to consult with the Director of Graduate Studies to check prior to enrolling in the courses in question.

3.4.2 Course Requirements for the SM2 with Area of Interest in Bioinformatics

Students selecting Bioinformatics as their area of interest follow a structured program of required courses, and then choose electives depending on the student’s background and interests. Specific requirements of this program include the following 55 credits of required ordinally graded courses:

BIO 210 The Analysis of Rates and Proportions
BIO 211 Regression and Analysis of Variance in Experimental Research
BIO 222 Basics of Statistical Inference
BIO 223 Applied Survival Analysis and Discrete Data Analysis
BIO 226 Applied Longitudinal Analysis
BIO 227 Fundamental Concepts in Gene Mapping
BIO 316 Quantitative Genomics Lab Rotation (pass grade allowable)
BIO 508 Genomic Data Manipulation
BIO 510 Programming I
BIO 512 Introduction to Computational Biology and Bioinformatics
BIO 513 Advanced Computational Biology and Bioinformatics
BIO 520 Concepts of Modern Statistical Genetics
EPI 249 Molecular Biology for Epidemiologists
EPI 511 Advanced Population and Medical Genetics
In addition, students select a minimum of 10 credits of ordinally graded courses from the two-year Bioinformatics Master’s core, including:

- BIO 230 Probability Theory and Applications I
- BIO 231 Statistical Inference I
- BIO 232 Methods I
- BIO 233 Methods II
- BIO 503 Introduction to Programming and Statistical Modeling in R
- BIO 509 Introduction to Statistical Computing Environments
- BIO 514 Introduction to Data Structures and Algorithms
- EPI 202 Elements of Epidemiologic Research
- EPI 203 Study Design in Epidemiological Research
- EPI 204 Analysis of Case-Control, Cohort, and Other Epidemiologic Data
- EPI 205 Practice of Epidemiology
- EPI 207 Advanced Epidemiologic Methods
- EPI 222 Genetic Epidemiology of Diabetes, Obesity, and Their Complications
- EPI 288 Data Mining and Prediction
- EPI 289 Models for Causal Inference
- EPI 293 Analysis of Genetic Association Studies
- BIOPHYS 101 Computational Biology
- BIOPHYS 170 Quantitative Genomics
- BIOPHYS 205 Computational and Functional Genomics
- BIOPHYS 376 Functional and Computational Genomics Studies of Transcription Factors and Cis Regulatory Elements

Other advanced courses in Biostatistics, including many of the special topics or Wintersession courses, and courses at MIT and the Faculty of Arts and Sciences (FAS) that are offered at an advanced level, may also be acceptable. Students are advised to consult with the Director of Graduate Studies to check prior to enrolling in the courses in question.

### 3.5 Degree Requirements for the 60-credit SM (SM60) in Biostatistics

The SM60 program has an applied emphasis and is geared toward students with an undergraduate degree in one of the mathematical sciences or an allied field (e.g., biology, psychology, or economics). At least 40 credits of course work are required, including 27.5 credits of required courses, a minimum of 5 credits of elective Biostatistics courses, and 2.5 credits each in courses in environmental health services and the social and behavioral sciences. The program culminates with a Master’s thesis and oral defense, summarizing work accomplished during a collaborative research practicum. The SM60 program is aimed at students seeking a terminal Master’s degree. Typically of 16 months duration (though dependent on how long the student takes to finish and defend their Master’s thesis), the focus of the SM60 program is on training graduates for applied biostatistics positions involving medical or epidemiologic research in teaching hospitals, universities, research organizations, and the pharmaceutical and biotechnology industries.

#### 3.5.1 Course Requirements for the SM60 in Biostatistics

A total of 60 credits are required for the SM60 degree. SM60 students follow a structured program of required courses, and then choose electives depending on the student’s background and interests. Specific requirements of this program include the following 27.5 credits of required ordinally graded courses:

- BIO 210 The Analysis of Rates and Proportions
- BIO 211 Regression and Analysis of Variance in Experimental Research
- BIO 222 Basics of Statistical Inference
BIO 223  Applied Survival Analysis and Discrete Data Analysis
BIO 226  Applied Longitudinal Analysis
RDS 280  Decision Analysis for Health and Medical Practices

In addition, students select a minimum of 5 credits of ordinally graded courses in Biostatistics to round out their program.

As the SM60 program is a professional Master’s degree program, students must also fulfill core requirements in various areas of public health. Core requirements in biostatistics, epidemiology, and health services administration are satisfied by the above degree requirements. In addition, students must select 2.5 credits of courses in environmental health sciences (from among EH 201, EH 202, EH 232, EH 278, or ID 215) and 2.5 credits of courses in social and behavioral sciences (from among SHDH 201, SHDH 207, SHDH 250, or SHDH 281).

### 3.5.2 Thesis Requirements for the SM60 in Biostatistics

An SM60 student must complete a 10-20 credit ordinally graded Master’s Thesis and Collaborative Research Practicum (BIO 325), usually taken after the required course work has been completed. This will typically involve data analysis for a research project under the direction of one or more mentors. The project could be supervised primarily by a faculty member in Biostatistics, or co-supervised by a doctoral-level investigator (at Harvard or elsewhere) and a faculty member in Biostatistics.

In this Collaborative Research Practicum, 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, including data summaries and graphical displays, regression methods, data interpretation, and comparison of alternative methods. 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, summarizes the appropriate 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 Director of Graduate Studies, and other Biostatistics faculty members or surrogates as needed. 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.

### 3.6 Degree Requirements for the One-Year SM (SM1) in Biostatistics

Students who have a Master’s degree in one of the mathematical sciences or a doctorate in a quantitative field may be qualified for the one-year Master’s program. To be admitted, applicants must have a mathematical and statistical background sufficient to achieve a level of proficiency after one year of study comparable to that achieved by the two-year program.

#### 3.6.1 Course Requirements for the SM1 in Biostatistics

A total of 42.5 credits are required for the one-year Master’s program. A minimum of 25 credits of ordinally graded courses must be taken from the one-year Biostatistics Master’s core, including:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
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<tbody>
<tr>
<td>BIO 214</td>
<td>Principles of Clinical Trials</td>
</tr>
<tr>
<td>BIO 222</td>
<td>Basics of Statistical Inference</td>
</tr>
<tr>
<td>BIO 223</td>
<td>Applied Survival Analysis and Discrete Data Analysis</td>
</tr>
<tr>
<td>BIO 226</td>
<td>Applied Longitudinal Analysis</td>
</tr>
</tbody>
</table>
BIO 227  Fundamental Concepts in Gene Mapping  
BIO 230  Probability Theory and Applications I  
BIO 231  Statistical Inference I  
BIO 232  Methods I  
BIO 233  Methods II  
BIO 235  Regression and Analysis of Variance  
BIO 238  Advanced Topics in Clinical Trials  
BIO 249  Bayesian Methods in Biostatistics or STAT 220  Bayesian Data Analysis  
BIO 287  Public Health Surveillance  
BIO 507  Introduction to Quantitative Methods for Monitoring and Evaluation  
BIO 508  Genomic Data Manipulation  
BIO 509  Introduction to Statistical Computing Environments  
BIO 510  Programming I  
BIO 512  Introduction to Computational Biology and Bioinformatics  
BIO 513  Advanced Computational Biology and Bioinformatics  
BIO 514  Introduction to Data Structures and Algorithms  
BIO 515  Measurement Error and Misclassification  
BIO 516  Inferential Methods in Infectious Diseases  
BIO 519  Mathematical Modeling of Cancer  
BIO 520  Concepts of Modern Statistical Genetics  
EPI 511  Advanced Population and Medical Genetics  
ID 542  Methods for Mediation and Interaction  
RDS 284  Decision Theory  
RDS 285  Decision Analysis Methods  

Other advanced courses in Biostatistics, including many of the special topics or Wintersession courses, and courses at MIT and the Faculty of Arts and Sciences (FAS) that are offered at an advanced level, may also be acceptable. Students are advised to consult with the Director of Graduate Studies to check prior to enrolling in the courses in question.

3.7  Biostatistics SM Program for Students in Another HSPH SD Program

In certain cases, the Department may entertain applications for an SM1 or SM2 program in Biostatistics from students already enrolled in another HSPH SD program. The student would need to meet the eligibility requirements for the SM1 or SM2 program and would be required to fulfill the SM degree requirements described above, following all HSPH student guidelines. Further information is available from the Director of Graduate Studies.
A  ADMINISTRATIVE REQUIREMENTS FOR DOCTORAL PROGRAM

Detailed requirements and deadlines are given at the Graduate School of Arts and Sciences webpage.

<table>
<thead>
<tr>
<th>Forms to be filed</th>
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</thead>
<tbody>
<tr>
<td>Prior to 4\textsuperscript{th} Semester:</td>
<td>Student sits for the written qualifying exam. Students who pass the exam should begin the process of identifying a dissertation advisor. Dissertation Progress Reports should be submitted starting November 15 following the passing of the written qualifying exam.</td>
</tr>
<tr>
<td>March 15 after passing written qual exam:</td>
<td>When a dissertation advisor has been selected, the student should formally petition for a change of advisor by notifying the Director of Graduate Studies, and the Manager of Academic Services of the change. The Department must be notified so that the change is submitted to GSAS.</td>
</tr>
<tr>
<td>May 15 after passing written qual exam:</td>
<td>Final doctoral program should be filed with the Department.</td>
</tr>
<tr>
<td>4\textsuperscript{th} Semester:</td>
<td>AM degree “on route” should be completed, and all paperwork filed for degree application by GSAS deadlines.</td>
</tr>
<tr>
<td>Before oral exam:</td>
<td>The student should nominate members of the Oral Examination Committee to the Department at least one month before scheduled exam date. This exam should be scheduled before May 15 of the year after passing the written qualifying exam or within seven semesters, whichever comes first. The student’s written paper should be submitted to the members of the Oral Examination Committee at least three weeks before the exam.</td>
</tr>
<tr>
<td>One month after oral exam:</td>
<td>The student should submit to the Department a form identifying the members of the Dissertation Committee. The student is expected to meet with the Dissertation Committee at least once every six months. The dissertation advisor and the student will file a Dissertation Progress Report on the student’s progress at six month intervals (November 15 and May 15).</td>
</tr>
<tr>
<td>Before the defense:</td>
<td>Submit a degree application form. GSAS requires that Ph.D. applicants file an Application for Degree by the dates listed on their academic calendar. (NOTE: The application deadlines are several months before graduation.) The student should submit a Dissertation Defense Scheduling Form to the Department at least three weeks prior to the dissertation defense. Copies of the dissertation should be provided to the Dissertation Committee and to the Department Chair at least two weeks prior to the defense. A Dissertation Acceptance Certificate will be completed by the Department before the dissertation defense and signed by the Dissertation Committee after the student’s defense. Please be aware that all titles, names, etc. must be exact on the Dissertation Acceptance Certificate (matching the information in the bound dissertation), and the name on both the form and the dissertation must match the complete name on the student records at GSAS, or the form will not be accepted by GSAS. Information about dissertation requirements for GSAS may be found at their website <a href="http://www.gsas.harvard.edu/current_students/form_of_the_phd_dissertation.php">http://www.gsas.harvard.edu/current_students/form_of_the_phd_dissertation.php</a>. A copy of the final bound dissertation must be submitted to the department.</td>
</tr>
</tbody>
</table>
B  DEPARTMENTAL FORMS

Doctoral Degree Forms

- Biostatistics PhD Degree Program Form
  http://www.hsph.harvard.edu/biostats/publications/handbook/PHD_Degree_Form.pdf

- Oral Examination Committee Nomination Form
  http://www.hsph.harvard.edu/biostats/publications/handbook/Orals_Committee_Nomination_Form.pdf

- Oral Examination Committee Scheduling Form
  http://www.hsph.harvard.edu/biostats/publications/handbook/Orals_Exam_Scheduling_Form.pdf

- Dissertation Committee Nomination Form

- Dissertation Committee Nomination Change Form

- Dissertation Progress Report Form

- Dissertation Defense Scheduling Form

Masters Degree Forms

- Biostatistics SM2 Degree Program Form
  http://www.hsph.harvard.edu/biostats/publications/handbook/SM2_Degree_Form_BIO.pdf

- Bioinformatics SM2 Degree Program Form
  http://www.hsph.harvard.edu/biostats/publications/handbook/SM2_Degree_Form_BIOINF.pdf

- Biostatistics SM60 Degree Program Form
  http://www.hsph.harvard.edu/biostats/publications/handbook/SM60_Degree_Form.pdf

- Biostatistics SM1 Degree Program Form
  http://www.hsph.harvard.edu/biostats/publications/handbook/SM1_Degree_Form.pdf

- Thesis Committee Nomination Form

- Thesis Defense Scheduling Form