HARVARD
T.H. CHAN
SCHOOL OF PUBLIC HEALTH
Department of Biostatistics

GRADUATE STUDENT HANDBOOK

Master of Science in Biostatistics

2023-2024

Contents

1 INTRODUCTION

This handbook describes the academic programs for the Master of Science in Biostatistics offered by the Department of Biostatistics at Harvard University. The Department offers courses of study leading to the Doctor of Philosophy degree and three Master of Science degrees (42.5, 60, and 80 credits, respectively) in Biostatistics. Both the Ph.D. and SM programs in biostatistics provide rigorous training in theory and practical experience in statistical, bioinformatics, and data science methods used in the biomedical sciences. Our programs are designed to prepare students for careers in the theory and practice of biostatistics, bioinformatics, and data science, especially as applied to the biomedical and health sciences. The Ph.D. program includes training in the application and development of methodology, consulting, teaching, and collaboration on a broad spectrum of health-related problems. The SM program includes training in designing research studies, analyzing and interpreting quantitative data, using modern computational methods, as well as collaboration and communication skills. There are opportunities for SM students to work with faculty on ongoing research projects and to serve as a teaching assistant for departmental courses. More than seventy faculty participate in these programs. The Department also offers separate Master of Science programs in Computational Biology and Quantitative Genetics (CBQG) and in Health Data Science (HDS).

The sections of this handbook include information and Departmental regulations concerning entrance requirements, program descriptions, degree requirements, and other Departmental policies for our Master of Science in Biostatistics programs. The Ph.D. Program is overseen by the Graduate School of Arts and Sciences and has a separate Graduate Student Handbook, whereas the SM degree is governed by the T.H. Chan 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* (https://gsas.harvard.edu/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* (https://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 departmental information is available at https://www.hsph.harvard.edu/biostatistics/. 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 Directors, and approved by the Executive Committee. The Directors are responsible for reviewing the student's program of study, and have the authority to consider exceptions to the rules and regulations established by the Department. Recommendations of the Directors are forwarded to the Executive Committee for final approval. The Directors and the Department Chairs welcome suggestions and comments.

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2 THE MASTER OF SCIENCE PROGRAMS

The Master of Science programs in Biostatistics train students in the basics of statistical theory, methods in planning studies, conducting analyses, 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, quantitative genetics, statistical genetics, data science, and medical and public health research, among other areas.

The Department of Biostatistics offers three Master of Science degree programs, with the appropriate program dependent on the student's background and interests. The same rich and diverse list of course offerings is available to students in all three degree programs, with specific subsets of the list appropriate for each program respectively. The SM80 and SM60 degrees share the same core requirements, with flexibility for the selection of electives to be tailored to one's own unique academic and professional goals. Due to the proximity of the SM BIO programs with the two other Master's degree programs in the department, the CBQG and HDS degrees, our students frequently enjoy elective courses from these closely related areas as well. Similarly, HDS and CBQG students enroll in SM BIO courses due to their own degree program requirements which incorporate our courses, or by elective choice. Below is a brief overview of the SM BIO degree programs offered by the Department of Biostatistics.

SM80

The 80-credit (two-year) Master of Science (SM80) degree provides training in statistical theory and a variety of statistical, computational, bioinformatics, and data science methods for application in medicine and public health. The SM80 program is appropriate for students seeking a full two-year program duration (which affords an additional semester for coursework compared to the SM60), and/or potential doctoral level work in the future. This program includes a culminating experience project. Graduates often seek Master's level medical research positions in myriad settings including non-profits, consulting, government, business, tech, pharma or biotech industries, health-focused startups, insurance, data scientist roles, and more.

SM60

The 60-credit (1.5 years) Master of Science (SM60) degree offers all of the same core and elective courses as the SM80, but may have more of an applied emphasis depending on the student's plan. The SM60 program includes a thesis requirement, and is designed for students seeking a shorter program duration, possibly more application in overall focus, and the collaborative yet individual experience of writing a supervised thesis. Graduates seek similar positions as those listed above for the SM80, upon completion of the degree.

SM42.5

The 42.5-credit (one-year) Master of Science (SM42.5) degree is designed for students with a prior graduate degree (Ph.D. or Master's degree) in mathematics or a related mathematical discipline. Ideally the student already has a mathematical and statistical background sufficient to undertake a shorter-duration, accelerated program in biostatistics. The SM42.5 makes available the same courses as the SM60 and SM80, but only a subset of the more advanced courses from this list may count toward the SM42.5 degree. SM42.5 students aim to achieve a level of proficiency after one year of study that is comparable to that obtained by students in the SM80 program.

2.1 Core Competencies

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

1. Designing research studies in medicine and public health (e.g., study design and population selection, sample size justification, data analysis plans, methods of data acquisition and organization, data

management methods, and protocol development).

2. Analyzing and interpreting quantitative data for scientific inference (e.g., graphical and tabular displays and visuals, 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 (e.g., including regression methods and extensions, survival data analysis, statistical and machine learning, bioinformatics, statistical genetics, and more).

The SM42.5 and SM80 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. This competency is demonstrated through the completion of a Culminating Experience (Section 2.13).

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

5. Disseminating new knowledge in a research discipline through the preparation of a written report of biostatistical analyses, comparison of different statistical methodologies, and oral presentation of results. This competency is demonstrated through the completion of a Master's Thesis and Collaborative Research Practicum (Section 2.11.2).

Specific program requirements are described in the following pages. Some requirements are common to all Master of Science programs, while others are specific to the degree program.

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 (https://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 (https://www.hsph.harvard.edu/admissions/).

2.2.2 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 and be clearly highlighted for reviewers. In addition, applicants are encouraged to have completed courses in probability, statistics, advanced calculus, and numerical analysis. Practical knowledge of a statistical computing package such as R, SAS, Stata, or SPSS is also desirable. Additional background in advanced mathematics, regression methods, biology, computing using a scripting language such as Python or Perl or relational databases, as well as prior research experience can also be beneficial.

As is delineated above, 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) SM42.5 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) SM80 program.

If candidates have questions about whether their coursework is meeting the requirements above, we recommend that they look at the required courses for the program in this handbook and decide. Also, we generally prefer in-person courses for such requirements, but if you choose an online course from platforms like edX or Coursera, such is only acceptable if the material and assessments are comparable to an in-person

university course. See this linked list of examples for comparison. If the courses taken do not have the titles mentioned above (like linear algebra or multivariable calculus), then make sure to explain in your statement of purpose in the application which courses you have taken that covered the materials. Please include dates taken, grades received, and institution (whether online or not) in the statement as well.

2.3 Intra/Inter-departmental Biostatistics Degree Program Switch Protocol

The Department of Biostatistics, and several other academic departments at the School (such as Epidemiology), offer Master's degree programs. These programs each have their own goals and requirements and make independent decisions about admissions. Students should carefully choose the program to which they apply and we expect students admitted to a program to meet the requirements of that program.

However, we recognize that the interests of some students may change during their time in graduate school. Therefore, the Department has established the following procedure for students applying for a change in program. This applies to students applying for a switch within the Department of Biostatistics, or between the Department of Biostatistics and another department at the School, such as Epidemiology. Please note that transfers between programs are not automatic and may not be approved, and if a student has received a scholarship or other funds from one degree program, that funding will not transfer to the new degree program.

1. Students must complete at least one full semester of coursework before applying for a program transfer. Students should apply to the degree program they intend to enroll in. Under no circumstances will a newly admitted student be granted a transfer approval before the degree program to which they applied begins, and certainly not before one semester into that degree program.

2. Students must enroll in and successfully pass any required coursework for their current program before beginning the transfer process. Please see your current degree program handbook for a list of required coursework. Students may also need to complete coursework in their proposed program so as to not fall behind in requirements to finish their program on time if approved for transfer.

3. Students must complete and submit a formal application and include an updated statement of purpose describing the reason for seeking a program transfer, current CV and one letter of recommendation (CV and letter not required for internal transfer in the BIO SM programs).

4. The Directors of department Master's programs, including the Directors of the student's current program and prospective program, will schedule an interview with the students to assess their application. Prior to this meeting, students will provide the documents listed in part 3 above to the program director(s), and will briefly explain their decision to apply for a transfer. In addition, the Directors of the prospective program must be given access to the students' original SPH SOPHAS application to the current degree program (the student must give approval for that access to the Admissions Office). The Directors will consider the applications and render a decision whether to approve or deny the transfer. These meetings will be scheduled in early January for students applying for transfer to start in the Spring semester, and in late May for students applying to transfer after the Spring semester.

5. The Directors will discuss and notify the student of their decision within three days. All decisions are **final**, and students are **not** allowed to reapply.

6. If approved, completed paperwork must be submitted to the Registrar's Office, and then to the Senior Manager of Academic Services.

Note that all program transfers are at the discretion of the Program Directors and are not guaranteed. If approved, students will be assigned a new academic advisor affiliated with the chosen degree program. It is the responsibility of the students to ensure that they complete all requirements for their degree program.

2.4 Curricular Practical Training (CPT) Approval for Students with F-1 Visas

To be considered CPT, the work must not only be related to the student's major field of study but must also be an integral part of an established curriculum. Before seeking off-campus internship opportunities, students are required to discuss their plans with Elizabeth Capuano (see contact info below) from the Harvard International Office to determine their CPT eligibility. Please note that CPT eligibility may be impacted by the March 2020 guidance issued by the Department of Homeland Security - Student Exchange Visitor Program.

There are two ways in which students are eligible for CPT:

1. Employment that is a required part of a degree program, such as a required internship or practicum. This requirement must be formally documented in school publications, such as a student handbook.

2. Employment that is not required by a degree program, but for which a program will award academic credits. This could include training courses such as a field studies course, or an independent study (see Section 2.5) course that is based on an internship.

International students who wish to pursue this option **MUST** speak with Elizabeth Capuano (elizabeth_capuano@harvard.edu), our representative at the Harvard International Office (HIO), **before beginning interview processes** at prospective internship sites to discuss the requirements for CPT authorization. Students should also speak to one of the directors about whether their employment would qualify for academic credits, as the academic credits are required for CPT authorization. When contacting the program directors, please complete the BIO-SM CPT Project Proposal form to submit to them for review. If CPT eligibility is established, please note that students **MUST** obtain CPT authorization **PRIOR** to beginning the internship. If doing a summer internship for academic credit, students must sign up for BST 305 CPT-Related Independent Study (Section 2.5) in the following fall semester, or during the summer (see last paragraph in Section 2.5) about tuition costs.

The most up-to-date information about CPT will be found here:
http://www.hio.harvard.edu/curricular-practical-training-cpt.

2.5 Independent Studies

2.5.1 General Independent Study

For independent study not related to a required thesis project or curricular practical training (CPT), the student should discuss with the chosen supervisor the credit hours needed (usually 2.5 credits per term*), and the scope of the work involved before enrolling. If the direct supervisor is not at the School, you'll need to find a department faculty member who will agree to review your progress, even if they are not involved in the project day-to-day. This person can be your academic advisor, one of the program directors, or any other member of the executive committee (Page 2). To register for independent study, the student should sign up for a section of BST 300 with Dr. Brent Coull (who is the Associate Chair), and in the petition to enroll include the name and email address of the direct supervisor, your internal faculty supervisor, and a 1-2 sentence description of the topic to be researched. At the time of registration, the student should also send an email to Jelena (cc'ing the direct supervisor) with the information about the project.

2.5.2 CPT-related Independent Study

For independent study related to curricular practical training (CPT), the student should follow the instructions of Section 2.4, and submit a 1-page proposal of the work to be done during this CPT to their program directors along with the information required by the Harvard International Office (HIO). Program directors will need both before approving the CPT work. At the end of the CPT work, students should submit a 1-page

*Students may only enroll in 5 credits of independent study in a given semester, and 10 credits maximum for the degree program.

report on the work done, signed by their off-campus supervisor. Both the proposal and the report should tie back to the competencies of the degree program (listed in Section 2.1 of this handbook). To register for the CPT-related independent study, the student should sign up for a section of BST 305 with Dr. Brent Coull (who is the Associate Chair), and in the petition to enroll include the name and email address of the direct supervisor.

2.6 Change to Part-Time Study / Leave of Absence

If students find it necessary to change their status, they may do so by submitting a General Petition to the Registrar's Office. Part-time master of science students may take fewer than 15 credits per term. Please read the information found at the Student Knowledge Center about changing your status (https://www.hsph.harvard.edu/r-o-student-knowledge-center/changing-full-time-part-time-status/.

Because of the core course schedule for the BIO SM60 degree program, you need to be aware that if you take a leave of absence from the program, you may disrupt your ability to complete the program in time, and you may have to pay a continuation fee or a full semester's worth of tuition for the extension needed. Please check with the Registrar's Office to confirm the charge that may be added.

2.7 Advising and Degree Program Approval

2.7.1 Academic Advisor

The Program Directors provide guidance and assistance to all Biostatistics SM students and can be approached with any questions a student may have. 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 their academic advisor, they are encouraged to discuss this with the Program Directors. In addition, the Department and SPH provide services for all students with clinically documented learning and/or physical disabilities.

2.7.2 Departmental Approval of Program

The Master's program plan must be submitted to the Department for approval, using the Master's Degree Program form specific to the student's degree provided by the Department. The program must be approved by the student's faculty advisor and the Program Directors. This plan should be submitted at least one semester prior to the expected graduation date for Master's students to the Senior Manager of Academic Services. The different degree program forms are found in Appendix A of this handbook.

2.7.3 Epidemiology Requirement

The School of Public Health requires that Master's students must successfully pass one Epidemiology course. The Department requires that EPI 201 be taken to satisfy this requirement. Ordinarily, this is taken during the first semester in residence. Any change from that requires the approval of the Program Director(s).

2.7.4 Public Health Practice Requirement

Students may be required to take a public health course e (ID 100: Foundations for Public Health) by the School of Public Health as part of their accreditation requirements. These requirements will be communicated to all incoming students by the School of Public Health directly.

2.7.5 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 Senior Manager of Academic Services in Biostatistics (see contact list on page 1) during the first semester in residence.

2.8 Teaching Fellow Guidelines

The department's current Teaching Fellow Guidelines may be found here (https://content.sph.harvard.edu/biostats/publications/handbook/TF_Guidelines.pdf. If you are assigned a teaching fellow appointment, please reference this document to understand the policies surrounding teaching at the department and the School.

2.9 Satisfactory Progress Requirements

For students in the SM80 program, a minimum of 60 ordinal credits is required by SPH (we require 50 of those from our core - Section 2.10.1). For students in the SM60 program, a minimum of 45 ordinal credits is required by SPH (we require 35 of those from our core - Section 2.11.1). For students in the SM42.5 program, a minimum of 30 ordinal credits is required by SPH (we require 25 of those from our core - Section 2.12.1).

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 Departmental requirements specified in Sections 2.10.1, 2.11.1, 2.12.1 (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 SPH's regulations for Master's students is found at https://www.hsph.harvard.edu/student-handbook/. All Master's students and their advisors should make sure that SPH and Departmental requirements are met according to schedule, and that the degree program form is submitted to the Senior Manager of Academic Services no later than one semester prior to the anticipated graduation date.

2.10 Degree Requirements for the Two-Year SM (SM80) in Biostatistics

A total of 80 credits are required for the SM80 program. The SM80 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, or who simply seek to take more varied and advanced courses in preparation for Master's level positions in research, industry, government, tech, consulting or other positions. Please refer also to Section 2 for further description of the SM80 degree program in biostatistics.

2.10.1 Course Requirements for the SM80 in Biostatistics

SM80 students can develop a flexible program in statistical methods, statistical theory, statistical computing, bioinformatics, data science, and health decision sciences, depending on the student's background and interests.

Specific requirements of the program include the following 20 credits of required ordinally graded courses:

BST	210	Applied Regression Analysis (5 credits)
BST	222	Basics of Statistical Inference (5 credits)
BST	223	Applied Survival Analysis (5 credits)
BST	226	Applied Longitudinal Analysis (5 credits)

In addition, students select a minimum of 35 credits of ordinally graded courses from the two-year Biostatistics Master's core (at least 25 credits must come from courses with a BST prefix), including[1]:

BST	212	Survey Research Methods in Community Health (2.5 credits)
BST	214	Principles of Clinical Trials (2.5 credits)
BST	216	Introduction to Quantitative Methods for Monitoring and Evaluation (2.5 credits)
BST	217	Statistical & Quantitative Methods for Pharmaceutical Regulatory Services (2.5 credits)

BST	221	Applied Data Structures and Algorithms (5 credits)
BST	227	Introduction to Statistical Genetics (2.5 credits)
BST	228	Applied Bayesian Analysis (5 credits)
BST	230	Probability I (5 credits)
BST	231	Statistical Inference I (5 credits)
BST	232	Methods (5 credits)
BST	238	Advanced Topics in Clinical Trials (2.5 credits)
BST	239	Health Survey Samples (2.5 credits)
BST	260	Introduction to Data Science (5 credits)
BST	261	Data Science II (2.5 credits)
BST	262	Computing for Big Data (2.5 credits)
BST	263	Statistical Learning (5 credits)
BST	267	Introduction to Social and Biological Networks (2.5 credits)
BST	273	Introduction to Programming (2.5 credits)
BST	280	Introductory Genomics & Bioinformatics for Health Research (2.5 credits)
BST	281	Genomic Data Manipulation (5 credits)
BST	282	Introduction to Computational Biology and Bioinformatics (5 credits)
BST	283	Cancer Genome Data Science (5 credits)
EPI	511	Advanced Population and Medical Genetics (5 credits)
GHP	525	Econometrics for Health Policy (5 credits)
ID	271	Advanced Regression for Environmental Epidemiology (2.5 credits)
RDS	280	Decision Analysis for Health and Medical Practices (2.5 credits)
RDS	282	Economic Evaluation of Health Policy and Program Management (2.5 credits)
RDS	284	Decision Theory (5 credits)
RDS	285	Decision Analysis Methods in Public Health and Medicine (2.5 credits)
RDS	500	Risk Assessment (2.5 credits)
SBS	263	Multilevel Statistical Methods: Concept and Application (5 credits)

[1]Not all courses in this list will be offered every year.

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 with the approval of the Program Directors. If you need cross-registration credit conversion, see: https://www.hsph.harvard.edu/r-o-student-knowledge-center/. Students are advised to consult with the Program Directors prior to enrolling in any courses in question. Courses offered to only undergrads are not allowed to be taken for credit by HSPH.

Note that a maximum of half your total credits per semester can be cross-registered courses without special permission, and a maximum of half of your required 80 credits can be cross-registered courses. This is a School policy.

Students can then choose electives depending on their background and interests. Students are strongly encouraged to pursue appropriate training in areas of application such as the biological sciences, biophysics, cancer, computational biology, environmental health, epidemiology, health policy, infectious disease, aging, international health, nutrition, psychiatry, social health, or other allied fields to prepare them for interdisciplinary collaborative research. Students may also wish to supplement their training by including additional courses in advanced mathematics, computer science, or advanced machine learning or deep learning.

2.10.2 Culminating Experience for the SM80 in Biostatistics

Please refer to section 2.13 for a full description of the Culminating Experience requirement.

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

The SM60 program has many of the salient features of the SM80, and may have an applied emphasis tailored by the student. At least 40 credits of course work are required (with up to 20 of the remaining credits reserved for the thesis), including 20 credits of required courses and a minimum of 15 credits of elective biostatistics courses. The program culminates with the popular Master's thesis and oral defense, which summarizes work accomplished during a collaborative research practicum. Typically of 17 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 and methodological positions involving medical or epidemiologic research in academic hospitals, universities, research organizations, and the pharmaceutical and biotechnology industries, data scientist roles, and more (please refer to Section 2).

2.11.1 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 20 credits of required ordinally graded courses:

BST 210 Applied Regression Analysis (5 credits)
BST 222 Basics of Statistical Inference (5 credits)
BST 223 Applied Survival Analysis (5 credits)
BST 226 Applied Longitudinal Analysis (5 credits)

In addition, students select a minimum of 15 credits of intermediate or advanced ordinally graded courses in Biostatistics to round out their program. At least 10 of these credits should have a BST prefix and at most 5 of these credits can come from relevant courses in computer science, risk and decision sciences, statistics, or quantitative epidemiology, with the approval of the Program Directors. Students are advised to consult with the Program Directors prior to enrolling in the courses in question. Courses offered to only undergrads are not allowed to be taken for credit by HSPH.

Note that a maximum of half your total credits per semester can be cross-registered courses without special permission, and a maximum of half of your required 60 credits can be cross-registered courses. This is a School policy.

2.11.2 Thesis Requirements for the SM60 in Biostatistics

A SM60 student must complete a 10-20 credit ordinally graded Master's Thesis and Collaborative Research Practicum (BST 325). Our students enjoy this popular 'thesis experience' and the included oral defense. This degree program requirement provides students with valuable real-world experience doing research and working with data often from Boston's premier biomedical or academic institutions. This culminating milestone in the SM60 degree program is not only a cogent summary of a student's study, methods, analyses, and contribution to the field(s), but also a great celebration of hard work, focus and devotion to a topic that is often of interest to the student personally. Students may ultimately achieve publication from their thesis work, although this often takes additional time and progress beyond the defense.

Timeframe

The SM60 thesis work is undertaken in a formal sense during the third semester, when the student officially registers for BST 325, and ultimately defends the thesis anytime from late November through mid-December when the semester ends. However, the thesis process usually commences after the required course work has been mostly completed. Students may begin to seek a thesis topic, and develop their overall thesis plan, late in the second semester and into the summer following. Students are responsible for seeking out and selecting their own potential thesis topic options and primary mentor(s) for such, their committee members, and for working/collaborating to develop a suitable thesis question to explore (often with guidance from the primary mentor/scientist). It is most helpful for a student to enter the fall with a solid thesis plan in place,

or one that is ironed out very early in the fall semester at the latest.

- A SM60 informational thesis meeting will be held by the SM BIO Program Director(s) typically toward the end of the second semester (Spring) into the degree program.
- The SM60 student will submit a Thesis Committee Nomination form once the committee members are known, and before scheduling the thesis defense. A thesis proposal should be submitted before final semester (see Appendix A).
- The thesis defense should be scheduled with the entire committee and the Senior Director of Academic Services, as early in the fall semester as the student is able to plan comfortably, and no later than mid-semester.
- The Master's thesis must be submitted to the thesis committee at least two weeks prior to the oral presentation.
- After the defense, any edits, modifications or additional clarifications must be incorporated by the student, and the final version submitted to the thesis committee and the Senior Manager of Academic Services by a date determined by the committee at the time of the defense (typically within 1-2 weeks after the defense, or earlier depending on when grades close for the relevant semester). An ordinal grade will subsequently be assigned, and a copy of the final will be placed in the student's file in the Department of Biostatistics.

Mentors and Committee

A student's thesis work will typically involve data analysis and/or methodology development for a research project under the direction of one or more mentors. Students may participate in research mentored by members at Harvard University, a Harvard-affiliated hospital, or other local organizations including non-profit organizations, biotech startup companies, or pharmaceutical companies, provided they also have a co-mentor among the Department of Biostatistics faculty.

The student selects three (more are selected in some cases) thesis committee members, one (sometimes two, depending on the study and circumstance) of which serves as primary research mentor(s). At least one committee member, or the primary research mentor, is a SM BIO Program Director(s), so that the student has a consistent presence of SM BIO program leadership in touch with the work, in addition to faculty/professionals outside the department. Thus, the project could be supervised primarily by a faculty member in Biostatistics (with a Program Director(s) also serving on the committee if not the primary mentor), or co-supervised by a doctoral-level investigator (at Harvard or elsewhere) and a faculty member in Biostatistics (also with a Program Director(s) on the committee, if not the co-supervisor). The committee members will include the student's primary practicum mentor(s), either or both of the Program Directors, and other Biostatistics faculty members or surrogates as needed. As noted above, the student will submit a Thesis Committee Nomination form before scheduling the thesis defense.

Thesis Work / Content

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, as well as clear communication of results (both written and oral). The student will carry out an extensive data analysis (which may involve expansion of existing statistical methods), often 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.

Before the start of the Fall semester of their second year, students should work with their thesis advisors to prepare a short thesis proposal outlining their research question, the data they will use, the methods that will be applied, and the anticipated results; any questions regarding human subjects research should also be

addressed. The thesis proposal should have section headings reflecting these four (or five) required elements as well as references cited and should be about two pages in length (although slightly longer is fine) but it should provide sufficient detail to allow the program directors to assess the proposed project. Once the proposal has been approved by the Program Directors, send the approved proposal to Jelena. Examples of previous successful proposals may be obtained from Jelena and/or David Cruikshank to aid in proposal development.

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). Examples of past SM60 student theses may be presented at the informational SM60 thesis meeting held in the second or third semester, and examples are also available upon request from the Senior Manager of Academic Services.

Evaluation

The Master's thesis and oral presentation will be evaluated by the selected thesis committee which consists of three (or more) members, as noted above. As outlined above, the Master's thesis must be submitted to the thesis committee at least two weeks prior to the oral presentation. The student typically receives additional feedback both during and after the oral defense that should subsequently be incorporated into the final version of the thesis. A brief (primarily) verbal evaluation will be provided to the student after the defense by the committee and primary mentor(s). The SM60 thesis is an ordinally graded degree requirement with the ordinal grade determined by the thesis committee.

2.12 Degree Requirements for the One-Year SM (SM42.5) 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 SM BIO degree program.

2.12.1 Course Requirements for the SM42.5 in Biostatistics

A total of 42.5 credits are required for the one-year Master's program. Specific requirements of the program include the following 5 credits of required ordinally graded courses:

BST 222 Basics of Statistical Inference (5 credits)

In addition, students must select a minimum of 20 credits of ordinally graded courses taken from the one-year Biostatistics Master's core, including[1]:

BST 214 Principles of Clinical Trials **PLUS**
BST 238 Advanced Topics in Clinical Trials (for a total of 5 credits)
BST 221 Applied Data Structures and Algorithms (5 credits)
BST 223 Applied Survival Analysis (5 credits)
BST 226 Applied Longitudinal Analysis (5 credits)
BST 227 Introduction to Statistical Genetics (2.5 credits)
BST 228 Applied Bayesian Analysis (5 credits)
BST 230 Probability Theory and Applications I (5 credits)
BST 231 Statistical Inference I (5 credits)
BST 232 Methods (5 credits)
BST 235 Advanced Regression and Statistical Learning (5 credits)
BST 249 Bayesian Methods in Biostatistics (5 credits)

BST	260	Introduction to Data Science (5 credits)
BST	261	Data Science II (2.5 credits)
BST	262	Computing for Big Data (2.5 credits)
BST	263	Statistical Learning (5 credits)
BST	267	Introduction to Social and Biological Networks (2.5 credits)
BST	280	Introductory Genomics & Bioinformatics for Health Research (2.5 credits)
BST	281	Genomic Data Manipulation (5 credits)
BST	282	Introduction to Computational Biology and Bioinformatics (5 credits)
BST	283	Cancer Genome Data Science (5 credits)

[1]Not all courses in this list will be offered every year.

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, provided that least 15 credits come from courses with a BST prefix. In addition, a popular elective for the SM42.5 that is not included in the core for this degree program is BST 210. If you need cross-registration credit conversion, see: https://www.hsph.harvard.edu/r-o-student-knowledge-center/. Students are advised to consult with the Program Directors prior to enrolling in the courses in question. Courses offered to only undergrads are not allowed to be taken for credit by HSPH.

Note that a maximum of half your total credits per semester can be cross-registered courses without special permission, and a maximum of half of your required 42.5 credits can be cross-registered courses. This is a School policy.

2.12.2 Culminating Experience for the SM42.5 in Biostatistics

Please refer to section 2.13 for a full description of the Culminating Experience requirement.

2.13 Culminating Experience for the SM80 and SM42.5 in Biostatistics

SM42.5 and SM80 students must write up a summary of a culminating research experience (or a collection of several) that has been performed beyond standard coursework. This could involve activities arising from a research assistantship, summer internship, independent study, job experience while a student in the program, or related work. Alternative approaches include the creation of a presentation of the summary material in poster or slide-set format, or use of the submission of a complete draft manuscript for which the student is the primary author.

Students often enjoy this opportunity to share the invaluable experiences they've had while in the degree program, and the written report serves as an element of their student record that can be included in discussions or materials with potential employers or schools. Some students even choose to present their Culminating Experience Report in the Biostat Student Seminar or similar presentation settings.

Timeframe

- At any time, and preferably by midway through the fall semester of their final year, students in the SM80 and SM42.5 degree programs typically seek experience(s) beyond coursework either within or external to the Department of Biostatistics, and may utilize such experience(s) to satisfy the culminating experience report requirement.
- The due date for this degree requirement is firm, and falls on the 3rd Friday in April. Required materials (see below) should be submitted electronically to the Program Directors and the Senior Manager of Academic Services by this date.
- An evaluation of the report will be provided to the student and placed in the student's file in the department prior to the school-designated deadline for confirmation of degrees.

Content

It is important for the written summary or other alternative materials to demonstrate each of the specific competencies of the Master of Science program (Section 2.1). The purpose of the Culminating Experience Report is to

- integrate knowledge acquired in Biostatistics coursework with general knowledge in medicine and public health (students should describe relevant Biostatistics or other quantitative courses that were useful for the work),
- demonstrate skills in the analysis and interpretation of quantitative data for scientific inference, including graphical visual displays and tabular summaries,
- use modern computational methods to effectively analyze complex or non-standard problems,
- utilize or explore probabilistic and statistical reasoning and theory to clearly address and analyze complex data, and
- demonstrate effective collaboration and communication skills.

In the report, students should therefore include the development of an appropriate research question, the statement of hypotheses, development and implementation of an analysis plan, and summary of findings. The Culminating Experience Report itself must be the original and individual writing and work of the student submitting the report in fulfillment of this requirement. The research or other activities (internship, independent study, job, etc.) around which the report is based, can be either individual work, or collaborative work entirely.

Students should submit the following materials according to the timeframe above:

1. The summary report (approximately 6-8 double-spaced pages not counting tables, figures, and references), as well as supporting figures, tables and references placed appropriately throughout the summary, and at the end, respectively.
2. A cover letter addressed to the SM BIO Program Director(s) that briefly and clearly summarizes the project, demonstrates competencies, and describes relevant Biostatistics or other quantitative courses that were useful for the work.

There is no oral presentation associated with this degree requirement as there is for the SM60 thesis.

Evaluation

The summary will be reviewed by a committee of two faculty members, chaired by either of the Program Directors. The focus of the review will be the demonstration of the competencies above. A written evaluation will be provided to the student, and also placed in the student's file in the department. This is not an ordinally graded degree requirement, but the evaluation is a thorough one, resulting in a rating of 'Excellent', 'Very Good', 'Good', 'Fair', or 'Poor/Unacceptable/Requires resubmission.' Please see this example evaluation form for the Culminating Experience Report.

Culminating Experience Report vs SM60 Thesis

The Culminating Experience Report is markedly different than the SM60 Thesis (Collaborative Research Practicum, see Section 2.11.2) in not only length, but overall focus and purpose. The Culminating Experience Report is just that – a rather brief but cogent report on an experience(s) peripherally related to a student's time and academic route in the degree program. The SM60 thesis is a very focused, more elaborate research undertaking with a formal thesis committee, and includes both a thesis writeup and an oral defense. The Program Directors can be consulted if there are any questions regarding these degree program requirements.

2.14 Biostatistics SM Program for Students in the PHS PhD Programs at SPH

In certain cases, the Department may entertain applications for the SM42.5 program in Biostatistics from students already enrolled in the PHS PhD program affiliated with faculty at Harvard Chan. The student would need to meet the eligibility requirements for the SM42.5 program and would be required to fulfill the rigorous SM42.5 degree requirements described above, following all Harvard Chan guidelines. The specific requirements for the degree are listed here. In general, a PhD student who received a previous SM degree from the Department of Biostatistics would not be considered for the SM42.5 in passing, but could be considered on a case-by-case basis. Further information is available from the Senior Manager of Academic Services, and the Program Directors.

Students who are earning the SM42.5 degree in Biostatistics 'in passing' to a doctoral degree in another department may be able to submit one of their dissertation papers to satisfy the culminating experience requirement, *provided the paper has advanced biostatistical methods employed*. As noted above, the paper should also be accompanied by a cover letter that demonstrates each of the specific competencies of the Master of Science program (Section 2.1) and that describes relevant Biostatistics or other quantitative courses that were useful for the work.

A BIOSTATISTICS MASTER'S DEGREE FORMS

- **Biostatistics SM42.5 Degree Program Form**
  https://content.sph.harvard.edu/biostats/publications/bio-sm_handbook/SM42.5_Degree_Form.pdf
- **Biostatistics SM80 Degree Program Form**
  https://content.sph.harvard.edu/biostats/publications/bio-sm_handbook/SM80_Degree_Form_BIO.pdf
- **Biostatistics SM60 Degree Program Form**
  https://content.sph.harvard.edu/biostats/publications/bio-sm_handbook/SM60_Degree_Form.pdf
- **Biostatistics SM60 Thesis Proposal Form**
  https://content.sph.harvard.edu/biostats/publications/bio-sm_handbook/BIO-SM_Thesis_Proposal_Form.pdf
- **Biostatistics SM60 Thesis Committee Nomination Form**
  https://content.sph.harvard.edu/biostats/publications/bio-sm_handbook/Thesis_Committee_Nomination_Form.pdf
- **Biostatistics SM60 Thesis Defense Scheduling Form**
  https://content.sph.harvard.edu/biostats/publications/bio-sm_handbook/Thesis_Defense_Scheduling_Form.pdf