PUBLIC HEALTH

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FIELDS OF STUDY

Programs of study are offered in the areas of Biostatistics, Chronic Disease Epidemiology, Environmental Health Sciences, Epidemiology of Infectious Diseases, Epidemiology of Microbial Diseases, Health Informatics, Health Policy and Management, and Social and Behavioral Sciences.

SPECIAL REQUIREMENTS FOR THE PH.D. DEGREE

Generally the first two years of the Ph.D. program are devoted primarily to course work and rotations for students in some areas. All doctoral students are required to successfully complete a minimum of ten graduate-level courses and must satisfy the individual departmental requirements, detailed below. Courses such as Dissertation Research, Preparing for Qualifying Exams, Research Ethics and Responsibility, and Seminar do not count toward the course requirements. However, students must register for these courses in order for them to appear on the transcript.

All first-year students must enroll in and complete training in Research Ethics and Responsibility (EPH 600). This course will introduce and prepare students for responsible conduct in research, including data acquisition and management, mentor/trainee responsibilities, publication practices and authorship standards, scientific misconduct, and conflict of interest. Research Ethics and Responsibility is offered annually and is graded Satisfactory/Unsatisfactory.

The Graduate School uses grades of Honors, High Pass, Pass, or Fail. Students are required to earn a grade of Honors in at least two full-term courses and must achieve a High Pass average. (This applies to courses taken after matriculation in the Graduate School and during the nine-month academic year.)
Teaching and research experiences are regarded as an integral aspect of the graduate training program. All students are required to serve as teaching fellows for two terms at the TF level 10 or 20, typically during years two and three. During the first term of teaching, students must attend a training session conducted by the Poorvu Center for Teaching and Learning. First-year students are encouraged to focus their efforts on course work and are not permitted to serve as teaching fellows. A Ph.D. student who has fulfilled the teaching requirement is not permitted to serve as a teaching fellow without special permission from the DGS. In the rare instances this exception is approved, the student will only be allowed to serve at the TF-10 level.

At the end of years one and two, advisers will be asked to complete a progress report for each student evaluating the student’s academic progress and describing the student’s readiness for teaching and/or conducting research. This is then discussed with the student and reviewed by the DGS. Students who have not progressed adequately will be asked to meet with the DGS to address the situation.

The qualifying exam is typically taken by the end of the second full academic year. With the assistance of the faculty adviser, generally after qualifying exams, each student requests appropriate faculty members to join a dissertation advisory committee (DAC). The DAC reviews and approves the prospectus as developed by the student and submits it to the DGS and the Graduate Studies Executive Committee (GSEC) for approval. The dissertation prospectus must be approved by the end of the third year.

To be admitted to candidacy, students must: (1) satisfactorily complete the course requirements for their department as outlined below, achieve grades of Honors in at least two full-term courses, and achieve an overall High Pass average; (2) obtain an average grade of High Pass on the qualifying exam; and (3) have the dissertation prospectus approved by the GSEC. Students who have been admitted to candidacy are required by the Graduate School to complete an annual Dissertation Progress Report.

Each DAC is required to meet as a group at least twice each year, and more frequently if necessary. The student schedules meetings of the DAC. The chair/adviser of the DAC produces a summary evaluation of progress and plans for the next six months. The student and the DGS receive a copy of the final document. The DAC reviews the progress of the dissertation research and decides when the dissertation is ready to be submitted to the readers. This decision is based on a closed defense of the dissertation, which involves a formal oral presentation by the student to the DAC. (At the adviser’s discretion, other invited faculty may be present.) Upon completion of the closed defense, the chair/adviser of the DAC submits the recommendation to the DGS along with the names of three appropriate readers.

Doctoral dissertations originating in Public Health must also be presented in a public seminar. This presentation is scheduled after the submission of the dissertation to the readers and preferably prior to the receipt and consideration of the readers’ reports. At least one member of the DAC supervising the dissertation and at least one member of the GSEC are required to attend the presentation.
Required Course Work

**BIOSTATISTICS**

Ph.D. students in Biostatistics (BIS) have the choice of two pathways: the *Biostatistics Standard Pathway* and the *Biostatistics Implementation and Prevention Science Methods Pathway*. In each pathway students must complete a minimum of sixteen courses (not including BIS 525, BIS 526, BIS 695, and EPH 600). Course substitutions must be identified and approved by the student’s adviser and the DGS.

Required courses (or their equivalents) for both pathways are: BIS 525 and BIS 526, Seminar in Biostatistics and Journal Club; BIS 610, Applied Area Readings for Qualifying Exams; BIS 623, Advanced Regression Models (or S&DS 612, Linear Models); BIS 628, Longitudinal and Multilevel Data Analysis; BIS 643, Theory of Survival Analysis; BIS 678, Statistical Practice I; BIS 691, Theory of Generalized Linear Models; BIS 695, Summer Internship in Biostatistical Research; EPH 508, Foundations of Epidemiology and Public Health; EPH 600, Research Ethics and Responsibility; EPH 608, Frontiers of Public Health; and S&DS 610, Statistical Inference. Students entering the doctoral program with an M.P.H. are exempt from EPH 608. Students with prior graduate-level epidemiology courses may be exempt from EPH 508.

Students in the *Biostatistics Standard Pathway* will be required to complete BIS 681, Statistical Practice II. In consultation with their academic adviser and approved by the DGS, students also choose a minimum of six additional electives that will best prepare them for dissertation work.

Students in the *Biostatistics Implementation and Prevention Science Methods Pathway* will be required to complete BIS 537, Statistical Methods for Causal Inference; BIS 629, Advanced Methods for Implementation and Prevention Science; BIS 631, Advanced Topics in Causal Inference Methods; and EMD 533, Implementation Science. In consultation with their academic adviser and approved by the DGS, students also choose a minimum of three additional electives. Recommended electives are:* BIS 536, Measurement Error and Missing Data; BIS 557, Computational Statistics; BIS 567, Bayesian Statistics; BIS 646, Nonparametric Statistical Methods and Their Applications; CDE 516, Principles of Epidemiology II; CDE 534, Applied Analytic Methods in Epidemiology; EMD 538, Quantitative Methods for Infectious Disease Epidemiology; HPM 570, Cost-Effectiveness Analysis and Decision-Making; HPM 586, Microeconomics for Health Policy and Management; HPM 587, Advanced Health Economics; HPM 611, Policy Modeling; SBS 541, Community Health Program Evaluation; SBS 574, Developing a Health Promotion and Disease Prevention Intervention; SBS 580, Qualitative Research Methods in Public Health; SBS 676, Questionnaire Development; S&DS 541, Probability Theory; S&DS 565, Introductory Machine Learning; and S&DS 600, Advanced Probability.

* Of these recommended electives, the following are *strongly* recommended: HPM 570, HPM 611, SBS 580, and S&DS 541.

Students funded by specific fellowships may be subject to additional requirements and should discuss this with their adviser.
CHRONIC DISEASE EPIDEMIOLOGY

Ph.D. students in Chronic Disease Epidemiology (CDE) must complete a minimum of seventeen courses (not including EPH 600). Course substitutions must be identified and approved by the student’s adviser and the DGS.

Required courses (or their equivalents) are: CDE 516, Principles of Epidemiology II; CDE 534, Applied Analytic Methods in Epidemiology; CDE 610, Applied Area Readings for Qualifying Exams; CDE 617, Developing a Research Proposal*; CDE 619, Advanced Epidemiologic Research Methods (or alternative course approved by the student’s adviser and the DGS); CDE 650, Introduction to Evidence-Based Medicine and Health Care; EHS 502/CDE 502, Physiology for Public Health; EPH 508, Foundations of Epidemiology and Public Health; and EPH 600, Research Ethics and Responsibility.

Students must also complete course work that introduces them to the breadth of public health (EPH 608, Frontiers of Public Health). Students entering the doctoral program with an M.P.H. may be exempt from EPH 608. In addition, in consultation with their dissertation adviser, students choose three 600-level course units in Biostatistics† (or equivalent quantitative courses as approved by the adviser and the DGS), as well as five additional electives that will best prepare them for their dissertation research. All electives must be approved by the adviser and the DGS.

* CDE 617 is not required of students funded by the Yale AIDS Prevention Training Program. These students must take an alternative course in order to meet the seventeen-course requirement.

† CDE 634, Advanced Applied Analytic Methods in Epidemiology and Public Health, and S&D 563, Multivariate Statistical Methods for the Social Sciences, are also options to fulfill the Biostatistics course requirement.

ENVIRONMENTAL HEALTH SCIENCES

Ph.D. students in Environmental Health Sciences (EHS) must take a minimum of thirteen courses (not including EHS 525, EHS 526, and EPH 600). However, more courses may be required by a student’s adviser. Course substitutions must be identified and approved by the student’s adviser and the DGS.

Required courses are: EHS 503, Public Health Toxicology; EHS 507, Environmental Epidemiology; EHS 508, Environmental and Occupational Exposure Science; EHS 525 and EHS 526, Seminar and Journal Club in Environmental Health; EPH 505, Biostatistics in Public Health; EPH 508, Foundations of Epidemiology and Public Health; EPH 600, Research Ethics and Responsibility; and either CDE 617, Developing a Research Proposal or EMD 625, How to Develop, Write, and Evaluate an NIH Proposal. Students must also complete course work that introduces them to the breadth of public health (EPH 608, Frontiers of Public Health). Students entering the doctoral program with an M.P.H. may be exempt from EPH 608. Ph.D. students enrolled in EHS 503, EHS 525, and EHS 526 may be assigned additional readings.

In addition, all students are required to complete two research rotations during the first year: EHS 619 and EHS 620. At the end of the research rotation students give a presentation and are graded based on their rotation work and presentation.

Students must take an additional four electives. Suggested electives (or equivalents approved by the student’s adviser and the DGS) are: BIS 505, Biostatistics in Public
Health II; BIS 623, Advanced Regression Models; BIS 628, Longitudinal and Multilevel Data Analysis; CDE 516, Principles of Epidemiology II; CDE 520, Case-Based Learning for Genetic and Environmental Diseases; CDE 534, Applied Analytic Methods in Epidemiology; EHS 502, Physiology for Public Health; EHS 511, Principles of Risk Assessment; EHS 530, Our Air, Our Health; EHS 531/HPM 531, Systematic Reviews, Meta-Analyses, and Meta-Research; EHS 537, Water, Sanitation, and Global Health; EHS 545, Molecular Epidemiology; EHS 547, Climate Change and Public Health; EHS 560/ENV 606, Methods in Climate Change and Health Research; EHS 563, Biomarkers of Exposure, Effect, and Susceptibility in the Epidemiology of Noncommunicable Disease; EHS 566, Causal Inference Methods in Public Health Research; EHS 567, Fundamentals of Green Engineering and Green Chemistry; EHS 568, Introduction to GIS for Public Health; EHS 569, Advanced GIS Workshop; EHS 581, Public Health Emergencies: Disaster Planning and Response; ENV 755, Modeling Geographic Space; and ENV 756, Modeling Geographic Objects.

Epidemiology of Microbial Diseases
Ph.D. students in Epidemiology of Microbial Diseases (EMD) must complete a minimum of ten courses (not including EPH 600). Course substitutions must be identified and approved by the student’s adviser and the DGS.

Courses in biostatistics, epidemiology, and microbiology are strongly recommended. The specific courses recommended depend on the background of individual students and their stated research interests. An individual program that includes courses, seminars, and research rotations is developed by the student and the student’s academic adviser. All students are required to complete three distinct research rotations. These are done in the fall and spring terms and in the summer between the first and second years. Students will be asked to prepare a brief presentation at the end of each rotation. These research rotations (EMD 670, EMD 671, and EMD 672) are graded and account for three of the required ten courses.

Students are required to complete course work in epidemiology (EPH 508, Foundations of Epidemiology and Public Health; or CDE 516, Principles of Epidemiology II). In addition, students must complete EMD 625, How to Develop, Write, and Evaluate an NIH Proposal (or CDE 617, Developing a Research Proposal); EPH 600, Research Ethics and Responsibility; and course work that introduces them to the breadth of public health (EPH 608, Frontiers of Public Health). Students entering the doctoral program with an M.P.H. may be exempt from EPH 608. Students with prior graduate-level epidemiology courses may be exempt from course work in epidemiology.

The following courses are suggested as appropriate for Ph.D. students in EMD; however, other courses in Public Health or in other schools or departments may also be appropriate and may be chosen and approved in consultation with the student’s adviser and the DGS: EMD 531, Genomic Epidemiology of Infectious Diseases; EMD 533, Implementation Science; EMD 538, Quantitative Methods for Infectious Disease Epidemiology; EMD 539, Introduction to Public Health Surveillance; EMD 548, Observing Earth from Space; EMD 553, Transmission Dynamic Models for Understanding Infectious Diseases; EMD 567, Tackling the Big Three: Malaria, TB, and HIV in Resource-Limited Settings; EMD 582, Political Epidemiology; HPM 570,
Cost-Effectiveness Analysis and Decision-Making; MGT 611, Policy Modeling; and S&DS 538, Probability and Statistics.

HEALTH POLICY AND MANAGEMENT

Ph.D. students in Health Policy and Management (HPM) are required to develop expertise in one of three areas of specialization: Economics; Organizational Theory and Management; or Political and Policy Analysis.

Students are required to complete the course work detailed below, or the equivalent of the topic areas covered in these courses. The course listing represents a suggested program of study. The standard number of courses taken is sixteen, with the option of obtaining credits for previous courses. With the approval of the academic adviser and DGS, alternative courses that better suit the needs of the student may satisfy the course work requirement. The departmental representative to the Graduate Studies Executive Committee, in conjunction with the student’s adviser and the DGS, is responsible for determining if core course requirements have been satisfied by previous course work or alternative courses. If so, the student should apply for a course waiver through the Graduate School. HPM students can only waive up to three of the sixteen courses.

Courses required of all students are: EPH 508, Foundations of Epidemiology and Public Health; EPH 600, Research Ethics and Responsibility; EPH 608, Frontiers of Public Health; and HPM 617 and HPM 618, Colloquium in Health Services Research. Students entering the program with an M.P.H. degree may be exempt from EPH 608. (EPH 600, HPM 617, and HPM 618 do not count toward the total number of required courses).

HPM 610, Applied Area Readings, is required of all second-year students. Additionally, all HPM students are expected to attend the departmental research seminar for faculty and the doctoral research seminar.


A minimum of four courses in Health Policy and Management, all with Ph.D. readings, are required. Suggested courses are: EPH 510, Health Policy and Health Care Systems; HPM 514, Health Politics, Governance, and Policy; HPM 560, Health Economics and U.S. Health Policy; HPM 570, Cost-Effectiveness Analysis and Decision-Making; HPM 573, Advanced Topics in Modeling Health Care Decisions; HPM 587, Advanced Health Economics; HPM 590, Economics, Addiction, and Policy; HPM 597, Capstone Course in Health Policy; and HPM 688, Managing Health Care in Complex Systems.
Areas of Specialization

Students in HPM must complete a minimum of four courses, all with Ph.D. readings, in their chosen area of specialization.

In Economics, students are required to take a graduate-level microeconomics course such as ECON 545, Microeconomics; and a year-long sequence in econometrics, selected in consultation with the student's adviser. (This will count towards the required Methods and Statistics courses.) In addition, students are required to take two field courses in a concentration area in which they plan to develop expertise. In Behavioral Economics, two courses such as: MGMT 758, Foundations of Behavioral Economics; and PSYC 553, Behavioral Decision-Making I: Choice. In Industrial Organization two courses such as: ECON 600, Industrial Organization I; and ECON 601, Industrial Organization II. In Labor Economics two courses such as: ECON 630, Labor Economics I; and ECON 631, Labor Economics II. In Public Finance, two courses such as: ECON 556, Topics in Empirical Economics and Public Policy; ECON 680, Public Finance I; and ECON 681, Public Finance II. In consultation with the student's adviser, other courses may be substituted.

In Organizational Theory and Management, four courses are required, selected in consultation with the student's adviser.

In Political and Policy Analysis, four courses are required, selected in consultation with the student's adviser. Suggested courses are: PLSC 800, Introduction to American Politics; PLSC 801, Political Preferences and American Political Behavior; and PLSC 803, American Politics III: Institutions.

HPM students take qualifying exams in each of three areas: (1) health policy and management; (2) empirical analysis and/or statistics; and (3) the student’s area of specialization. Typically, these are taken in the summer after two years of course work.

SOCIAL AND BEHAVIORAL SCIENCES

Ph.D. students in Social and Behavioral Sciences (SBS) or the Maternal Child Health Promotion Pathway must complete a minimum of fifteen courses (not including EPH 600) from the following courses or their equivalents. Course substitutions must be identified and approved by the student’s adviser and the DGS.

Required courses for students in SBS or the Maternal Child Health Promotion Pathway (or their equivalents) are: CDE 617, Developing a Research Proposal or EMD 625, How to Develop, Write, and Evaluate an NIH Proposal*; EPH 508, Foundations of Epidemiology and Public Health; EPH 600, Research Ethics and Responsibility; SBS 580, Qualitative Research Methods in Public Health; SBS 610, Applied Area Readings for Qualifying Exams; and SBS 699, Advanced Topics in Social and Behavioral Sciences. Students must also complete course work that introduces them to the breadth of public health (EPH 608, Frontiers of Public Health). Students entering the doctoral program with an M.P.H. may be exempt from EPH 608. One of the following: SBS 574, Developing a Health Promotion and Disease Prevention Intervention; SBS 541, Community Health Program Evaluation; SBS 593, Community-Based Participatory Research in Public Health.

SBS students: In consultation with their dissertation adviser, students choose three advanced-level (500 level or above) statistics or methods courses (from Biostatistics,
Psychology, Political Science, Sociology, Anthropology, or Statistics and Data Science†) as well as five additional electives that will best prepare them for their dissertation research.

Maternal and Child Health Promotion Pathway: Students that choose this pathway will be required to take the following three courses: EMD 533, Implementation Science; SBS 594, Maternal-Child Public Health Nutrition, and HPM 542, Health of Women and Children. Students in this pathway will take two additional electives that will best prepare them for their dissertation research. In addition, students must choose three of the following statistics or methods courses: EPH 505, Biostatistics in Public Health; BIS 505, Biostatistics in Public Health II; CDE 516, Principles of Epidemiology II; BIS 621, Regression Models for Public Health or BIS 623, Advanced Regression Methods; CDE 566 (EHS 566), Causal Inference Methods in Public Health Research or EMD 582, Political Epidemiology; CDE 634, Advanced Applied Analytic Methods in Epidemiology and Public Health; BIS 628, Longitudinal and Multilevel Data Analysis; BIS 630, Applied Survival Analysis; S&DS 563, Multivariate Statistical Methods for the Social Sciences.

Students supported by training grants may be subject to additional requirements and should discuss with the principal investigator of the grant whether there are training-specific requirements.

* CDE 617/EMD 625 is not required of students funded by the Yale AIDS Prevention Training Program. These students must take an alternative course in order to meet the fifteen-course requirement.

† For Social and Behavioral Students not in the Maternal Child Health Promotion Pathway, course examples include (but are not limited to): CDE 516, Principles of Epidemiology II; S&DS 563, Multivariate Statistical Methods for the Social Sciences; and SBS 676, Questionnaire Development.

M.D./PH.D. PROGRAM REQUIREMENTS FOR PUBLIC HEALTH

All M.D./Ph.D. students must meet with the director of graduate studies (DGS) in Public Health, if they are considering affiliating with Public Health. Students in this program are expected to meet the guidelines listed below in the time frame outlined. The DGS must approve any variations to these requirements.

Teaching

One term of teaching is required. If students are approved by the DGS to teach beyond this requirement, they can be compensated. In the rare instance that teaching beyond the requirement is approved, the student will only be allowed to serve as a TF 10. If a student has served as a teaching fellow elsewhere on campus, this experience may be counted toward the requirement. DGS approval is required to waive the teaching requirement on the basis of previous Yale teaching experience.

Rotations/Internships

Students should do two rotations/internships with potential advisers in Public Health. The purpose of these rotations/internships is to learn research approaches
and methodologies and/or to allow the student time to determine if the faculty’s research interests are compatible with the student’s research interests. These rotations/internships are usually done during the summer between the first and second years of medical school. In some cases, students may need to defer this requirement until the summer after the second year after taking certain courses and/or completing readings in order to possess the background necessary for a successful rotation/internship.

**Required Course Work**

M.D./Ph.D. students are generally expected to take the same courses as traditional Ph.D. students. Departmental requirements vary; therefore, students should confer with the DGS and their Ph.D. adviser.

**Timeline for Qualifying Exam**

Students generally will take medical school courses in years one and two. Students can take Public Health courses or other appropriate courses during this time, if scheduling allows. Once affiliated with the Public Health program, students will complete all course requirements for the department. This generally takes a minimum of two terms but can take up to four terms after affiliating with Public Health. The qualifying exam is commonly completed after the fourth term of affiliation with the Ph.D. program in Public Health, but it can be done earlier with approval of the Ph.D. adviser and the DGS.

**Prospectus Timeline**

Following completion of the qualifying exam, students should focus on the prospectus, which must be approved by the Public Health Graduate Studies Executive Committee (GSEC) before the end of the student’s sixth term as an affiliated Ph.D. student in Public Health.

**Admission to Candidacy**

To be admitted to candidacy, students must: (1) satisfactorily complete the course requirements for their department as outlined above, achieve grades of Honors in at least two full-term courses, and achieve an overall High Pass average; (2) obtain an average grade of High Pass on the qualifying exam; and (3) have the dissertation prospectus approved by the GSEC. All M.D./Ph.D. students must be admitted to candidacy before the start of their fourth year in the Ph.D. program (i.e., before the start of the seventh term).

**MASTER’S DEGREES**

**M.Phil.** The M.Phil. is awarded to doctoral students who have advanced to candidacy. When students advance to candidacy, the registrar’s office automatically submits a petition for the awarding of the M.Phil. degree.

**Terminal Master's Degree Program** The School offers a terminal master’s degree program leading to an M.S. in Public Health in four concentrations: Biostatistics (a two-year program), Chronic Disease Epidemiology (a one-year program), Epidemiology of Infectious Diseases (a one-year program), and Health Informatics
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(a two-year program). All students must fulfill both the departmental and Graduate School requirements for a terminal M.S. degree.

Students must have an overall grade average of High Pass, including a grade of Honors in at least one full-term graduate course (for students enrolled in the one-year programs in Chronic Disease Epidemiology and Epidemiology of Infectious Diseases) or in at least two full-term graduate courses (for students enrolled in the two-year programs in Biostatistics and Health Informatics). In order to maintain the minimum average of High Pass, each grade of Pass must be balanced by one grade of Honors. For more details, please see Course and Honors Requirements under Policies and Regulations.

A Biostatistics, Chronic Disease Epidemiology, or Epidemiology of Microbial Diseases student who is withdrawing from the Ph.D. program, and has successfully completed all required course work for the terminal M.S. degree (described below), may apply and be recommended for the M.S. in Public Health. In the other departments, students must have successfully completed (prior to withdrawal) at least ten courses in the doctoral program and a capstone experience, achieving a minimum of two Honors grades and an overall High Pass average. Students who withdraw after qualifying for or receiving the M.Phil. are not eligible for an M.S. degree.

Fields of Study

TERMINAL M.S. WITH CONCENTRATION IN BIOSTATISTICS

This two-year program provides training in clinical trials, epidemiologic methodology, implementation science, statistical genetics, and mathematical models for infectious diseases. Students have a choice of three pathways: the Biostatistics Standard Pathway, the Biostatistics Implementation and Prevention Science Methods Pathway, and the Data Science Pathway. Part-time enrollment is permitted.

Course Requirements

The Biostatistics Standard Pathway and Implementation and Prevention Science Methods Pathway require the completion of fifteen courses; the Data Science Pathway requires the completion of sixteen courses (not including BIS 525, BIS 526, BIS 695, EPH 100, EPH 101, and EPH 600).

All pathways Required courses (or approved substitutions) for all three pathways are: BIS 525 and BIS 526, Seminar in Biostatistics and Journal Club; BIS 623, Advanced Regression Models (or S&DS 612, Linear Models); BIS 628, Longitudinal and Multilevel Data Analysis; BIS 630, Applied Survival Analysis (or BIS 643, Theory of Survival Analysis); BIS 695, Summer Internship in Biostatistical Research; EPH 509, Fundamentals of Epidemiology; EPH 600, Research Ethics and Responsibility; EPH 608, Frontiers of Public Health; S&DS 541, Probability Theory (or S&DS 600, Advanced Probability, or S&DS 551, Stochastic Process); and S&DS 542, Theory of Statistics (or S&DS 610, Statistical Inference). Students entering the program with an M.P.H. may be exempt from EPH 508. Students in all pathways will also be required to attend a Professional Skills Seminar, EPH 100 and EPH 101 (details provided in the first term).

Biostatistics Standard Pathway Students in this pathway are also required to complete BIS 678, Statistical Practice I; BIS 679, Advanced Statistical Programming in SAS
and R; and BIS 681, Statistical Practice II. They must also complete three electives in Statistics and Data Science. Suggested electives are: S&DS 563, Multivariate Statistical Methods for the Social Sciences; S&DS 565, Introductory Machine Learning; S&DS 612, Linear Models (cannot fulfill elective requirement if used to substitute for BIS 623); or any other S&DS 600-level course. Students must also select two electives in Biostatistics. Suggested electives are: BIS 557, Computational Statistics; BIS 567, Bayesian Statistics; BIS 643, Theory of Survival Analysis (cannot fulfill elective requirement if used to substitute for BIS 630); BIS 646, Nonparametric Statistical Methods and their Applications; and BIS 691, Theory of Generalized Linear Models. Alternative electives must be approved by the student’s adviser and the DGS.

Students wishing to complete a thesis may enroll in BIS 649 and BIS 650, Master’s Thesis Research. This would be an additional requirement and cannot replace any of the required courses noted above. All students who complete a thesis will be required to present their research during a public seminar organized by the Biostatistics department.

Biostatistics Implementation and Prevention Science Methods Pathway Students in this pathway are also required to complete BIS 629, Advanced Methods for Implementation and Prevention Science; BIS 678, Statistical Practice I; BIS 679, Advanced Statistical Programming in SAS and R; BIS 681, Statistical Practice II; and EMD 533, Implementation Science. They must also complete three electives.* At least one of these electives must be from the following: BIS 536, Measurement Error and Missing Data; BIS 537, Statistical Methods for Causal Inference; and BIS 631, Advanced Topics in Causal Inference Methods. Up to two of these electives must be from the following: CDE 516, Principles in Epidemiology II; CDE 534, Applied Analytic Methods in Epidemiology; EMD 538, Quantitative Methods for Infectious Disease Epidemiology; HPM 570, Cost-Effectiveness Analysis and Decision-Making; HPM 586, Microeconomics for Health Policy and Health Management; HPM 587, Advanced Health Economics; HPM 611, Policy Modeling; SBS 541, Community Health Program Evaluation; SBS 574, Developing a Health Promotion and Disease Prevention Intervention; SBS 580, Qualitative Research Methods in Public Health; SBS 676, Questionnaire Development; and S&DS 565, Introductory Machine Learning. Alternative electives must be approved by the student’s adviser and the DGS.

A master’s thesis is strongly recommended in place of BIS 681 and one elective.

* Of the electives, the following are strongly recommended: HPM 570, HPM 611, SBS 541, and SBS 580.

Data Science Pathway Students in this pathway are also required to complete BIS 620, Data Science Software Systems; BIS 687, Data Science Capstone; and two of the following five courses: BIS 550, Topics in Biomedical Informatics and Data Science; BIS 555, Machine Learning with Biomedical Data; BIS 557, Computational Statistics; BIS 634, Computational Methods for Informatics; and BIS 646, Nonparametric Statistical Methods and Their Applications. One course in machine learning is required (if not taken from the list above) from the following: BIS 555, Machine Learning with Biomedical Data; BIS 557, Computational Statistics; BIS 634, Computational Methods for Informatics; BIS 646, Nonparametric Statistical Methods and Their Applications; CB&B 555, Unsupervised Learning for Big Data; CB&B 567, Topics in Deep Learning: Methods and Biomedical Applications; CB&B 663, Deep
Learning Theory and Applications; CB&B 745, Advanced Topics in Machine Learning and Data Mining; or S&DS 565, Introductory Machine Learning. Students must also complete one course related to databases from the following: BIS 550, Topics in Biomedical Informatics and Data Science; BIS 638, Clinical Database Management Systems and Ontologies; or CPSC 537, Introduction to Database Systems. Two additional electives are required from the machine learning or database list, or from BIS, S&DS, or CB&B. Alternative courses from Public Health, Computer Science, or other departments must be approved by the Data Science Pathway director and the DGS.

Students wishing to complete a thesis may enroll in BIS 649 and BIS 650, Master's Thesis Research. This would be an additional requirement and cannot replace any of the required courses noted above. All students who complete a thesis will be required to present their research during a public seminar organized by the Biostatistics department.

**TERMINAL M.S. WITH CONCENTRATION IN CHRONIC DISEASE EPIDEMIOLOGY**

This one-year program is designed for medical and health care professionals (e.g., M.D., Ph.D., D.V.M., D.D.S., D.M.D.) who seek the skills necessary to conduct epidemiological research in their professional practice. Part-time enrollment is permitted.

**Course Requirements**

The Chronic Disease Epidemiology concentration requires the completion of ten courses (not including CDE 525, CDE 526, and EPH 600), including a capstone course.* Required courses (or substitutions approved by the student’s adviser and the DGS) are: CDE 516, Principles of Epidemiology II; CDE 525 and CDE 526, Seminar in Chronic Disease Epidemiology; CDE 617, Developing a Research Proposal (or CDE 600, Independent Study or Directed Readings); EPH 508, Foundations of Epidemiology and Public Health; EPH 600, Research Ethics and Responsibility; and EPH 608, Frontiers of Public Health. Students must also complete three quantitative courses from the following list (in consultation with the student’s adviser, other courses may be approved): BIS 536, Measurement Error and Missing Data; BIS 537, Statistical Methods for Causal Inference; BIS 575, Introduction to Regulatory Affairs; BIS 621, Regression Models for Public Health; BIS 628, Longitudinal and Multilevel Data Analysis; BIS 630, Applied Survival Analysis; CDE 634, Advanced Applied Analytic Methods in Epidemiology and Public Health; S&DS 530, Data Exploration and Analysis; and S&DS 563, Multivariate Statistical Methods for the Social Sciences.

In addition, students must complete two electives in Chronic Disease Epidemiology and one additional elective chosen in consultation with the student’s adviser. Suggested CDE electives are: CDE 502, Physiology for Public Health; CDE 532, Epidemiology of Cancer; CDE 534, Applied Analytic Methods in Epidemiology; CDE 535, Epidemiology of Heart Disease and Stroke; CDE 545, Health Disparities by Race and Social Class: Application to Chronic Disease Epidemiology; CDE 551, Global Noncommunicable Disease; CDE 562, Nutrition and Chronic Disease; CDE 572, Obesity Prevention and Lifestyle Interventions; CDE 582, Health Outcomes Research; CDE 597, Genetic Concepts in Public Health; and CDE 650, Introduction to Evidence-Based Medicine
and Health Care, and CDE 588, Perinatal Epidemiology. Alternative electives must be approved by the student's adviser and the DGS.

* In the capstone course CDE 617, the student is required to develop a grant application that is deemed reasonably competitive by the instructor. An alternative to this capstone course is an individualized tutorial (CDE 600) in which the student completes a manuscript that is suitable for submission for publication in a relevant journal.

**TERMINAL M.S. WITH CONCENTRATION IN EPIDEMIOLOGY OF INFECTIOUS DISEASES**

This one-year program offers two areas of specialization: a quantitative area aims to provide quantitatively focused research training in the epidemiology of infectious diseases, focusing on the analysis of communicable disease data as well as modeling and simulation; and a clinical area aims to provide research training for clinicians and clinical trainees interested in furthering their research expertise. Part-time enrollment is permitted.

**Course Requirements**

The Epidemiology of Infectious Diseases concentration consists of ten courses (not including EPH 600, Research Ethics and Responsibility, and EMD 525/EMD 526, a yearlong seminar in infectious disease epidemiology). Course substitutions must be identified and approved by the student's adviser and the DGS.

The required courses (or approved substitutions) for the quantitative area of specialization include: BIS 623, Advanced Regression Models; BIS 630, Applied Survival Analysis; EMD 517 and EMD 518, Principles of Infectious Diseases I and II; EMD 525 and EMD 526, Seminar in Epidemiology of Microbial Diseases; EMD 553, Transmission Dynamic Models for Understanding Infectious Diseases (or EMD 539, Introduction to Public Health Surveillance); EMD 538, Quantitative Methods for Infectious Disease Epidemiology; EMD 625, How to Develop, Write, and Evaluate an NIH Proposal (or EMD 563, Laboratory and Field Studies in Infectious Diseases); EPH 508, Foundations of Epidemiology and Public Health; EPH 600, Research Ethics and Responsibility; EPH 608, Frontiers of Public Health; one elective; and a capstone project (see below).

The required courses for the clinical area of specialization include: BIS 505, Biostatistics in Public Health II (or CDE 534, Applied Analytic Methods in Epidemiology); EMD 517 and EMD 518, Principles of Infectious Diseases I and II; EMD 525 and EMD 526, Seminar in Epidemiology of Microbial Diseases; EMD 530, Health Care Epidemiology: Improving Health Care Quality through Infection Prevention (or EMD 536, Outbreak Investigations: Principles and Practice); EMD 567, Tackling the Big Three: Malaria, TB, and HIV in Resource-Limited Settings (or EMD 533, Implementation Science); EMD 625, How to Develop, Write, and Evaluate an NIH Proposal (or EMD 563, Laboratory and Field Studies in Infectious Diseases); EPH 505, Biostatistics in Public Health; EPH 508, Foundations of Epidemiology and Public Health; EPH 600, Research Ethics and Responsibility; EPH 608, Frontiers of Public Health; one elective; and a capstone project (see below).

There are two capstone course options: (1) students will develop an NIH-style research proposal focusing on a topic related to infectious disease epidemiology (EMD 625, How
to Develop, Write, and Evaluate an NIH Proposal); or (2) students may elect to enroll in EMD 563, Laboratory and Field Studies in Infectious Diseases, which will provide students with hands-on training in laboratory or epidemiological research techniques.

Suggested electives include: EMD 531, Genomic Epidemiology of Infectious Diseases; EMD 537, Water, Sanitation, and Global Health; EMD 541, Health in Humanitarian Crises; EMD 546, Vaccine and Vaccine Preventable Diseases; EMD 580, Reforming Health Systems: Using Data to Improve Health in Low and Middle Income Countries; EMD 582, Political Epidemiology. Alternative electives may be approved in consultation with the student’s adviser and DGS.

TERMINAL M.S. WITH CONCENTRATION IN HEALTH INFORMATICS

This two-year program provides well-rounded training in health informatics, with a balance of core courses from such areas as information sciences, clinical informatics, clinical research informatics, consumer health and population health informatics, and data science, and more broadly health policy, social and behavioral science, biostatistics, and epidemiology. First-year courses survey the field; the typical second-year courses are more technical and put greater emphasis on mastering the skills in health informatics. Part-time enrollment is not permitted.

Course Requirements

The Health Informatics concentration consists of a total of fourteen courses (excluding EPH 600, Research Ethics and Responsibility): eight required courses, four electives, and satisfactory completion of a yearlong capstone project (BIS 685 and BIS 686).

The eight required courses are: BIS 562, Clinical Decision Support or BIS 640, User-Centered Design of Digital Health Tools; BIS 633, Population and Public Health Informatics; BIS 634, Computational Methods for Informatics; BIS 638, Clinical Database Management Systems and Ontologies; CB&B 740/BIS 560, Introduction to Health Informatics; CB&B 750/BIS 550, Core Topics in Biomedical Informatics; EPH 508, Foundations of Epidemiology and Public Health, or EPH 509, Fundamentals of Epidemiology; and EPH 608, Frontiers of Public Health. Students who have demonstrated a mastery of topics covered by the required courses may substitute more advanced courses as approved by the student’s adviser and the DGS.

Four electives are required. Suggested electives are: BIS 540, Fundamentals of Clinical Trials; BIS 557, Computational Statistics; BIS 567, Bayesian Statistics; BIS 620, Data Science Software Systems; BIS 621, Regression Models for Public Health; BIS 628, Longitudinal and Multilevel Data Analysis; BIS 630, Applied Survival Analysis; BIS 691, Theory of Generalized Linear Models; BIS 568, Applied Machine Learning in Healthcare; CB&B 555, Unsupervised Learning for Big Data; CB&B 567, Topics in Deep Learning: Methods and Biomedical Applications; CB&B 645, Statistical Methods in Computational Biology; CB&B 663, Deep Learning Theory and Applications; CB&B 745, Advanced Topics in Machine Learning and Data Mining; CDE 566, Causal Inference Methods in Public Health Research; CPSC 546, Data and Information Visualization; CPSC 564, Algorithms and their Societal Implications; CPSC 577, Natural Language Processing; CPSC 582, Current Topics in Applied Machine Learning; EMD 533, Implementation Science; EPH 510, Health Policy and Health Care Systems; HPM 560, Health Economics and U.S. Health Policy; HPM 570, Cost-Effectiveness Analysis and Decision-Making; IMED 625,

Alternative electives may be approved in consultation with the student’s adviser and DGS.

Ph.D. or terminal M.S. degree program materials are available upon request to the Office of the Director of Graduate Studies (c/o M. Elliot), School of Public Health, Yale University, PO Box 208034, New Haven CT 06520-8034; 203.785.6383; email, melanie.elliot@yale.edu.

REQUIRED COURSES

For a complete list of Public Health courses, see the School of Public Health bulletin, available online at https://bulletin.yale.edu; and Yale Course Search at https://courses.yale.edu.

All Ph.D. students are required to take the following courses. Students entering the program with an M.P.H. may be exempt from EPH 608.

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