MPH/MSPH Degree Programs

Student Handbook

EMORY
ROLLINS SCHOOL OF PUBLIC HEALTH
Department of Biostatistics and Bioinformatics

http://www.sph.emory.edu/bios

THE FIELD OF BIOSTATISTICS

Biostatistics is the science that applies statistical theory and methods to the solution of problems in the biological and health sciences. A few examples of research questions which biostatistics can help answer are: What mathematical models can describe transmission and infection probabilities of infectious diseases such as AIDS and influenza? What are the risk factors associated with breast cancer? What preventive steps can people take to reduce the risk of heart disease? How many IV drug users have contracted AIDS in Georgia?

The main areas of effort for biostatisticians include collaborative research and consulting, methodological research, and education. In collaborative research, biostatisticians work on research studies with experts in the biological and health sciences. The biostatisticians' responsibilities include analysis of data and interpretation of results. Equally important, however, is the responsibility to assist in the planning and conduct of the study to ensure consistency with good statistical practice. Methodological research, such as developing mathematical models to describe biological phenomena, is conducted to enhance the existing bodies of knowledge in theoretical and applied biostatistics. Biostatisticians educate others about biostatistics through the teaching of graduate and continuing education courses, seminars, collaborative research and consulting activities.

Students entering graduate programs in biostatistics come from a variety of undergraduate fields. Many have undergraduate degrees in mathematics, applied mathematics or statistics. Others may have majored in the biological or social sciences. While specific requirements vary depending on the particular degree sought by a student, all students are expected to have a strong undergraduate background in mathematics or statistics, and a strong desire to study the theory and application of statistical methods in the biological and health sciences.

Upon enrolling in a biostatistics program, students take courses in statistical methods and theory. The methods courses focus on ways to select and apply statistical techniques that are appropriate for different types of problems. The theory courses provide rigorous instruction in the formal mathematical structure underlying the statistical techniques. Heavy use is made of computers in most biostatistics courses. Required and elective courses from other public health or biomedical fields are also included in the program of study.

Employment prospects for Masters level biostatisticians have been excellent in recent years. Positions as researchers and data analysts are commonly available in industry (e.g., pharmaceutical, consulting), academia (e.g., schools of public health and schools of medicine) and government agencies (e.g., the Centers for Disease Control and Prevention, local or state health departments). The monthly news magazine of the American Statistical Association (ASA), *Amstat News*, contains nationwide listings of career opportunities for biostatisticians. For more information about careers in biostatistics, visit the ASA website at www.amstat.org/careers.

THE DEPARTMENT OF BIOSTATISTICS AT EMORY UNIVERSITY

The Department of Biostatistics at Emory University was established in the early 1960's as the Department of Statistics and Biometry in the School of Medicine. In Fall 1990, it became one of six departments in the Rollins School of Public Health. The Department has 39 faculty, 15 adjunct and visiting faculty and one Emerita faculty.

Mission

The Department's mission is to establish the Rollins School of Public Health Department of Biostatistics as a recognized leader of biostatistical science in the United States. This includes pursuing excellence in the four core responsibility areas:

> **Education:** Educate others about biostatistics through mentoring of and teaching graduate students, inter-disciplinary courses, continuing education courses, and seminars.
>
> **Methodological Research:** Conduct methodological research to enhance the existing bodies of knowledge in theoretical and applied statistics.
>
> **Collaborative Research:** Conduct collaborative research studies that use biostatistical methods with experts in the biological and health sciences in which the statistician makes substantial contributions, from assistance in the planning and conduct of the study to analysis of data and interpretation of results.
>
> **Service:** Provide statistical support for research projects outside the department that are limited in time, nature, and scope. Participate on local and national committees or other "citizenship" responsibilities.

Teaching

The Department of Biostatistics and Bioinformatics offers the MSPH and MPH degrees in Biostatistics and Public Health Informatics through the Rollins School of Public Health. The Department has approximately 100 students in our masters programs.

Research

The research activities of the faculty are diverse and include studies of national and international scope. Department faculty conduct research relating to survival analysis, biomedical imaging statistics, spatial statistics, geographic information systems, disease ecology, clinical trials, the analysis of missing and mismeasured data, next-generation sequencing, genomics, proteomics, longitudinal analysis, high-dimensional variable selection, and estimating equation theory. Department faculty also regularly collaborate in statistical issues relating to cardiology, ophthalmology, neurology, environmental epidemiology, reproductive epidemiology, aging, and quality of life.

Consulting/Collaboration

Faculty of the department collaborate with researchers at the Centers for Disease Control and Prevention, the Carter Center of Emory University, the Emory University School of Medicine, and other health-related organizations. The Department coordinates the activities of the Biostatistics Collaboration Core, which serves as a resource for advice on the design, conduct, and analysis of studies in the health sciences. Students may gain hands-on experience in practical biostatistical problems through working with faculty on real-life consulting problems.

Opportunities for Practical Training

Opportunities for practical experience are often available in the form of collaborative research with a Biostatistics and Bioinformatics faculty member or summer internships with agencies affiliated with the Department. Some of these opportunities provide limited stipends. In the past, students have held internships at the Centers for Disease Control and Prevention, and at pharmaceutical and consulting firms in the Atlanta area. Teaching opportunities have also been available.

REAL Program

Rollins Earn And Learn (REAL) is a **work-study program** funded by Rollins that offers eligible, full-time MPH and MSPH students valuable opportunities to *earn while they learn* through applied public health experiences in real-world settings. Opportunities include federal, state, county, and other government agencies, as well as Emory-affiliated programs, for-profit, and nonprofit organizations throughout Atlanta. This program helps approximately 500 Rollins students find meaningful public health work opportunities each year. These integral experiences often fulfill practicum requirements, lead to thesis opportunities, and provide an enriching experience for both employers and students. In other words, it's a win-win.

Computing

Faculty and students have access to a variety of central servers, workstations, and microcomputers running UNIX, Linux, Mac OS, Windows and other operating systems. Software includes EPIINFO, Fortran, IMSL, LaTeX, Mathematica, Minitab, R, SAS, SPSS, Splus, StatExact, , Sudaan, C, and C++, WinBUGS[1]. Communication capabilities include access to the Internet. The Department has its own computer lab for students to use.

AFFILIATED SCHOOLS, CENTERS & INSTITUTES

The Emory School of Medicine

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[1] *The following products are trademarked by their respective companies: , UNIX, Linux, MacOS, Windows EPIINFO, Fortran, IMSL, LaTex, Mathematica, Minitab, R,SAS, SPSS, Splus, StatExact, , C, C++, and Sudaa, WinBUGS..*

The Emory School of Medicine is involved in an extensive program of teaching, research, and service. The School strives to offer the best possible learning opportunities in clinical medicine and research programs. Biostatistics and Bioinformatics faculty have extensive collaborative ties with researchers in the School of Medicine, including faculty at the General Clinical Research Center (GCRC), Winship Cancer Institute, and Departments of Genetics, Ophthalmology, Radiation Oncology, Pathology, Cardiology, Neurology, Rehabilitation Medicine, the Vaccine Center, and the Yerkes Primate Research Center.

The Centers for Disease Control and Prevention (CDC)

The CDC is a branch of the US Department of Health and Human Services that is internationally renowned for its work in public health. Biostatistics and Bioinformatics faculty have strong collaborative ties with researchers at the CDC, examples of which are given in the Research Activities section of this document. Several of the Department's adjunct faculty hold appointments in various offices and centers at the CDC, including the Epidemiology Program Office, Center for HIV/AIDS, Center for Environmental Health, Center for Infectious Disease, and Center for Prevention Services.

Emory Winship Cancer Institute

The Emory Winship Cancer Institute is a comprehensive cancer treatment, research and medical training facility recognized nationally and internationally for its capabilities. The Department of Biostatistics serves as a collaborative WCI partner in the areas of biostatistical research and informatics. The mission of the Biostatistics Research and Informatics (BRI) Core is to offer comprehensive, multi-disciplinary resources for the design and conduct of populational, clinical and basic science studies. These include the development of innovative statistical methodology, storage and retrieval of data generated, appropriate statistical analysis, and summarization of the results.

Within this context the Biostatistics and Bioinformatics Research and Informatics Core coordinates and manages statistical activities in the WCI to ensure that investigators have ready access to statistical consultation and support and provides statistical expertise in the design of experiments and studies, including research proposal development, sample size determination, randomization procedures, and plans for interim reviews and final analysis. In collaboration with the Clinical Translational Review Committee, the BRI Core reviews the integrity and statistical soundness of all studies involving human subjects, and interacts with the Clinical Trials and Translational Research Office in the development of protocols and the monitoring and reporting the clinical data.

Biostatistics Collaboration Core

The Biostatistics Collaboration Core (BCC) offers comprehensive statistical consultation and computational services to faculty, staff, and students in the Rollins School of Public Health, the Woodruff Health Sciences Center, and throughout Emory University. Its primary interest is in

assuring appropriate use of statistical methodology in all stages of research including preparation of grants and contracts, assistance in analyzing and presenting research data, and statistical review of manuscripts in the publication process.

THE COMMUNITY

Emory University

The 631 acre Emory campus is located in a historic Atlanta suburb about 15 minutes from downtown. The tree-covered, rolling hills provide an ideal college setting for the 11,000 students and the university faculty. The Quadrangle forms the center of the campus and includes many of the university's oldest buildings, several of which are listed on the National Register of Historic Places. Located on the Quadrangle are the Carlos Museum and the Pitts Theology Library, site of the second largest collection of theological titles in North America. Emory has six other libraries for a total of more than two million volumes.

The George W. Woodruff Physical Education Center, a twenty-one-million-dollar recreational complex, is one of the finer sports facilities in the country. It includes seventeen tennis courts, a fifty-meter swimming pool, gymnastics facilities, basketball courts, racquetball and squash courts, indoor and outdoor tracks, a soccer field, badminton and volleyball courts, a dance studio, combatives room, weight room, and human performance laboratory.

Adjacent to the campus is Lullwater, home of the university president. This park-like area of 185 acres includes a 12-acre lake and wooded jogging trails. Lullwater is open to the entire university community.

The Rollins School of Public Health is part of the Robert W. Woodruff Health Sciences Center which also includes the School of Medicine, the Nell Hodgson Woodruff School of Nursing, Emory University Hospital, Emory Midtown Hospital, and the Yerkes Regional Primate Research Center.

The Carter Center of Emory University addresses national and international issues of public policy and brings to Emory a wide range of scholars, government leaders, business executives and other professionals.

Emory University has been invited to join the Association of American Universities, which is made up of 63 of the most productive and accomplished research universities in the country. Emory has also been named to the top category of Research I Universities by the Carnegie Foundation. *U.S. News & World Report* ranked Emory 7th in the nation for its Master of Public Health and 21st overall among national universities. Emory is also currently ranked among the top ten colleges and universities with the largest endowments, with the highest rate of growth in research dollars and grants among universities in the country.

Atlanta

Atlanta is a progressive, dynamic city that has evolved into the cultural, educational, and financial hub of the South. The population of almost 6 million is a mixture of people from the South and other parts of the US along with people from almost every foreign country imaginable, giving the city a rich ethnic and cultural diversity. An efficient rapid rail and city bus system and an advanced highway grid make the entire metro area accessible by both public and private transportation.

Almost any activity is available in the metro area. Atlanta is home to professional baseball, football, basketball, soccer teams, and NASCAR racing. Cultural activities include the Atlanta Symphony Orchestra, the Alliance and Fox Theaters, the Atlanta Ballet, the Atlanta Opera, and the High Museum of Art. Atlanta hosted the 1996 Summer Olympic games.

Atlanta has a dynamic business climate. More than 450 of the Fortune 500 companies have operations in Atlanta. Atlanta has the busiest airport in the US, Hartsfield Jackson International Airport.

Atlanta's climate makes it an extremely livable city, with four distinct seasons. Warm weather extends through the middle of fall; the winter is usually mild with a few snow days each year. The city is nationally known for its brilliant azaleas, rhododendrons, and dogwoods that bloom every spring. Atlanta is just a few hours from the mountains of North Georgia and the Carolinas and from the beaches of Georgia and Florida.

MPH/MSPH DEGREES OFFERED BY THE DEPARTMENT OF BIOSTATISTICS AND BIOINFORMATICS

- Master of Public Health in Biostatistics (MPH)
- Master of Science in Public Health in Biostatistics (MSPH)
- Bachelors of Arts/Bachelors of Science -Master of Science in Public Health in Biostatistics (BA/BS-MSPH)

Which Degree Program Should I Choose?
The degree programs are distinct and it is important to understand which one best fits your needs. The table below details some of the major differences between the programs.

	MPH in Biostatistics	**MSPH in Biostatistics**
Program Focus	Applied Biostatistics, general public health applications	Preparation for doctoral programs in biostatistics, clinical and biomedical statistics, including public health
Credits Required	42	48
Elective Credits	2-5	5
Thesis Required?	Yes	Yes
Cohort size	25	40
Sample key skills	Study design, data management, data analysis, survey analysis, in public health	Study design, data analysis, statistical theory in biomedical research (including public health)
Sample Career path	Public health agency, local health department, public health-based NGO, medical school, doctoral study in public health discipline (e.g., epidemiology, environmental health, global health)	Pharmaceutical company, clinical research organization, public health agency, doctoral study in Statistics or Biostatistics

MPH in Biostatistics

The MPH programs in biostatistics offered through the Rollins School of Public Health are designed for individuals with good quantitative skills and interests in the health sciences. Besides courses in biostatistics and epidemiology, the MPH programs include core courses from other public health disciplines. The MPH program provides some training in biostatistics to students who are interested in broader public health related issues.

Students can enter the MPH programs from a variety of academic and professional backgrounds. Some applicants pursue a degree in biostatistics directly after completing undergraduate studies. For others, study in biostatistics is undertaken after completion of medical or public health training or experience. To the extent possible, the curriculum of each student is tailored to his or her background and interests. Students with prior, relevant course work may receive academic credit toward their degree program in biostatistics.

Admission Requirements

A baccalaureate degree from an accredited college or university is required for admission into the MPH program. **Successful completion of multivariate calculus (Calculus III) and a course in linear algebra with a grade of B+ or better are required for admission to the Biostatistics MPH program.** Applicants must submit GRE scores unless they have a doctoral degree in a comparable field. Scores for all sections of the GRE must be above the 50th percentile with a GPA of 3.5 or higher. International applicants whose native language is not English must take the Test of English as a Foreign Language (TOEFL) with a score of 95 or higher.

Applicants to biostatistics are selected on the basis of their quantitative skills and their potential to make a contribution to the practice of biostatistics in a public health setting. Admissions criteria are:

1. Previous studies and grades, especially in quantitative courses such as mathematics, statistics, and computer sciences;

2. Graduate Record Examination (GRE) scores, especially the quantitative and analytic portions;

3. Letters of recommendation that allow the evaluation of the applicant's quantitative abilities and background in public health; and

4. Course work, experience, or interest in health-related subjects.

Tuition and Financial Aid

A small number of merit-based scholarships are available for MSPH and MPH students. US citizens and permanent residents may apply for needs-based financial aid through the Emory Office of Financial Aid. Research assistantships and internships may be available to students in these programs.

Competencies in MPH in Biostatistics

Upon completion of the MPH degree, the graduate will be able to:

- Identify statistical issues in contemporary public health problems.
- Perform power and sample size calculations to assist in the design of clinical or observational studies.
- Use statistical software for advanced data management.
- Analyze continuous data using linear regression models and discrete data using generalized linear models.
- Analyze right-censored data with time-to-event regression models.
- Analyze correlated data (longitudinal and multi-level) using mixed effect and marginal models.
- Explain fundamental concepts of probability and inference used in statistical methodology.

MPH in Biostatistics Course Plan

This is a MPH program for a student who arrives with the required mathematics background.

Year 1 – Fall Semester

Course No.	Title	Credits
BIOS 506	Foundations of Biostatistical Methods	4
BIOS 510	Introduction to Probability Theory	4
BIOS 531	SAS Programming	2
BIOS 590R	Seminar in Biostatistics	1
EPI 530	Epi Methods I	4
PUBH 500	Introduction to Public Health	0
PUBH 501	Inter-Professional Team Training	0

Year 1 – Spring Semester

Course No.	Title	Credits
BIOS 507	Applied Regression Analysis	4
BIOS 511	Intro. to Statistical Inference	4
BSHE 500	Behavioral Sciences in Public Health	2
HPM 500	Intro to US Health Care System	2
BIOS 590R	Seminar in Biostatistics	1
PUBH 502	Public Health Professional Development Seminar	0

Year 1 – Summer Semester

Course No.	Title	Credits
BIOS 595	Applied Practical Experience (APE)	0

Year 2 – Fall Semester

Course No.	Title	Credits
BIOS 521	Applied Survival Analysis	2
BIOS 525	Longitudinal & Multilevel Data Analysis	2
BIOS 580	Statistical Practice I	2
GH 500	Critical Issues in Global Health	2
EOH 500	Perspectives in Environmental Health	2
BIOS 590R	Seminar in Biostatistics	1

Year 2 – Spring Semester

Course No.	Title	Credits
BIOS 581	Statistical Practice II (Capstone)	2
OR		
BIOS 599R	Thesis	2
BIOS 590R	Seminar in Biostatistics	
	Elective(s)	4

TOTAL CREDIT HOURS: 42

Required Courses: In the MPH program, there are 7 required Biostatistics courses (BIOS 506, BIOS 507, BIOS 510, BIOS 511, BIOS 521, BIOS 525 and BIOS 531) which serve as the foundation of the degree program. Students must attain at least a B- or better in BIOS 506, BIOS 507, BIOS 510, and BIOS 511 to progress to the next level of coursework.

Core Courses: A student must take a core course from each of the following departments: Behavioral Sciences & Health Education, Environmental Health, Health Policy & Management, and Global Health.

Professional Development Courses: Students will register for three required Professional Development courses in their 1st Fall semester (PUBH 500, PUBH 501, and PUBH 502). These

classes involve mostly self-administered, self-paced activities outside of the classroom with very minimal in-class requirements to enhance professional development, knowledge, and understanding.

Electives: A student has to take from four semester hours of elective courses.

The total number of credit hours required for the degree is 42. To receive the MPH degree, the student must pass all the required and elective courses, including the practicum experience described above, maintain a cumulative GPA of at least B-, and submit either a Capstone or acceptable MPH thesis.

Applied Practice Experience (APE)

An Applied Practice Experience (APE) is a unique opportunity for graduate students to integrate and apply practical skills and training learned through course work and prior experiences in a professional public health environment. All RSPH graduate students are required to complete an APE of at least 200 hours in a public health agency, institution, or community under the supervision of site supervisor and the guidance of the Department. Although there are no credits associated with the APE requirement, the completion of the requirement is noted on the student's transcript.

MSPH in Biostatistics

The MSPH program in biostatistics offered through the Rollins School of Public Health are designed for individuals with good quantitative skills and interests in the health sciences. Besides courses in biostatistics and epidemiology, the MSPH programs include core courses from other public health disciplines. The MSPH program provides rigorous training in biostatistical methods and their applications. Students in this program are trained for positions in government and private health agencies, industry, and research institutes. The MSPH program may also serve as a preparation for entering a doctoral program in biostatistics.

Students can enter the MSPH program from a variety of academic and professional backgrounds. Some applicants pursue a degree in biostatistics directly after completing undergraduate studies. For others, study in biostatistics is undertaken after completion of medical or public health training or experience. To the extent possible, the curriculum of each student is tailored to his or her background and interests. Students with prior, relevant course work may receive academic credit toward their degree program in biostatistics.

Admission Requirements

A baccalaureate degree from an accredited college or university is required for admission into the MSPH program. **Successful completion of multivariate calculus (Calculus III) and a course in linear algebra with a grade of B+ or better are required for admission to the Biostatistics MPH program.** Applicants must submit GRE scores unless they have a doctoral degree in a comparable field. Scores for all sections of the GRE must be above the 50th percentile with a GPA of 3.5 or higher. International applicants whose native language is not English must take the Test of English as a Foreign Language (TOEFL) with a score of 95 or higher.

Applicants to biostatistics are selected on the basis of their quantitative skills and their potential to make a contribution to the practice of biostatistics in a public health setting. Admissions criteria are:

1. Previous studies and grades, especially in quantitative courses such as mathematics, statistics, and computer sciences;
2. Graduate Record Examination (GRE) scores, especially the quantitative and analytic portions;
3. Letters of recommendation that allow the evaluation of the applicant's quantitative abilities and background in public health; and
4. Course work, experience, or interest in health-related subjects.

Tuition and Financial Aid

A small number of merit-based scholarships are available for MSPH and MPH students. US citizens and permanent residents may apply for needs-based financial aid through the Emory Office of Financial Aid. Research assistantships and internships may be available to students in these programs.

Competencies in MSPH in Biostatistics

Upon completion of the MSPH degree the graduate will be able to:

- Identify statistical issues in contemporary public health problems.
- Perform power and sample size calculations to assist in the design of clinical or observational studies.
- Use statistical software for advanced data management.
- Analyze continuous data using linear regression models and discrete data using generalized linear models.
- Analyze right-censored data with time-to-event regression models.
- Analyze correlated data (longitudinal and multi-level) using mixed effect and marginal models.
- Assess the impacts of assumptions in advanced statistical analysis using probability and statistical theory.
- Apply concepts in probability and statistical theory to define performance or extend basic statistical analysis techniques.
- Assess technical accuracy and performance of advanced analytic methods.

MSPH in Biostatistics Course Plan

This is a MSPH program for a student who arrives with the required mathematics background.

Year 1 – Fall Semester

Course No.	Title	Credits
BIOS 508	Biostatistical Methods I	4
BIOS 512	Probability Theory I	4
BIOS 531	SAS Programming	2
BIOS 590R	Seminar in Biostatistics	1
EPI 530	Epi Methods 1	4
PUBH 500	Introduction to Public Health	0
PUBH 501	Inter-Professional Team Training	0

Year 1 – Spring Semester

Course No.	Title	Credits
BIOS 509	Applied Linear Models	4
BIOS 513	Statistical Inference I	4

BSHE 500	Behavioral Sciences in Public Health	2
HPM 500	Intro to US Health Care System	2
BIOS 590R	Seminar in Biostatistics	1
PUBH 502	Public Health Professional Development Seminar	0

Year 1 – Summer Semester

Course No.	Title	Credits
BIOS 595	Applied Practical Experience (APE)	0

Year 2 – Fall Semester

Course No.	Title	Credits
BIOS 522	Survival Analysis Methods	2
BIOS 526	Modern Regression Analysis	3
BIOS 580	Statistical Practice I	2
GH 500	Critical Issues in Global Health	2
EOH 500	Perspectives in Environmental Health	2
BIOS 590R	Seminar in Biostatistics	1

Year 2 – Spring Semester

Course No.	Title	Credits
BIOS 581	Statistical Practice II (Capstone)	2
OR		
BIOS 599R	Thesis	2
BIOS 590R	Seminar in Biostatistics	1
	Elective(s)	9

TOTAL CREDIT HOURS: 48

Required Courses: In the MSPH program, there are eight required Biostatistics courses (BIOS 508, BIOS 509, BIOS 512, BIOS 513, BIOS 522, BIOS 526, and BIOS 531) which serve as the foundation of the degree program. Students must attain at least a B- or better in BIOS 508, BIOS 509, BIOS 512, and BIOS 513 to progress to the next level of coursework.

Core Courses: A student must take a core course from each of the following departments:

Behavioral Sciences/Health Education, Environmental Health, Health Policy & Management, and Global Health.

Professional Development Courses: Students will register for three required Professional Development courses in their 1st Fall semester (PUBH 500, PUBH 501, and PUBH 502). These classes involve mostly self-administered, self-paced activities outside of the classroom with very minimal in-class requirements to enhance professional development, knowledge, and understanding.

Electives: A student has to take nine semester hours of elective courses.

The total number of credit hours required for the degree is 48. To receive the MSPH degree, the student must pass all required core and elective courses, maintain a cumulative GPA of at least B-, and submit an acceptable MSPH thesis.

Applied Practice Experience (APE)

An Applied Practice Experience (APE) is a unique opportunity for graduate students to integrate and apply practical skills and training learned through course work and prior experiences in a professional public health environment. All RSPH graduate students are required to complete an APE of at least 200 hours in a public health agency, institution, or community under the supervision of site supervisor and the guidance of the Department. Although there are no credits associated with the APE requirement, the completion of the requirement is noted on the student's transcript.

BA/BS -MSPH Program in Biostatistics

Emory College and the Rollins School of Public Health (RSPH) jointly offer a 5-year bachelors/master's degree program. Students have an opportunity to complete a Bachelor of Arts (BA) degree/ Bachelor of Science (BS) degree in Emory College, most likely with a major concentration in Mathematics and Computer Sciences, and a Master of Science in Public Health (MSPH) degree in Biostatistics within five years. Emory College students can apply, and may be admitted, to the program during their third (Junior) year and enroll in 12 semester hours of credits in MSPH courses during their fourth (Senior) year. Course credits taken by Emory College students in the RSPH during the fourth (Senior) year count towards the required 132 hours of credit for the Bachelor of Arts degree as well as for the required 48 hours for the MSPH degree in Biostatistics. Two undergraduate courses (totaling 6 semester hours) offered by the Department of Mathematics will also count towards the MSPH degree in Biostatistics. Students graduating from Emory College with the BA degree will then take courses during their fifth year as MSPH student in the RSPH.

Admission

Students normally apply for admission to the program early in their third (Junior) year. Although applicants to the Rollins School of Public Health are required to submit Graduate Record Examination scores, applicants to this program will be selected on the basis of performance and promise as Emory undergraduates. The Department of Biostatistics will review student applications (and may choose to interview them as part of the process) and make the admissions decision in consultation with the Department of Mathematics and Computer Sciences. Students will learn of their acceptance during their third (Junior) year, prior to the time of pre-registration for the Fall Semester of their fourth (Senior) year. In order to strategically plan an academic program that will meet all undergraduate requirements and allow time for the required courses during their fourth (Senior) year, students may have to work with their undergraduate academic advisor as early as their third (Junior) year.

It is expected that students enrolling in this program will have completed the following undergraduate courses in Mathematics and Computer Sciences: Mathematics 111, 112, 211, 221, 361 and 362. A background in the biological sciences is preferable but not required. Students should be in good academic standing at the time of admission.

Advisement

Once students are admitted to the program, they will be assigned an academic advisor in the Department of Biostatistics and Bioinformatics whom they may consult in addition to their undergraduate academic advisor.

Degree Requirements

<u>College, BA/BS:</u> The program does not affect requirements for a major concentration, including College distribution and writing requirements. Students will complete the required number of credit hours to graduate with a BA/BS degree at the end of four years. MSPH courses in the RSPH taken during the fourth (Senior) undergraduate year will count towards the 132 semester hours required for the BA degree (and also, the required 48 hours for the MSPH degree). BIOS 508 and BIOS 509 will contribute 8 hours toward the 20 elective hour requirement for the

Mathematics BA degree.

Tuition and Financial Aid

Students entering the School of Public Health in the 5th year are like any other new student. They are considered dual degree students and are only charged tuition and fees in their 5th year from RSPH. Hence, RSPH only sees them as being at RSPH for one year.

Competencies in BA/BS -MSPH in Biostatistics

Upon completion of the MSPH degree the graduate will be able to:

- Identify statistical issues in contemporary public health problems.
- Perform power and sample size calculations to assist in the design of clinical or observational studies.
- Use statistical software for advanced data management.
- Analyze continuous data using linear regression models and discrete data using generalized linear models.
- Analyze right-censored data with time-to-event regression models.
- Analyze correlated data (longitudinal and multi-level) using mixed effect and marginal models.
- Assess the impacts of assumptions in advanced statistical analysis using probability and statistical theory.
- Apply concepts in probability and statistical theory to define performance or extend basic statistical analysis techniques.
- Assess technical accuracy and performance of advanced analytic methods.

BA/BS -MSPH in Biostatistics Course Plan

Required Courses:

Year 3 - Fall Semester

Course No.	Title	Credits
MATH 361	Probability and Statistics	3

Year 3 - Spring Semester

Course No.	Title	Credits
MATH 362	Probability and Statistics II	3

Year 4 - Fall Semester

Course No.	Title	Credits

BIOS 508	Biostatistical Methods I	4
BIOS 531	SAS Programming	2
EPI 530	Epi Methods I	4
HPM 500	Intro to US Health Care System	2

Year 4 - Spring Semester

Course No.	Title	Credits
BIOS 509	Applied Linear Models	4
BSHE 500	Behavioral and Social Sciences in Public Health	2
EOH 500	Perspectives in Environmental Health	2

Year 4 - Summer Semester

Course No.	Title	Credits
BIOS 595R	Applied Practice Experience (APE)	0

Year 5 - Fall Semester

Course No.	Title	Credits
BIOS 522	Survival Analysis Methods	2
BIOS 526	Modern Regression Analysis	3
BIOS 580	Statistical Practice I	2
GH 500	Critical Issues in Global Health	2
PUBH 500	Introduction to Public Health	0
PUBH 501	Inter-Professional Team Training	0

Year 5 - Spring Semester

Course No.	Title	Credits
BIOS 581	Statistical Practice II (Capstone)	2
OR		
BIOS 599R	Thesis	2
PUBH 502	Public Health Professional Development Seminar	0
	Electives	9

TOTAL CREDIT HOURS: 48

Core Courses: A student must take a core course from each of the following departments: Behavioral Sciences/Health Education, Environmental Health, Health Policy & Management, and Global Health.

Professional Development Courses: Students will register for three required Professional Development courses in their 1st semester of their 5th year (PUBH 500, PUBH 501, and PUBH 502). These classes involve mostly self-administered, self-paced activities outside of the classroom with very minimal in-class requirements to enhance professional development, knowledge, and understanding.

Electives: A student has to take nine semester hours of elective courses.

The total number of credit hours required for the degree is 48. To receive the MSPH degree, the student must pass all required core and elective courses, maintain a cumulative GPA of at least B-, and submit an acceptable MSPH thesis.

Applied Practice Experience (APE)

An Applied Practice Experience (APE) is a unique opportunity for graduate students to integrate and apply practical skills and training learned through course work and prior experiences in a professional public health environment. All RSPH graduate students are required to complete an APE of at least 200 hours in a public health agency, institution, or community under the supervision of site supervisor and the guidance of the Department. Although there are no credits associated with the APE requirement, the completion of the requirement is noted on the student's transcript.

COURSE DESCRIPTIONS

BIOS 506 (4) Foundations of Biostatistical Methods: This course presents a sophisticated introduction to the concepts and methods of biostatistical data analysis. The topics include descriptive statistics; probability; applications of the binomial, Poisson and normal distributions; sampling distributions; point and confidence interval estimation; hypothesis testing; a variety of one- and two-sample parametric and non-parametric methods for analyzing continuous or discrete data; and simple linear regression. The course will also equip students with computer skills for implementing these statistical methods using statistical software R. Prerequisites: College-level courses in linear algebra and calculus.

BIOS 507 (4) Applied Regression Analysis: This is the first regression analysis course in applied statistics designed for MPH students. Both theoretical and applied aspects of linear regression and generalized linear regression modeling will be covered in this course. The emphasis will be on applications. The first part of the course covers the following topics: simple linear regression, multiple linear regression, analysis of variance, confounding and interaction, residual and influence diagnostics, variable transformations, multicollinearity, model selection and validation. The second part of the course includes: generalized linear models, introduction to maximum likelihood estimation, logistic regression, nominal and ordinal logistic regression, Poisson regression. Parameter interpretation and scientific interpretation of results will be emphasized throughout the course. Students are expected to use SAS (or R), when necessary, for homework assignments.

BIOS 508 (4) Biostatistical Methods: This course is a required course for BIOS MSPH students. It is taken by the BIOS MSPH students and PhD students in the Fall semester of their first year in the program. The prerequisites include College-level courses in Linear algebra and Calculus and programming experience in either SAS or R (or concurrent enrollment in BIOS 531: SAS Programming.) This course provides a mathematically sophisticated introduction to the concepts and methods of biostatistical data analysis. It aims to provide the students the skills to collaborate with investigators and statistical colleagues in the analysis of data from biomedical and public health studies and to communicate the results of statistical analyses to a broad audience. The topics include descriptive statistics; probability; detailed development of the binomial, Poisson and normal distributions and simulation of random variables from these distributions; sampling distributions; point and confidence interval estimation; simulation studies; hypothesis testing; power analysis and sample size calculations; a variety of one- and two-sample parametric and non-parametric methods for analyzing continuous or discrete data and resampling statistics. The course will also equip students with computer skills for implementing these statistical methods using standard statistical software SAS or R.

BIOS 509 (4) Applied Linear Models: The course covers statistical methodology for the analysis of continuous outcome data, primarily from cross-sectional studies and designed experiments. We introduce the key matrix-based methods for estimation and inference based on the multiple linear regression model. Subsequently, topics include secondary hypothesis testing and restrictions, regression diagnostics, model selection, confounding and interaction, analysis of variance and covariance, and an introduction to random effects and the mixed linear model.

BIOS 510 (4) Probability Theory I: Axiomatic probability, random variables, distribution theory, special parametric families of univariate distributions, joint and conditional distributions,

distributions of functions of random variables, and probability modeling. Prerequisite: calculus and multivariate analysis.

BIOS 511 (4) Introduction to Statistical Inference : This course provides an introduction to statistical inference. The course is required for Biostatistics MPH students and taken in the second semester of the first year. Fundamental concepts in statistical inference will be covered including: statistical models, sampling distributions, standard errors, asymptotic normality, confidence intervals, hypothesis tests, power analysis. Common frameworks for inference will be discussed including: parametric/likelihood-based inference, the delta method, bootstrap, permutation tests, Bayesian inference.

BIOS 512 (4) Probability Theory I: Introduction to probability, random variables, distributions, conditional distributions, expectations, moment generating functions, and convergence concepts.

BIOS 513 (4) Statistical Inference I: Introduces the theory of parameter estimation, interval estimation, and tests of hypotheses. In this course, we emphasize the classical "frequentist" (i.e., Neyman-Pearson-Wald) approach to inference. As time permits, we briefly explore alternative paradigms of inference such as neo-Fisherian, Bayesian, and statistical decision theory. This course is required for Biostatistics MSPH students and typically is taken in the second semester of the first year.

BIOS 516 (1) Introduction to Large- Scale Biomedical Data Analysis: This is the overview course for the Bioinformatics, Imaging and Genetics (BIG) concentration in the PhD program of the Department of Biostatistics and Bioinformatics. It aims to introduce students to modern high-dimensional biomedical data, including data in bioinformatics and computational biology, biomedical imaging, and statistical genetics. This course will be co-taught by all BIG core faculty members, with each faculty member giving one or two lectures. The focus of the course will be on the data characteristics, opportunities and challenges for statisticians, as well as current developments and hot areas of the research fields of bioinformatics, biomedical imaging and statistical genetics.

BIOS 520 (2) Clinical Trials Methodology: Covers the organization, methodology, and reporting results of clinical trials. Topics covered include: conceptualization, ethical considerations, protocol adherence and compliance, and data collection, as well as statistical techniques such as randomization, double-blind techniques, sample size determination, and analysis considerations. Prerequisites: BIOS 500, or BIOS 506.

BIOS 521 (2) Applied Survival Analysis: This course will provide an introduction to statistical concepts and methods related to the analysis of survival data. Topics include survival functions, hazard rates, types of censoring and truncation, life table, log-rank tests, Cox regression models, and parametric regression models. The emphasis is on practical implementation of standard survival analysis methods using SAS or R and results interpretations.

BIOS 522 (2) Survival Analysis Methods: Deals with the modern methods used to analyze time-to-event data. Background theory is provided, but the emphasis is on using methods and interpreting the results. The course provides coverage of survivorship functions, Kaplan-Meier curves, logrank test,

Cox regression, model fitting strategies, model interpretation, stratification, time dependent covariates, and introduction to parametric survival models. Computer programs are used. A data analysis project is required. Prerequisites: BIOS 500 and BIOS 501, or BIOS 506 and BIOS 507.

BIOS 524 (2) Introduction to Analytic Methods for Infectious Diseases: Introduces dynamic and epidemiologic concepts particular to infectious diseases, including the elements of the infection process; transmission patterns, epidemic, endemic, micro- and macroparasitic diseases; zoonoses, basic reproduction number; dependent happenings; and direct and indirect effect of intervention. Prerequisites: Previous or concurrent enrollment in BIOS 500 or BIOS 506, and BIOS 510.

BIOS 525 (2) Longitudinal and Multilevel Data Analysis: This course introduces students to regression techniques commonly used in analyzing longitudinal and multilevel data that are frequently encountered in biomedical and public health research. This course draws motivating examples from environmental and social epidemiology, health services research, clinical studies, and behavioral sciences. The course focuses on data analysis and interpretation. Students will gain practical experience using R/SAS/Stata for statistical computing.

BIOS 526 (3) Modern Regression Analysis: This course introduces students to modern regression techniques commonly used in analyzing public health data. Topics include: (1) parametric and non-parametric methods for modeling non-linear relationships; (2) methods for modeling longitudinal and multilevel data that account for within group correlation; (3) Bayesian regression modeling; and (4) methods for multivariate outcomes. Prerequisites: BIOS 509 or instructor's permission.

BIOS 531 (2) SAS Programming: This course offers instruction in basic SAS programming. It assumes no prior knowledge of SAS, and begins with an introduction to the data step and procedure call. Topics covered include: dataset manipulation, report writing, arrays, looping, simulation, SAS macro, SAS Interactive Matrix Language (IML), SAS Graphics, and SAS Output Delivery System (ODS). The course prepares students to take the Base SAS Certification exam. Students who pass this exam successfully receive a certificate of completion from the SAS Institute. Prerequisites: BIOS 501 or equivalent, OR BIOS 506 (concurrent), OR permission of the instructor.

BIOS 532 (2) Statistical Computing: Programming style and efficiency, data management and data structures, hardware and software, maximum likelihood estimation, matrix methods and least squares, Monte Carlo simulation, pseudo-random number generation, bootstrap, and UNIX-based computing and graphical methods. Prerequisite: BIOS 531, BIOS 506, and BIOS 510, or permission of instructor.

BIOS 534 (2) Machine Learning: This course covers fundamental machine learning theory and techniques. The topics include basic theory, classification methods, model generalization, clustering, and dimension reduction. The material will be conveyed by a series of lectures, homeworks, and projects.

BIOS 540 (2) Introduction to Bioinformatics: This course is an introduction to the field of Bioinformatics for students with a quantitative background. The course covers biological sequence analysis, introductions to genomics, transcriptomics, proteomics and metabolomics, as well as some basic data analysis methods associated with the high-throughput data. In addition, the course introduces concepts such as curse of dimensionality, multiple testing and false discovery rate, and

basic concepts of networks.

BIOS 544 (2) Introduction to R programming for Non-BIOS students: The goal of the course is to will provide an introduction to R in organizing, analyzing, and visualizing data. Once you've completed this course you'll be able to enter, save, retrieve, summarize, display and analyze data.

BIOS 545 (2) R Programming for BIOS students: This course covers the basic contents of R programming with applications on statistical data analysis. Topics include data types, language syntax, basic graphics, debugging, creating packages and documentation.

BIOS 550 (2) Sampling Applications I: How to select probability samples and analyze data using simple random sampling, stratified random sampling, cluster sampling and multistage sampling. The software package PC-SUDAAN is used for data analysis. Prerequisite: BIOS 500 and 501 or BIOS 506.

BIOS 555 (2) High-Throughput Data Analysis using R and BioConductor: This course covers the basics of microarray and second-generation sequencing data analysis using R/BioConductor and other open source software. Topics include gene expression microarray, RNA-seq, ChIP-seq and general DNA sequence analyses. We will introduce technologies, data characteristics, statistical challenges, existing methods and potential research topics. Students will also learn to use proper Bioconductor packages and other open source software to analyze different types of data and deliver biologically interpretable results.

BIOS 560R (VC) Current Topics in Biostatistics: A faculty member offers a new course on a current topic of interest for both PhD and Master's students.

BIOS 570 (2) Introduction to Statistical Genetics: This is an introductory course for graduate students in Biostatistics, Bioinformatics, Epidemiology, Genetics, Computational Biology, and other related quantitative disciplines. The course will cover statistical methods for the analysis of family and population based genetic data. Topics covered will include classical linkage analysis, population-based and family based association analysis, haplotype analysis, genome wide association studies, basic principles in population genetics, imputation-based analysis, pathway based analysis, admixture mapping, analysis of copy number variations, and analysis of massively parallel sequencing data. Students will be exposed to the latest statistical methodology and computational tools on gene mapping for complex human diseases.

BIOS 580 (2) Statistical Practice I: This course will cover topics dedicated to preparing students to collaborate as biostatisticians for public health and biomedical projects with non-statisticians. Covered topics will include consulting versus collaboration, ethics, nonstatistical aspects of collaboration (e.g. interpersonal communication), and negotiating expectations with clients. The students will work together in small groups to develop research questions based on an existing real life datasets and discussion with clinical collaborator, conduct power analyses, choose the appropriate statistical methodology to analyze the research questions, then answer at least one of the questions, and present the results in both oral and written format. In addition, individually each student will complete a series of milestones that results in oral and/or written proposal for individual capstone project to be completed in the Spring semester.

BIOS 581 (2) Statistical Practice II (Capstone): This is a required course for the MPH and MSPH students in the Biostatistics and Bioinformatics program in their final spring semester. The purpose of the course is to help students with their capstone project in project management, manuscript writing, and oral presentation while they conduct their project with their individual BIOS advisors. Students will review journal articles to critique study design and statistical analysis methods in a journal club format. They will learn how to write journal articles section by section through lectures and homework assignments. They will develop a manuscript based on their capstone project. At the end of the semester, each student will give an oral presentation on his/her capstone project. Each student will also make a poster on his/her capstone project. Students will receive feedbacks from their peers and instructors to improve their writing and presentation skills. The prerequisite is BIOS 580 - Statistical Practice I.

BIOS 590R (1) Seminar in Biostatistics: features invited speakers, departmental faculty, students, and others who discuss special topics and new research findings.

BIOS 595R (0) Practicum: Enables students to apply skills and knowledge in an applied setting through a supervised field training experience in a public health setting that complements the student's interests and career goals. Must meet RSPH guidelines and have departmental approval.

BIOS 597R (VC) Directed Study: Provides an in-depth exposure to specific topics not covered in regular courses, for example, statistical genetics and specialized experimental designs.

BIOS 598R (VC) Special Projects: Involves intern-like participation on specific scholarly, research, or developmental projects that expose students to the role of the statistical consultant or collaborator in a variety of research settings.

BIOS 599R (VC) Thesis: Master's thesis research.

BIOS 707 (4) Advanced Linear Models: Generalized inverse of a matrix; vectors of random variables; multivariate normal distribution; distribution theory for quadratic forms of normal random variable; fitting the general linear models by least squares; design matrix of less than full rank; estimation with linear restrictions; estimable functions; hypothesis testing in linear regression; and simultaneous interval estimation. Prerequisites: BIOS 507, BIOS 511, and a course in matrix algebra.

BIOS 709 (4) Generalized Linear Models: Studies analysis of data using generalized linear models, as well as models with generalized variance structure. Parametric models include exponential families such as normal, binomial, Poisson, and gamma. Iterative reweighted least squares and quasi-likelihood methods are used for estimation of parameters. Methods for examining model assumptions are studied. Generalized estimating equations (GEE) and quadratic estimating equations are introduced for problems where no distributional assumptions are made about the errors except for the structure of the first two moments. Illustrations with data from various basic science, medicine, and public health settings. Prerequisite: BIOS 511 and BIOS 707.

BIOS 710 (4) Probability Theory II: Axioms of probability, univariate and multivariate distributions, convergence of sequences of random variables, Markov chains, random processes, martingales. Prerequisite: BIOS 512 and BIOS 511.

BIOS 711 (4) Statistical Inference II: Examines the fundamental role of the likelihood function in statistical inference, ancillary and sufficient statistics, estimating functions, and asymptotic theory. This course presents conditional, profile and other approximate likelihoods; various ancillary concepts; generalizations of Fisher information in the presence of nuisance parameters; optimality results for estimating functions; and consistency/asymptotic normality of maximum likelihood and estimation function-based estimators. It briefly discusses alternative approaches to inference including Bayesian, Likelihood Principle, and decision theory. Prerequisite: BIOS 710.

BIOS 722 (2) Advanced Survival Analysis: In-depth coverage of theory and methods of survival analysis, including censoring patterns and theory of competing risks, nonparametric inference, estimating cumulative hazard functions, Nelson estimator, parametric models and likelihood methods, special distributions, two sample nonparametric tests for censored data, power considerations and optimal weights, sample size calculations for design purposes, proportional hazards model, partial likelihood, parameter estimation with censored data, time-dependent covariates, stratified Cox model, accelerated failure time regression models, grouped survival analysis, multivariate survival analysis, and frailty models. Prerequisite: BIOS 510, BIOS 511, BIOS 522.

BIOS 723 (4) Stochastic Processes: Provides dual coverage of the theory and methods for dealing with the diversity of problems involving branching processes, random walks, Poisson processes, and birth and death processes, Gibbs sampling, martingale counting processes, hidden Markov chains, inference on semi-Markov chains and chain of events modeling. Applications will be drawn from the biological sciences, including the theory of epidemics, genetics, survival analysis, and models of birth-migration-death, and the design and analysis of HIV vaccine trials. Prerequisites: Matrix algebra and BIOS 710.

BIOS 724 (2) Analytic Methods for Infectious Disease Interventions: Advanced analytic, statistical, and epidemiologic methods particular to infectious diseases including analysis of infectious disease data and evaluation of intervention. Prerequisites: BIOS 511.

BIOS 726 (2) Applied Multivariate Analysis: This course investigates multivariate techniques. The main subject areas covered are inferences about multivariate means, multivariate regression, multivariate analysis of variance (MANOVA) and covariance (MACOVA), principal components, factor analysis, discriminant analysis and classification, and cluster analysis. Appropriate programs such as SAS and S-PLUS will be demonstrated. Prerequisite: BIOS 507 and BIOS 511.

BIOS 731 (2) Advanced Statistical Computing: This course covers the theories and applications of some common statistical computing methods. Topics include Markov chain Monte Carlo (MCMC), hidden Markov model (HMM), Expectation-Maximization (EM) and Minorization-Maximization (MM), and optimization algorithms such as linear and quadratic programming. The class has two main goals for students: (1) learn the general theory and algorithmic procedures of some widely used statistical models; (2) develop fluency in statistical programming skills. The class puts more emphasis on implementation instead of statistical theories. Students will gain computational skills and practical experiences on simulations and statistical modeling. This course requires significant amount of programming. Each set of homework involves the implementation of certain algorithms using high-level programming language (such as Matlab or R).

BIOS 732 (2) Advanced Numerical Methods: The course covers topics in traditional numerical analysis specifically relevant to statistical estimation and inference. The topics covered include numerical linear algebra, the root finding problem (maximum likelihood) methods such as IRLS, Newton-Raphson, and EM algorithm, and Bayesian techniques for marginalization and sampling for use in statistical inference (MCMC methods). Additional topics may include numerical integration and curve fitting. Prerequisites include BIOS 532, BIOS 710 and BIOS 711, or permission of the instructor. BIOS 711 may be taken concurrently.

BIOS 736 (2) Statistical Analysis with Missing and Mismeasured Data: The goal of the course is to introduce the concepts and methods of analysis for missing data. Topics will include methods for distinguishing ignorable and non-ignorable missing data mechanisms, single and multiple imputation, hot-deck imputation. Computer intensive methods will be used. Prerequisites: BIOS 511 and PhD Biostatistics student.

BIOS 737 (2) Spatial Analysis of Public Health Data: This course will familiarize students with statistical methods and underlying theory for the spatial analysis of georeferenced public health data. Topics covered include kriging and spatial point processes. In addition, review recent computational advances for applying these methods. Prerequisites: BIOS 506, BIOS 507, BIOS 510, BIOS 511.

BIOS 738 (2) Bayesian and Empirical Bayes Methods: Includes Bayesian approaches to statistical inference, point and interval estimation using Bayesian and empirical Bayesian methods, representation of beliefs, estimation of the prior distribution, robustness to choice of priors, conjugate analysis, reference analysis, comparison with alternative methods of inference, computational approaches, including Laplace approximation, iterative quadrature, importance sampling, and Markov Chain Monte Carlo (Gibbs sampling). Various applications such as small area estimation, clinical trials and other biomedical applications will be used as examples. Prerequisite: BIOS 511.

BIOS 745R (2) Biostatistical Consulting: This course will cover topics dedicated to preparing doctoral students to lead biostatistical collaborations with non-statisticians in public health, biology, and medicine academic environments. Covered collaboration topics will include consulting versus collaboration, ethics, non-statistical aspects of collaboration (e.g. interpersonal communication), and negotiating expectations with clients. Covered biostatistical topics will include specific aim refinement, appropriate study design for the research question, assessment of feasibility (time and effort) of different statistical methods for the same problem, statistical review of grant proposals including power calculations, and appropriate summarization/presentation of results to non-statistical audiences.

Experience is the best way to nurture the critical thinking skills necessary for excellent biostatistical collaboration. Students will be given weekly assignments to further develop skills in each of the topic areas. Assignment tasks will be drawn from completed projects the course instructors have encountered. In addition, each student, under the mentorship of the course instructors or faculty in the Department of Biostatistics and Bioinformatics will engage in a collaboration experience. Each student will collaborate with a clinical investigator and provide biostatistical support to all aspects of their project. True to real-life experiences, types of projects will vary depending on the investigator and their research question of interest.

BIOS 760R (VC) Current Topics in Biostatistics: A faculty member offers a new course on a current topic of interest for PhD students.

BIOS 770 (2) Advanced Statistical Genetics: This course provides a comprehensive survey of the statistical methods that have been recently developed for the designs and analysis of genetic association studies. Specific topics include genome-wide association studies, likelihood inference and EM algorithm, case-control sampling and retrospective likelihood, secondary phenotypes in case-control studies, haplotypes and untyped SNPs, population stratification, meta-analysis, multiple testing, winner's curse, copy number variants, next-generation sequencing studies, rare variants and trait-dependent sampling.

BIOS 777 (1) How to Teach Biostatistics: Prepares students for teaching introductory level courses in biostatistics. The topics discussed are: syllabus development, lecturing, encouraging and managing class discussion, evaluating student performance, test and examinations, cheating, the role of the teaching assistant, teacher-student relationships, teaching students with weak quantitative skills, teaching students with diverse backgrounds, teaching health sciences students, teaching medical students, use of audio-visual techniques, and use of computers. Each student is required to teach a certain subject to the other students and the instructor, followed by a discussion of presentation strengths and weaknesses.

BIOS 780 (1) Research Methods in Biostatistics: Acquaints students with a variety of areas of biostatistical research and provides the chance to do preliminary reading in an area of interest. Each student reads a few papers in an area of interest, and presents the material to the group. Topics and readings can be suggested by the faculty member in charge or by the students. This course may be repeated for credit. (Satisfactory/unsatisfactory grading only.)

BIOS 795R (VC) Pre-Candidacy Research: Research pertaining to a dissertation and preparing for the proposal.
BIOS 797R (VC) Directed Study: Provides an in-depth exposure to specific topics not covered in regular courses, for example, statistical genetics and specialized experimental designs.

BIOS 799R (VC) Dissertation: Research pertaining to a dissertation and preparing for the defense.

Informatics

INFO 500 (2) Principles of Public Health Informatics I: Public health informatics is an emerging field. While there are a variety of definitions for this term, in this course we shall define PHI as the application of information systems and technology to public health practice and research.

INFO 501 (2) Principles of Public Health Informatics II: The goal of this course is to provide an overview of some of the major areas in which information systems are used in public health. For each example, we will discuss the opportunities presented and challenges faced in the design,

development, deployment, and maintenance of these systems.

INFO 503 (2) Management Principles for Informatics**:** The purpose of this course is to allow students to gain understanding of multiple dimensions to management related to provision of information services. At the end of this course, students should be able to evaluate and justify information technology investments, evaluate the utility of alternative information system delivery modes, and plan strategically for future information system development.

INFO 511 (3) Analytics: This course covers the principles of data visualization, both for presentation and analysis. Using commercial and open source software, we will explore different data visualization techniques and the design principles.

INFO 521 (3) Database Development for Public Health: This course will cover the principles utilized in data management and database development for purposes of Public Health. *This is primarily a skills-based course* - the students will learn to create a relational database using Microsoft Access 2013, as well as gaining an understanding of the important terminology, standards and data management principles utilized by data management teams.

INFO 530 (2) Geographic Information Systems: Introduces the use of geographic information systems (GISs) in the analysis of public health data. Addresses basic GIS operations such as buffering, layering, and spatial queries, and develops GIS skills through homework and case studies. Addresses introductory cartography and basic statistical aspects of spatial analysis.

INFO 532 (4) Principles if Geographic Information Systems: The course introduces the use of geographic information systems (GISs) in the analysis of public health data. We develop GIS skills through homework and case studies, and particularly address basic GIS operations such as buffering, layering, and spatial queries as well as more advanced GIS capabilities such as geodatabases. In addition to GIS issues we address introductory cartography, and basic statistical aspects of spatial analysis.

INFO 540 (2) Informatics and Analytics in Public Health Surveillance: In this class, students will learn about the use of advanced state-of-the-art computing technologies to synthesize very large datasets to support decisions in public health surveillance and research.

INFO 541 (2) Electronic Medical Records and Public Health Surveillance: In this class, students will learn about the use of the electronic health record as it relates to public health surveillance. As such it covers the background and history of the EHR, the issues and barriers in its adoption, the ethical and legal issues surrounding it, and its use in public health surveillance.

INFO 542 (2) Knowledge Management: Knowledge management refers to how organizations gather, use, and store the knowledge they acquire. This class will cover the differences between data and knowledge, the strategic use of knowledge to inform decision-making, implementation and knowledge transfer, and the cultural issues surrounding knowledge.

INFO 544 (2) Network Science in Public Health: In this class, we will cover key concepts of networks. We will illustrate how network science can be used in public health research and evaluation. Lecture sessions will be followed by laboratory sessions in which topics from the prior

lecture are developed further. In particular students will gain hand-on experience with software tools for analyzing and visualizing network data.

INFO 550 (2) Software Engineering: This course seeks to teach principles of software engineering through hand-on experience in constructing a real-life project. During this project, the student will be exposed to SE tools, including version control, deployment software, and integrated development envirnoments (IDEs).

INFO 560R (VC) Current Topics in Public Health Informatics: A faculty member offers a new course on a current topic of interest to both masters and doctoral students.

INFO 595 (0) Applied Practical Experience: Enables students to apply skills and knowledge in an applied setting through a supervised field training experience in a public health setting that complements the student's interests and career goals. Must meet RSPH guidelines and have departmental approval.

INFO 597R (VC) Directed Study: Provides an in-depth exposure to specific topics not covered in regular courses, for example, statistical genetics and specialized experimental designs.

INFO 598R (4) Capstone: Involves intern-like participation on specific scholarly, research, or developmental projects which expose students to the role of the statistical consultant or collaborator in a variety of research settings.

Contact Information

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