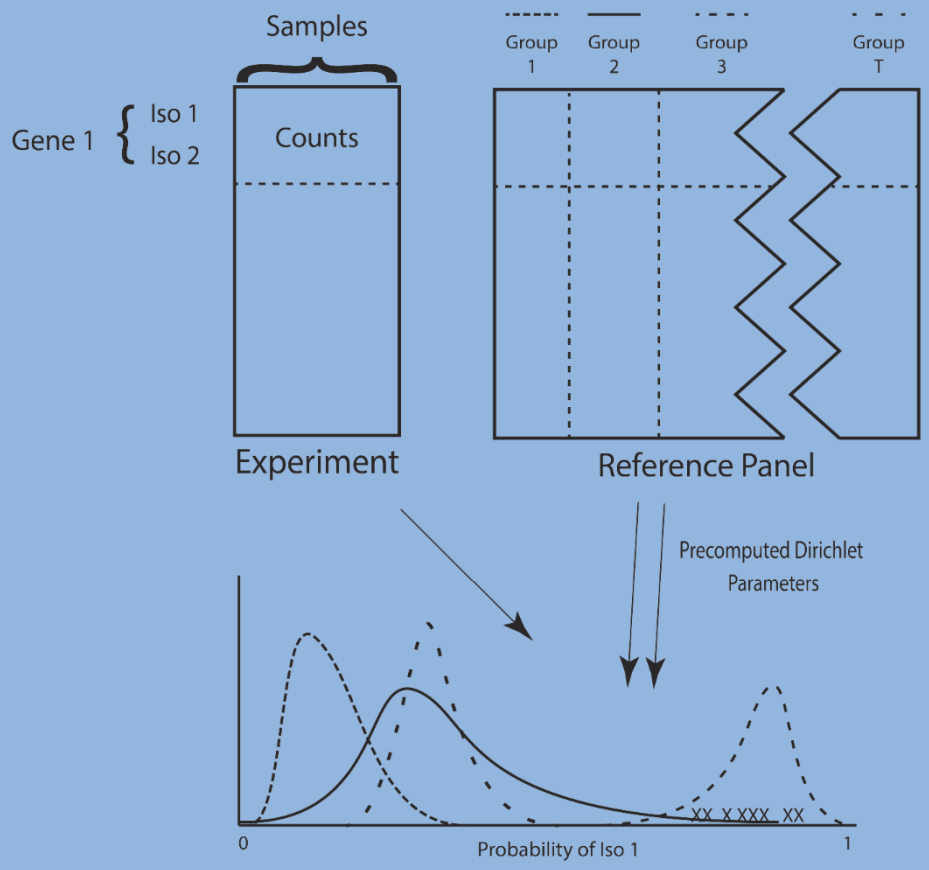
Biostatistics

ACADEMIC INFORMATION MANUAL

2022-2023 Edition



DEPARTMENT OF BIOSTATISTICS | GILLINGS SCHOOL OF GLOBAL PUBLIC HEALTH

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Figure above from McCabe, Nobel, Love. *Biostatistics* (2021, doi: 10.1093/biostatistics/kxab013).

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WELCOME FROM THE CHAIR AND ASSOCIATE CHAIR

Scientists in nearly all disciplines collect quantifiable data to address important research questions. We biostatisticians collaborate with our colleagues in a wide variety of disciplines across the health sciences to define research questions and delineate clear research objectives, optimize the design of studies or data analyses intended to address those objectives, develop innovative data science and statistical methods for data acquisition and analysis, and apply methods to ensure replication and appropriate interpretation of results. The field of biostatistics is at the cutting edge of the newest developments in the health sciences. The Department of Biostatistics at the University of North Carolina is proud to be one of the leading academic research departments of biostatistics in the world. For over seventy years, our department has been at the forefront of biostatistics and public health training and research.

The graduate and undergraduate training in our department is rigorous and state-of-the art. Our students take interesting but challenging courses in statistical theory, data science and applications. At the same time, most of our students participate actively in the methodological and collaborative research conducted by our faculty. Graduates of our program are prepared to be leaders in biostatistics, as illustrated by a roster of over 1000 successful alumni. Our graduates are faculty members at leading universities around the world and hold leadership positions in all employment sectors. UNC Biostatistics alumni include: chairs and deans in academia; directors of divisions and offices in government agencies, such as the Food and Drug Administration (FDA), the National Institutes of Health (NIH), and the Centers for Disease Control (CDC); and leaders in the pharmaceutical industry, the software development industry, and many other institutions in the health sciences and data science industries.

The Biostatistics Department understands the need for intentional diversity and is committed to equity. We are fully aligned with the Gillings School's Inclusive Excellence Action Plan and with the goal stated in that plan, namely "for all students, faculty, and staff members alike to be adequately equipped to advocate for inclusive excellence in their phenomenal work in North Carolina, the United States, and the world." As part of the Department's mission, we seek opportunities to promote equity and diversity in our profession and beyond. We strive to maintain an open and inclusive environment in the department, so that throughout their undergraduate and graduate studies, Biostatistics students at UNC can be confident their voices are heard. As an example, feedback from course evaluations is used to improve each of our courses, with the goal that our student body receives the best education in biostatistics available today.

Many of our graduate students receive financial support. This comes from our training grants in areas such as environmental biostatistics and research in statistical genomics and cancer as well as from many research projects of our faculty. Biostatistics faculty direct or co-direct two Gillings Innovative Laboratories, the Laboratory for Innovative Clinical Trials, and the Causal Inference Research Laboratory, both of which provide student research opportunities. Other research projects currently providing graduate student funding include methodological research grants as well as large-scale epidemiologic studies and clinical trial networks. The latter include studies of cardiovascular health in the US population as a whole and in the growing US

Hispanic/Latino population, studies of chronic obstructive pulmonary disease (COPD) and severe asthma, and studies of chronic low back pain that are part of the NIH Help End Addiction Long-Term (HEAL) initiative conducted in response to the critical opioid epidemic. Current methodological research projects focus on: new methods for producing and reading mammograms; complex adaptive trial designs in cancer, master protocols of Covid-19 therapies; causal inference to assess behavioral interventions in HIV/AIDS; precision medicine in diabetes, cystic fibrosis, and cancer; environmental health, data science, and translational medicine applied to a variety of disease areas; and many other methodologies, too numerous to list here.

This partial list of research projects demonstrates that our faculty members are very actively involved in important and timely research in biostatistics methods and health science applications. At the same time, they are excellent teachers and bring the excitement of their research interests into the classroom. Our faculty members regularly receive teaching awards given by the Gillings School of Global Public Health and the University. Our faculty also value and enjoy working with students one-on-one in research projects and on their doctoral dissertations. Many of our students co-author several peer-reviewed publications before they graduate.

Students are offered a broad range of required and elective courses for their Biostatistics degree programs – BSPH, MS, and PhD – each of which is described here. They can also take advantage of the exceptionally strong and diverse course offerings from other departments within the Gillings School, the Statistics and Operations Research Department (STOR) in the School of Arts and Sciences, and from other departments and schools across the UNC campus. Through our non-traditional courses such as statistical consulting and varied special topics, biostatistics students graduate from our program ready to launch their own successful careers.

We are excited about greeting you in person as we return to campus for the fall 2022 semester. We look forward to getting to know you better in the coming years and wish you the best of success here at UNC!

Lisa M. LaVange, Chair

Michael G. Hudgens, Associate Chair

DEPARTMENT OVERVIEW

The Department of Biostatistics in the Gillings School of Global Public Health of the University of North Carolina at Chapel Hill stands as one of the best departments of its kind in the world. The Department was established in 1949 with the goals to advance statistical science and, ultimately by its application, to improve human health. To achieve these goals, the Department of Biostatistics offers training and research programs to develop and apply innovative statistical methods to problems of human health and disease, including basic biomedical sciences.

Mission Statement

Our mission is to forge dramatic advances in health science research that benefit human health in North Carolina, the US, and globally through the development of profound and paradigm-shifting innovations in biostatistical methodology and the thoughtful implementation of biostatistical practice to solve public health problems.

We bring about positive, equitable, and sustainable changes in health by:

A. Supporting excellence in biostatistical practice by conducting theory and methods research of clear relevance to practice
B. Promoting sound application of new and existing statistical methods
C. Fostering equity and diversity in the biostatistics field and beyond;
D. Improving biostatistical education at the undergraduate and graduate levels
E. Working with undergraduate colleges to promote biostatistics as a discipline for graduate studies and a professional career
F. Anticipating and meeting the learning needs of our students by maintaining an open and inclusive environment in the department
G. Using the tools of our discipline to enhance human welfare through collaboration in research with colleagues in the biological and health sciences
H. Seeking opportunities to advance the biostatistics profession.

Goal

Our goal is to be a world leader in statistical research and statistical practice for the purposes of improving the public's health, improving biostatistical education, and advancing the biostatistics profession.

ADMINISTRATIVE PERSONNEL

Department of Biostatistics

Department Chair– Lisa M. LaVange*, lisa.lavange@unc.edu*

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Haibo Zhou – Biostatistics for Research in Environmental Health, *zhou@bios.unc.edu*

DEPARTMENT/FACULTY MEETINGS

At the beginning of each academic year, the Department Chair and Associate Chair decide the time and days of regular departmental meetings. Additional meetings may be called as needed.

All faculty members (Instructors and above) are eligible to vote at the regular departmental meetings.

The agenda for each meeting is developed by the Chair, Associate Chair, Assistant Chair, and Chair's Executive Assistant. Agenda items should be provided to the Executive Assistant at least one week before the meeting.

The Chair or Associate Chair (or an appointed representative) presides over all meetings. In general, Robert's Rules of Order are followed in the conduct of the meetings.

A faculty meeting may be held when necessary to consider business of such a nature that students should not be present (for example, decisions with respect to Department-wide written examinations). Attendance is restricted to faculty at these meetings.

Minutes are prepared by the Executive Assistant and given to the Chair and Associate Chair for approval. Copies are distributed via email along with the agenda in advance of the next meeting.

2022-2023 – Department Meetings are provisionally scheduled for the following Thursdays, 2-3 PM

August 25 (faculty only)

September 15

October 27

November 17

December 15

January 19

February 16

March 23

April 20

May 18

ORIENTATION AND ADVISING

Orientation

At the beginning of the year, the Department's Academic Program Support Coordinator (APSC), with the help of the Directors of Undergraduate and Graduate Admissions, organizes orientation meetings for all new students. At these meetings, students are introduced to members of the faculty and staff, as well as the Department Chair, Associate Chair, and the Directors of Undergraduate and Graduate Admissions and Studies. Current information about the department, degree requirements, and departmental research activities is also provided.

Academic Information Manual (AIM)

Policies and procedures governing all degree programs offered by the Department are described in the Academic Information Manual (this document) which is updated at the beginning of each academic year. At the start of the fall semester, students are provided a link to the latest version of the AIM on the Department's website. Students must adhere to the policies specified in the AIM for the year that they matriculate, unless otherwise specified. For example, students who begin their degree program in the academic year 2022-2023 will follow policies in the 2022-2023 AIM. If policies change during a student's time in the program, the student may be offered the opportunity to be subject to the updated policy. This option is not guaranteed and is at the discretion of the Director of Graduate/Undergraduate Studies. Previous versions of the AIM for the past six years are accessible on the Department's website.

Appointment of Faculty Mentors

Academic advising and mentoring are essential components of the Gillings School education. Biostatistics is committed to providing the advice, assistance, and support that students need at every step throughout the degree program. A successful system of academic advising and mentoring is highly dependent upon a shared commitment of students, staff, and faculty to the process and availability of timely, accurate information.

The Director of Undergraduate Studies usually advises all undergraduates.

Responsibilities for academic advising are shared between the Department's Academic Coordinator and the faculty mentors assigned to students. The Academic Coordinator, the Academic Program Support Coordinator, and the Director of Graduate Admissions appoint faculty mentors for newly admitted graduate students. The selections are made with consideration of such factors as interests of the students and faculty, any specialized fellowship support, and faculty commitments. Any request for change in faculty mentor assignment should be directed to the Director of Graduate Admissions and/or the Department's Academic Coordinator. The faculty mentor advises students on departmental matters, course information and selection, and academic progress. For doctoral students, the faculty mentor is replaced by the dissertation advisor, once selected.

Duties of Academic Program Support Coordinator (APSC)

The APSC is the liaison between the students and the Academic Coordinator. Prior to the entry of new students, the APSC sends the faculty mentors information about the backgrounds of their advisees and the degree program to which each advisee has been admitted. Before each semester's registration opens, the APSC sends new students a copy of the course schedule and other relevant registration material.

Students should see the APSC for their departmental needs. If the APSC is not available and the request is not urgent, then an email should be sent. If there is an urgent need, the student should try to contact either the Academic Coordinator or the APSC. Meetings between the faculty mentor and advisee should be arranged by the advisee directly.

What can the Academic Program Support Coordinator help with?

- Works with the Academic Coordinator at the department level as an expert in navigating academic policies, procedures, and program requirements.
- Assistance with preparing and submitting forms to appropriate offices for academic needs.
- Serves as liaison between the department and other Gillings offices. Works closely with the Directors of Graduate Admissions and Graduate Studies to maintain departmental information and procedures in accordance with university policy and procedures and keep students informed of such.

Duties of the Academic Coordinator (AC)

The Academic Coordinator:

- Is a Gillings School Student Affairs professional that serves in the role of primary academic advisor but does not take the place of the faculty mentor for course information and selection.
- Serves as an expert in navigating academic policies, procedures, program requirements, and campus resources
- Helps with necessary paperwork including, but not limited to, registration transactions, policy exceptions, transfer requests, continuous enrollment or leave of absence, etc.
- Assists in tracking students' progress toward degree completion
- Is available via email, appointment, drop-in, or cohort academic advising sessions

What can the Academic Coordinator help with?

- Academic Strategies: The Academic Coordinator can help with strategies for success at Gillings,including effective study habits, test-taking strategies, time management, test anxiety, etc.
- Academic Advisement: The Academic Coordinator can help with navigating degree requirements. The Academic Coordinator willdiscuss degree requirements, progress towards degree completion, and plans for graduating.
- Involvement on Campus: The Academic Coordinator is knowledgeable about opportunities to make themost of the Gillings experience. Students should work with the Academic Coordinator to create individual plans to get involved on campus and within the community.
- Navigating Campus Resources: When students feel overwhelmed or stressed out, the Academic Coordinator can help connect them with the right resources to get back on a path to success.

Duties of Faculty Mentors

The primary responsibilities of the faculty member appointed to advise a newly admitted student are to provide initial guidance regarding the academic program of the advisee and to carry out selected academic functions (such as assistance regarding options for practical training or for a research project) related to completion of academic program requirements. However, after the first semester, primary responsibility should shift to students for updating plans to satisfy their degree programs and for discussing such plans with their advisors. Students are expected to meet with their faculty mentor at the beginning of each semester to discuss course selection and academic progress.

Faculty mentors are specifically expected to confer with their advisees in all selections of courses, and

to sign appropriate forms showing their approval of the course plans (as well as any subsequent course additions or drops) of their advisees.

In carrying out their responsibilities, faculty mentors need to keep up to date on the academic and related requirements of the degree programs for which they are advising students, and to monitor the progress of their advisees in meeting these requirements.

Every student is responsible for keeping an updated degree checklist (available from the Academic Coordinator). This should be done with their faculty mentor at the beginning and end of each semester. In the final year, the checklist must be verified and signed off by the Director of Graduate Studies. Students will also be responsible for completing with their faculty mentor the Biostatistics Annual Graduate Student Progress & Goals report in their 2nd year and every subsequent year of graduate study. This must be completed with and signed by the faculty mentor or doctoral adviser (if registered for dissertation credit).

The Faculty Mentor:

- Is a full time Gillings School faculty member
- Serves as an expert in the student's specific field of study
- Provides feedback regarding courses related to the student's overall academic goals and career interests
- Suggests professional development opportunities, funding opportunities, recognition awards, etc.
- Is available to discuss appropriateness of course selection each semester

Faculty Mentor Relationship

While each student is assigned an individual faculty mentor, they are also encouraged to develop relationships with other faculty members throughout their time at Gillings. These individuals may serve as future references for students, connect them to potential future employers, and help to expose students to otherwise unknown professional resources in their area of study. The value of building relationships with our phenomenal facultymembers cannot be overstated.

Students are responsible for: scheduling, preparing for, and keeping appointments; seeking out contacts and information; and knowing the basic requirements of their individual programs. Ultimately, students are responsible for making their own decisions based on the best information and advice available, and on their own judgment.

Faculty mentors are responsible for helping students develop professionally by suggesting opportunities based on their own expertise and experience in the field, connecting students to professional networks relevant to their interests, and providing guidance on career interests. Faculty mentors stay current with trends in the field, conferences and professional development opportunities, and other valuable discipline-specific resources.

Absence of Faculty Mentors

Faculty mentors who have to be away during registration, or for any length of time during the year, should make arrangements, in consultation with the Academic Coordinator, for another faculty member to meetwith their advisees when they need faculty assistance. If such arrangements are not made, changes in a student's program may be made at the discretion of the Director of Graduate Studies and the Academic Coordinator.

TUITION REMISSION POLICY

All students who meet the eligibility requirements outlined by the Graduate School will receive in-state tuition and mandatory student fees. First-year doctoral students who are non-NC residents will also receive tuition remission. Tuition remission is guaranteed for doctoral students who are non-NC residents only in their first year.

Tuition Remission for returning students (2nd year and beyond) is subject to the availability of funds, which are allocated by the Graduate School. Eligibility is determined on a semester-by-semester basis and is contingent upon the following factors (not necessarily in priority order):

(a) full time student status;
(b) number of tuition remissions received;
(c) high quality performance in course work;
(d) high quality performance in GRA activities;
(e) compliance with guidelines set by the Graduate School.

Enrollment Requirements

PhD Students:
Full-time enrollment is required (9 hours or more) during the first two years of graduate study. Thereafter, once all other degree requirements have been satisfied, students must enroll for at least 3 hours of BIOS 994. Credit hours of courses that are not required for your degree will not be counted towards tuition remission.

MS Students:
Full enrollment is required (9 hours or more) during the first three semesters of graduate study. Thereafter, once all other degree requirements have been satisfied, students must enroll in BIOS 992.

All students must remain appropriately enrolled for the entire semester to be eligible for and to retain tuition remission or an in-state tuition award for the relevant semester.

Dropping below the minimum enrollment requirement during the semester will result in the loss of tuition remission, and the financial responsibility rests on the student.

BSPH Students:
Full-time enrollment is consistent with the designations in UNC Arts & Sciences: Registrar's Webpage with Enrollment Information

Duration of Support

1. Students in the MS program are eligible for tuition remission and/or in-state tuition awards for up to four semesters, depending on the availability of funds from the Graduate School.
2. PhD students are eligible for tuition remission and/or in-state tuition awards for up to ten semesters, depending on the availability of funds from the Graduate School.
3. A student who completes a degree in one UNC academic program, then enrolls in another UNC academic program, or changes academic programs without receiving a degree, is only eligible for the maximum number of semesters noted above.

Criteria indicating lack of excellent academic progress include poor academic performance (e.g., as indicated by the grade of F or L in any course) and/or the inability to maintain full-time student status (except in certain circumstances, such as a major illness or personal hardship).

BACHELOR OF SCIENCE IN PUBLIC HEALTH (BSPH)

Degree Description

The Bachelor of Science in Public Health program is designed for students who have strong quantitative abilities and an interest in applications of math, statistics, and computer programming to health-related issues. The program prepares students for entry-level professional statistical and programming careers and provides a firm academic base for subsequent studies in biostatistics, medicine, and other fields.

Degree Competencies

Upon satisfactory completion of this course of study the student will be able to:

1. Perform descriptive and inferential data analyses to answer varied research questions (BIOS 500H)
2. Interpret data analysis results for a variety of audiences (BIOS 500H)
3. Use software appropriately in data collection, data management, and analysis (BIOS 511)
4. Demonstrate the use of elementary statistical theory including the use of basic concepts of probability, random variation, and common statistical probability distributions (BIOS 650)
5. Demonstrate strong quantitative skills through the successful completion of calculus, linear algebra,and discrete mathematics (MATH 233, MATH 347, and MATH 381)

In addition to these competencies, all BSPH Biostatistics students meet the Public Health CEPH competencies through the Public Health Core coursework: EPID 600, SPHG 351 and SPHG 352.

Admission Requirements

The first two years of the four-year course of study are usually completed within UNC-CH's General College. Students typically apply to the BSPH Biostatistics Program in January of their sophomore (or second) year for fall admission in their junior (or third) year. Admission requirements include:

1. Completion of MATH 231, 232, and 233 before an admission decision can be made. Thus, MATH 233must be completed by May of the sophomore (or second) year.
2. Completion of BIOL 101 and BIOL 101L and COMP 110 (or COMP 116) before entering theprogram in the fall of the junior (or third) year.
3. Completion of at least 60 credits and the majority of their General College requirements before entering the program in the fall.
4. A minimum GPA of 3.2.

The application consists of a transcript, two letters of recommendation (at least one recommendation from aquantitative/math person), and a personal statement. Applications are submitted completely online.

Prospective students should familiarize themselves with program prerequisites early in their General Collegestudies and are encouraged to discuss their plans with the Director of Undergraduate Studies, who holds periodic information sessions for prospective students. More information is available here: http://sph.unc.edu/bios/faqs-undergraduates-2/

Program Requirements

1. BIOL 201 or 202 (both these courses have a prerequisite of CHEM 101)
2. BIOS 500H, 511, 645, 650, 664, 668 (or 662) and 691
3. EPID 600, SPHG 351 and SPHG 352
4. MATH 381 (or STOR 215), MATH 521 or 528, and MATH 347

BSPH students are required to earn a grade of C (or higher) for all above required courses.

Advanced students who wish to double major or have a minor are encouraged to take some of the required courses (such as MATH 381, BIOL 201 (or 202), MATH 347) in their freshman and sophomore years to allow flexibility of scheduling in their last two years.

BIOS 500H can be taken in the freshman or sophomore years (if space is available) to introduce interested students to the discipline of biostatistics and to allow flexibility of scheduling in the junior and senior years.

Students must also meet UNC-CH graduation requirements including: completion of at least 120 semester hours; a 2.0 (C) average on all work attempted at UNC-CH; at least 45 credit hours must be earned from UNC-CH courses; at least 24 of the last 30 credit hours applied to degree requirements must be earned from UNC-CH courses. See the Undergraduate Bulletin for complete details.

Academic achievement is recognized at graduation with the designations of Distinction (Overall GPA ≥ 3.5) and Highest Distinction (Overall GPA ≥ 3.8).

Senior Honors Project in Biostatistics

A senior honors project is intended for the small number of undergraduates who choose to complete original research. Attempting an honors project requires a substantial time commitment, dedication, and the ability to work independently. The senior honors project is not designed to reward academic achievement. However, students must have a grade point average of 3.3 or higher at the end of the semester preceding the semester when they intend to begin honors research work and maintain a GPA of at least 3.3 while completing the project

Faculty member availability to guide the student in their honors work governs whether a student can begin a research project. Students are responsible for finding a biostatistics faculty member to direct their honors project

Students attempting an honors project must enroll in at least six credit hours of acceptable research coursework (usually BIOS 693H- 3 hours in the fall and BIOS 694H - 3 hours in the spring). As part of this coursework, students carry out a research project, prepare a paper based on the project, and give an oral presentation on their honors research.

Senior honors papers are reviewed by a committee of three individuals which include the primary biostatistics faculty research advisor and usually at least one person from another department. The review committee is selected by the student and their research advisor after consultation with the Director of Undergraduate Studies.

To graduate with Honors, a student must complete the honors project including oral presentation and have a GPA of at least 3.3 at the end of the first semester of the senior year on (a) all courses taken at

UNC-CH and (b) the courses required for the biostatistics major.

To be eligible for consideration of Highest Honors designation, students must also have a GPA of at least 3.6 in (a) and (b) above. Evaluation of Honors vs. Highest Honors designation is made by a subcommittee of the faculty based on scholarly merit of the senior honors project and student presentation.

More information regarding deadlines and university regulations is available at http://honorscarolina.unc.edu/research/senior-honors-thesis/ and from the FAQs on the BSPH Sakai Site.

Example BSPH Biostatistics Curriculum

During the BSPH student's freshman and sophomore years, they should complete approximately 60 credit hours, including the following courses:

- BIOL 101, 101L: Principles of Biology and its Laboratory
- COMP 110 or 116: Introduction to Programming
- MATH 231: Calculus of Functions of One Variable I
- MATH 232: Calculus of Functions of One Variable II
- MATH 233: Calculus of Functions of Several Variables

Note that the calculus series must be completed before a student can be admitted to the BSPH program. Completing all General College requirements during the student's first two years is recommended.

During the BSPH student's junior and senior years, approximately 60 credit hours should be completed. The following table presents an example plan of study for these two years.

FALL JR • BIOS 500H (3): Intro to Biostatistics • BIOS 511 (4): Intro to Stat Computing (SAS) • MATH 381 (3): Discrete Mathematics • SPHG 351 (3): Foundations in Public Health • FREE ELECTIVE	SPRING JR • BIOS 645 (3): Principles of Experimental Analysis (Multiple Linear Regression) • MATH 521 (3): Advanced Calculus I **or** MATH 528: Math for the Physical Sciences • EPID 600 (3): Principles of Epidemiology • SPHG 352 (4): PH Systems and Solutions • FREE ELECTIVE
FALL SR • BIOS 650 (4): Probability and Inference I • BIOS 691 (1): Field Obs. In Biostatistics • MATH 347 (3): Linear Algebra • FREE ELECTIVE • FREE ELECTIVE	SPRING SR • BIOS 664 (4): Sample Survey Methodology • BIOS 668 (3): Design of PH Studies • BIOL 201 (4)*: Ecology and Population Biology **or** BIOL 202*: Genetics • FREE ELECTIVE

*BIOL 201 and 202 have a prerequisite of CHEM 101

Note that taking the biostatistics courses in the above order is recommended because they are offered fall only/spring only and may have prerequisites. This example program assumes that a student does not have substantial AP credit and does not plan to pursue a double major with another degree program. Many students are able to take the courses included in the above table earlier than in their junior/senior years, allowing flexibility to double major or to pursue other opportunities in their last two years.

DUAL BSPH/MS DEGREE

OVERVIEW: The Dual BSPH/MS program identifies a coherent course of study for students to fulfill some of the MS degree requirements in Biostatistics while pursuing a BSPH Biostatistics degree in accordance with University guidelines.

The degree requirements for each degree are unchanged.

The program attracts a small number of high-achieving students because the coursework is rigorous and may not offer clear advantages depending on the student's priorities. This program is best suited for students who seek a terminal MS biostatistics degree and are prepared to take the four MS Core courses in their Year 4.

Completion of the dual degree within five years is not guaranteed; some sample schedules span more than five years. Alternatively, qualified students can also start the MS curriculum early without being admitted to the Dual Degree program. Details, rules, and sample semester-by-semester curricula are available from the Director of Undergraduate Studies or on the BSPH Sakai Site.

ADMISSION: See separate documentation on BSPH Sakai Site.

BENEFITS:

1. Dual Degree student can transfer in a *maximum of 12 hours* of approved coursework from undergraduate compared to "Any Student" can transfer in a *maximum of 10 hours* (30% of 36 hours) of approved coursework from undergraduate.
2. Dual Degree students have an abbreviated application.
3. Dual Degree students can potentially gain MS status 'early.' Once they have MS Status, students are *eligible* for (but are not guaranteed) graduate funding.

OTHER CONSIDERATIONS:

1. Taking BIOS 660/661/662/663 in Year 4 is difficult not only because of the rigor of the courses but also because full time status for an undergraduate is higher than for graduate students. Students may be able to take one or more of these MS courses without needing to be in the Dual Degree. If a student takes these courses as undergraduate, they are on the "A/B/C" grading scale rather than "H/P/L/F" scale.
2. Students in Dual Degree may not have sufficient availability for a double major, senior honors project, math courses suggested for those interested in PhD, etc.

More information is available here: Guidelines for Dual Bachelor Masters Degrees

PLANNING: Planning ahead is critical for students interested in the Dual Degree program; students are encouraged to consult with the Director of Undergraduate Studies early in their undergraduate career.

Sample plans are available on the BSPH Biostatistics Majors Sakai site.

- Students interested in the BSPH/MS dual degree program are encouraged to apply to the BSPH program (not the Dual BSPH/MS Degree) in their freshman year and begin coursework in Biostatistics by their sophomore year, including BIOS 511 and BIOS 500H.
- Students are also encouraged to take required math courses MATH 381 (Foundations and DecisionSciences) and MATH 347 (Linear Algebra) early in their undergraduate program.
- Early preparation will allow students to have sufficient prerequisite courses to take BIOS 660,

BIOS 661, BIOS 662, and BIOS 663 in their 4th year in preparation for the MS qualifying exams at the beginning of their 5th year.

MASTER OF SCIENCE (MS)

Degree Description

The Master of Science (MS) program is designed to provide research-oriented training in the theory and methodology of biostatistics and its applications to the solution of problems in the health sciences.

Degree Competencies

Upon satisfactory completion of this program, the student will have:

1. MS01: demonstrated an understanding of probability and statistical inference, including the fundamental laws ofclassical probability, discrete and continuous random variables, expectation theory, bivariate and multivariate distribution theory, maximum likelihood methods, hypothesis testing, power, and likelihoodratio, score, and Wald tests [BIOS 660, 661];
2. MS02: demonstrated ability to apply the elementary methods of statistical analysis, including those based onclassical linear models and on nonparametric alternatives, involving categorical, discrete, normal, or ranked data, to problems of description, goodness of fit, univariate location and scale, bivariate independence and correlation, regression analysis, and the comparison of independent and matched samples possibly adjusting for covariables [BIOS 662,663];
3. MS03: used computers for research data management (applying a defensible standard of documentation,archiving, protection of confidentiality, and audit trail) and for the analysis of data with standard statistical program packages [BIOS 511];
4. MS04: learned to develop an efficient design of an observational or experimental study in the health sciences[BIOS 841];
5. MS05: gained successful experience in statistical consulting, including interaction with research workers in the health sciences, abstracting statistical aspects of substantive problems, and communicating the results topersons without specialized biostatistical training (as evaluated by the consultees), and observed and evaluated nonacademic biostatistical programs in the Research Triangle area [BIOS 841, BIOS 691];
6. MS06: completed a course requiring a written report related to the statistical aspects of a problem in the health sciences, a case study, or a contribution to statistical methodology [BIOS 992].

In addition, students must meet or exceed CEPH 2016 Public Health competencies through completion of SPHG600.

Admission Requirements

Requirements for admission include an acceptable bachelor's degree with mathematics training at least including multivariable calculus and linear algebra.

Time / Residence Requirements

The Graduate School requires a minimum program residence credit of two full semesters either by full-time registration of by part-time registration over several semesters. The MS in Biostatistics, however, usually requires about two years for completion. All requirements for the degree must be completed within five years of matriculation. Please refer to the Graduate School Handbook for additional information.

Course Requirements

Students must complete at least 36 hours of coursework for the MS in Biostatistics degree, 21 of which must be taken in residence. The following is a summary of the coursework required. Note that for students who do not exempt any required courses, the total number of credit hours for all required courses below is greater than 36 hours.

1. **Basic Statistics**
   - BIOS 511, 660, 661, 662, 663, 667, and 680.
2. **Intermediate and Advanced Statistics**
   - Six hours of course work numbered 664 or higher not including 667 and 680 in Biostatistics or equivalent in the Department of Statistics and Operations Research (STOR) at UNC or in the Department of Statistics at North Carolina State University (NCSU).
3. **Practicum**
   - BIOS 691, 841, 843 (2 semesters (credits) are required), and 992. Note that BIOS 992 and 843 can only be taken in the 2nd year of study. Note also that there are mandatory attendance requirements for BIOS 843 described in the course syllabus. In addition, each MS student may be required to grade up to two courses (see Section on Instructional Assistants).
4. **Supporting Program**
   - EPID 600 or 710 (or equivalent), plus SPHG 600 (see Section on Supporting Program).

Timing of coursework: Typically, BIOS 511, 660, 661, 662 and 663 are first-year MS courses; BIOS 667, 680, 841, 843, 992, and BIOS electives (e.g., 664, 665, 668, 670, etc.) are usually second-year MS courses; supporting program courses can be taken at any time.

Transferring in course hours

A. For any student: See transfer credit policies which allow up to 30% of required hours for a master's degree to be transfer credit, at the discretion and approval of the Director of Graduate Studies. Thus, up to 30% of 36 hours (=10 hours) for the MS degree can transferred from elsewhere (or from UNC-CH undergraduate) – noting that course(s) must be approved by Director of Graduate Studies.

   Implementation: Any student who wishes to transfer in credit hours to the MS program must have coursework approved by Director of Graduate Studies. Approval is not guaranteed. The previous coursework must be deemed equally or more rigorous compared to the analogous course within our MS program. Students should include in their request: a) syllabus of previous course; b) transcript showing when course was taken and grade – successful approvals usually have previous grades of "A" or "B" and the previous courses are recently (usually within the last 5 years) taken; and c) reasoning/justification for request (Example: I am seeking to transfer in 3 credits from a course taken at my previous university. The previous course, Stat XXX, was very similar to Bios 511. I earned an A and took the course last year. In addition, I have my SAS certification…..)

   Transferring in credits for the MS Core Courses are rarely approved for courses taken outside our department. In other words, for these courses (Bios 660/661/662/663), MS students are expected to enroll in these courses even if they took previous versions of similar courses.

For students who have taken MS courses at UNC–CH, the student may petition to exempt the course in the MS program as well as transfer in those hours (up to a maximum of 10 hours). Example: an undergraduate UNC-CH student who takes and performs well in, say, Bios 511/Bios 660/ or Bios 664 as an undergraduate may petition to exempt that course and transfer in those hours.

B. For students in the Dual Degree (BSPH/MS). These students may to transfer in up to 12 hours of credit. The courses must be on the list below or approved by the Director of Graduate Studies. Courses that fulfill undergraduate requirements can potentially be 'double counted' toward the MS program. Courses that can used include the following:

   Courses in the BSPH program that also fulfill MS requirements (Bios 511, Bios 691, Bios 664, Bios 668, Epi 600)

   Courses not fulfilling any BSPH requirement (Examples: Bios 512, Bios 660, Bios 661, Bios 662, Bios 663)

Exempting coursework: Some students (for example, graduates of UNC's BSPH Biostatistics program or students with a strong math/stat background) may be allowed to exempt a limited number of individual required courses on a case-by-case basis based on their previous coursework. For example, BSPH biostatistics students from UNC-CH have satisfied the requirement of BIOS 511, BIOS 691, 6 hours of credit at or above BIOS 664, EPID 600 and SPHG 600 (through completion of the five SPH core courses) and can be exempted from those courses. These students will still need to fulfil the remaining requirements including 36 hours of approved coursework. Thus, these students gain flexibility in selecting coursework and should work with their faculty mentor in course selection depending on their interests and goals.

The Department's checklist for the MS degree requirements can be obtained from the Academic Coordinator.

Examinations

All candidates are required to pass the MS Written Examination. All candidates are required to take the examination after they have completed their first year in this Department (See Section on Department-Wide Written Examinations page 31). No formal oral examination is required (except as required for the master's paper course, BIOS 992).

Application for Graduation

Students must notify the Graduate School of their plan to graduate by applying to graduate through their ConnectCarolina portal no later than the deadline shown in the University Registrar's Calendar for the semester in which they expect to graduate. Applications should only be submitted for the semester in which the student realistically intends to graduate and are valid for one semester only. If a student does not graduate in the semester expected, they must submit another application for graduation in a future semester. The department registrar will also notify students via email of deadlines. See List of Web Sites at the end of the AIM for links.

Please refer to the The Graduate School Handbook for additional information.

MASTER OF PUBLIC HEALTH (MPH) WITH CONCENTRATION IN PUBLIC HEALTH DATA SCIENCE

The Gillings School of Global Public Health's Master of Public Health (MPH) is a comprehensive integrated program providing students with the skills and knowledge to help solve some of the most critical public health problems across the state of North Carolina and around the globe. MPH students choose from among 12 diverse concentrations, ranging from Environmental Health Solutions to Population Health for Clinicians, each anchored in the core Public Health curriculum. The Department of Biostatistics, in conjunction with the Department of Epidemiology, sponsors the concentration in Public Health Data Science (PHDS).

Data science draws upon multiple disciplines, combining the statistical skills to manipulate data and make inferences, the mathematical skills to model phenomena and make predictions, and the computer science skills to manage and analyze large data sets. Our MPH program with PHDS concentration offers a unique focus on leveraging the foundational statistical, mathematical and computer science elements of data science to generate useful information from data sources relevant to public health. As a student in this concentration, you will benefit from the instruction and mentorship of top-ranked faculty in the biostatistics department and across the Gillings School. Our chief focus is to optimize data science to help address the most critical public health problems in the world today.

In addition to the MPH core public health courses, PHDS students take five concentration courses that cover the basic concepts of probability and statistical inference, data science, machine learning, and epidemiologic methods. Students then choose elective courses from multiple disciplines offering data science methods and applications within the Gillings School and in other schools and departments across the UNC campus. The MPH Practicum gives students an opportunity to partner with communities and organizations for hands-on experience in solving public health problems during the summer following their first year in the program. A comprehensive master's paper/project provides the MPH culminating experience to round out the program in the second year.

For more information about the Gillings MPH program, see: https://sph.unc.edu/resource-pages/master-of- public-health/.

For details about the PHDS concentration, see: https://sph.unc.edu/resource-pages/master-of-public-health/public-health-data-science-concentration/.

DOCTOR OF PUBLIC HEALTH (DRPH)

Fall 2018 is the final matriculating cohort for the existing Biostatistics DrPH program. Students currently in the DrPH program must satisfy the DrPH degree requirements as stated in the AIM of the year they entered the program, available here https://sph.unc.edu/bios/current-students/

DOCTOR OF PHILOSOPHY (PHD)

Degree Description

The Doctor of Philosophy (PhD) program is designed to provide advanced, research-oriented training in theory and methodology to prepare individuals for academic careers or for research positions anywhere.

Degree Competencies

Upon satisfactory completion of this program the student will have:

1. demonstrated mastery of: (a) the theory of probability and statistical inference, by successfully passing the written qualifying exam in theory, and (b) the application of said theory to solve a variety of applied statistical problems in the health sciences, by successfully passing the written qualifying exam in applications [https://www.bios.unc.edu/distrib/exam/];
2. learned advanced biostatistical techniques, including the ability to
    - PH01: design cost-effective surveys and experiments (including clinical trials) for collecting data on topics relevant to health, taking account of sampling error, measurement error, nonresponse, and other sources of bias and variability [BIOS 662, BIOS 663, BIOS 841, and BIOS 767];
    - PH02: use advanced parametric and semiparametric models for the analysis of public health data, including linear regression, mixed models, methods for categorical data, generalized linear (mixed) models, generalized estimating equations, survival analysis, and Bayesian methods [BIOS 762, BIOS 767, BIOS 780];
    - PH03: discern when standard methods are not appropriate, when nonparametric methods based on randomization and ranks may be substituted, or when new methods must be developed [BIOS 662 and BIOS 780];
    - PH04: estimate survival curves from time-to-event data which may involve censoring and time- dependent covariates, and test for differences among treatments and for the effects of covariates [BIOS 780]; and
    - PH05: apply advanced statistical computing methods such as the EM algorithm, MCMC method,and optimization procedures, and write efficient R, SAS, and C++ code [BIOS 611, BIOS 762, and BIOS 735];
3. PH06: used computers for research data management (applying a defensible standard of documentation,archiving, protection of confidentiality, and audit trail) and for the analysis of data with standard statistical program packages [BIOS 611, BIOS 735, BIOS 841, BIOS 850];
4. PH07: carried out independent methodological research, including the writing of a scholarly dissertation andpublishing papers based on the dissertation in respected statistical journals [BIOS 994];
5. PH08: gained successful practical experience in statistical consulting, including interaction with research workersin the health sciences, abstracting statistical aspects of substantive problems, and communicating the results to persons without specialized biostatistical training; if not outside academia, then this consulting experience can be obtained by serving in the Biometric Consulting Laboratory (BCL), the Collaborative Studies Coordinating Center (CSCC), the Lineberger Comprehensive Cancer Center (LCCC), the North Carolina Translational Research and Clinical Studies (NC TraCS), or as a member of another university research project team [BIOS 841 and

BIOS 843];

6. PH09: taught basic statistical theory and applications effectively, not only to biostatistics majors, but also to other health science practitioners [BIOS 850].

Admission Requirements

1. An appropriate prior Bachelor's or Master's degree in Statistics, Biostatistics, or a closely related field.
2. Strong mathematical training including linear algebra and multivariable calculus. Advanced calculus/elementary analysis are strongly encouraged, but on occasion exceptional students are admitted without these courses. In such cases, the student will take MATH 521 during the first year of study.

Time / Residence Requirements

Doctoral students are required to complete a minimum residence credit of four full semesters, and at least two of the required four semesters of residence must be earned in contiguous (i.e., fall to spring or spring to fall) registration on this campus. All requirements for the degree must be completed within eight years since the student matriculated in the program. Please refer to the Graduate School Handbook (The Graduate School Handbook (unc.edu)) for additional information.

Course Requirements

The Gillings School of Global Public Health requires a minimum of 18 semester hours of course work beyond the Master's degree for a PhD student to be able to take the PhD written qualifying examinations and to begin work on their dissertation. The Department of Biostatistics requirements are as indicated below. Requirements (1), (2), and (3) may be waived for students who have had previous training or experience deemed equivalent by the Director of Graduate Studies (DGS). Courses counted toward the Gillings School of Global Public Health requirements, or taken at UNC prior to entry into the program, may be included in (5).

(1) Mathematics

- Advanced Calculus and /or Real Analysis

The PhD student is required to take BIOS 760 and BIOS 761. This requires working knowledge of advanced calculus equivalent to at least the level of MATH 521 at UNC-CH.

- Linear Algebra

The PhD student is required to take BIOS 762. This requires working knowledge of the material in MATH 422, 577, and 547 at UNC-CH.

Students who have not taken advanced calculus and/or real analysis are required to take an equivalent course at UNC such as MATH 521

(2) Statistical Computing and Data Science

- BIOS 611. This is a required course in data science.
- BIOS 735. This is a required advanced statistical computing course.

(3) Basic Statistics

- The elements of probability, statistical inference, statistical methods, and linear regression. Required courses are: BIOS 662, BIOS 663, BIOS 672, and BIOS 673. Most of these courses are

included in atypical MS program.

(4) Advanced Statistics

- Required Courses: BIOS 735, BIOS 760, BIOS 761, BIOS 762, BIOS 767, BIOS 780, and BIOS 850
- Electives: At least 9 semester hours. Acceptable courses include all those numbered at the 700-level in Biostatistics or in (Mathematical) Statistics at UNC-CH, and equivalent courses in Statistics atother institutions as approved by the DGS. Requests to count 700-level courses in STOR toward this requirement are considered individually.

  NOTE: BIOS 735, 760, 761, 762, 767 are typically taken during the second year of study and 780 is typically taken during the third year, following completion of BIOS 662, 663, 672 and 673 during the first year of study for students who are admitted to the PhD program with a bachelor's degree.

- Bootcamps
  - Students taking BIOS 760 in the fall semester are required to take the Real Analysis Bootcamp, offered each summer, in the summer immediately preceding that fall semester
  - Students taking BIOS 762 in the fall semester are required to take the Linear Algebra Bootcamp, offered each summer, in the summer immediately preceding that fall semester.
  - PhD students taking BIOS 611 in a fall semester are required to take the SAS Bootcamp, offered each summer, in the summer immediately preceding the fall semester.

(5) Supporting Program

- A supporting program of at least 6 semester hours, including EPID 600 or 710 and SPHG 600 (orequivalent), is required.

(6) Practicum

- BIOS 841 and BIOS 843 (4 semesters (credits)) are required. BIOS 843 can be taken only if you have taken both the theory and applications written qualifying exams. Note that there are mandatory attendance requirements for BIOS 843 described in the course syllabus.
- In addition, each PhD student may be required to grade up to 3 courses (up to 4 for a combined MS/PhD program).

(7) Dissertation Registration

- All doctoral students must register for a minimum of 3 credit hours of dissertation work (BIOS 994).

(8) Transfer of Credits

- A doctoral student may request transfer up to 6 credit hours from another institution. Courses transferred are subject to examination at the time of the PhD oral examination. The Committee may recommend the transfer of both course and residence credit in its report to the Graduate School,which has the final responsibility for approving the transfer. Transferred credit does not relieve the student of the residence requirement of at least one academic year of continuous full-time study, or the equivalent, at UNC-CH. *See the List of Web Sites for link to Graduate School forms.*

  NOTE: This Department requires no "Research Skill" or "Language" as defined by the Graduate School. It may be beneficial to a student's program to take more computing or a foreign language (e.g., French may be desirable for a demography student). These individual arrangements are

left to the students and their advisors.

The Department's checklist for the PhD degree requirements can be obtained from the Academic Coordinator.

To enhance your UNC experience, the department offers numerous ways for students to finance their education, get involved in volunteer service activities, and participate in various student organizations.

Degree Examinations and Dissertation

Written Qualifying Examinations

Each PhD student is required to pass the PhD written qualifying examinations in biostatistics theory and applications. The PhD written qualifying examinations are usually taken in the beginning of the third year of the program, depending on the student's prior obtained degree before entering the program. See the Section on Department-Wide Written Examinations page 31 for details.

Doctoral Committee

In the Department of Biostatistics, the Doctoral Committee combines the functions of two committees as specified by the Graduate School: (1) the Doctoral Oral Examination Committee, and (2) the Dissertation Committee.

After the candidate has entered the final stage of planned course work, has chosen a topic for PhD dissertation research, and has been declared ready by the dissertation advisor, the student and advisor recommend the composition of the Doctoral Committee to the DGS for approval. The composition of each Doctoral Committee is to be approved in writing by both the chairperson of the Department and the DGS. An appropriate form to accommodate this approval process is available from the Academic Coordinator. This form will solicit information regarding the proposed dissertation topic. The student should first consult with the Academic Coordinator concerning completion of forms and acceptability of committee appointments.

At least five persons shall constitute the Doctoral Committee. A majority of the members must be full members of the Graduate Faculty in the student's major academic program (i.e., Biostatistics). Other members may be limited members of the Graduate Faculty or special appointees. The Committee must also include a representative of the supporting program.

Preliminary Doctoral Oral Examination

In the Department of Biostatistics, the preliminary oral examination consists of two parts, a written document, and an oral presentation. The preliminary doctoral written document also consists of two parts:

1. The first part is the student's review of the literature for the proposed dissertation topic, on which the student will be questioned by the Committee. This portion of the written document must be at least 12 pages in length, excluding the bibliography section.
2. The second part is concerned with the research already obtained, and the feasibility of the proposed dissertation research. This portion of the written document must be at least 20 pages in length, excluding the bibliography section. An appropriate maximum length for the literature review and proposal is about 40 pages.

As stated in the Graduate School Handbook, students should have fulfilled, or will have fulfilled by the end of the semester in which the preliminary oral examination is to be taken, all required course work and the minimum residence requirements for the doctorate. Additional considerations include the

following:

- No doctoral student is allowed to take the preliminary oral examination until they have passed both the theory and applications written qualifying examinations.
- No doctoral student is allowed to take the preliminary oral examination without having completed all necessary coursework covered on the exam.
- A student must be registered for at least three (3) credit hours of BIOS 994 to take the preliminary oral examination.
- The preliminary oral examination must precede the final thesis defense by at least 4 months.
- In addition, no preliminary doctoral examination can be scheduled until the student has obtained some tangible research results as judged by the dissertation advisor.
- The literature review and proposal to be considered at the preliminary oral examination must be submitted to the Doctoral Committee at least three weeks before the oral is scheduled. An appropriate maximum length for the literature review and proposal is about 40 pages

Preliminary Oral Examination Instructions

It is important that all PhD students follow the timeline and process for the preliminary oral examination described here. This process should be started as soon as the dissertation committee is confirmed with the advisor. A checklist of items that should be completed or are in progress before the preliminary oral examination process can begin include:

1. Student must have completed and passed the written qualifying examinations (theory and applications).
2. An abstract must be completed.
3. The full proposal can be added later, but no less than 3 weeks before the prelim date.
4. Both the Doctoral Committee Composition and Doctoral Exam Report forms must be completed, saved, and uploaded into a folder created to contain all the dissertation materials.

To begin the process, students should access http://internal.bios.unc.edu, enter their ONYEN and password, click OK, and proceed by clicking on Oral Exam Request. The following is a brief summary of the timeline and steps required to complete the process:

5. Section one should be completed. The student should enter their room information after they have received confirmation from SPH.
6. Section two should be completed. The dropdown box will have names of all BIOS faculty. If a dissertation committee member is not in the list, their name will need to be entered.
    a. If a dissertation committee member is not listed on Graduate School Designation, a copy of their CV should be uploaded. In general tenure track/tenured professors are on the list, and research or clinical track professors may or may not be on the list. By clicking on Graduate School Designation, a student can see if their committee members are listed.
7. At 5 weeks out, the student will need to upload their abstract and ensure the Doctoral CommitteeComposition and Doctoral Exam Report forms are uploaded.
8. At 3 weeks out, the student will need to have their proposal uploaded in the online system. If the time to the scheduled prelim is less than 3 weeks, the system *will not* allow the proposal to be uploaded, and the prelim will need to be rescheduled.
9. At 2 weeks out**,** the system will send out a prelim announcement, the doctoral committee composition and doctoral exam report forms, and the proposal and abstract to the student

and their dissertation committee members.

After the examination, the completed reporting forms should be returned to the Academic Coordinator. For any part of the prelim, the Dissertation Committee may award a PASS or FAIL, or a PASS subject to specified conditions (such as additional course work, or the passing of a special examination covering a specific topic). A student who fails a part of the prelim is entitled to one re- examination, but not until at least 3 months have elapsed. Re-examination of the first part may be in writing, by request of the student. Appeals of Committee decisions may be made to the faculty of the Department through the Department Chair.

Doctoral Research

The research for the PhD dissertation is a scientific and original project conducted by the student under supervision of the dissertation advisor or co-advisors. This research is expected to be of such scope, independence, and skillful presentation as to indicate that the candidate has acquired a mastery of the research methodology and its application and has contributed new knowledge to this subject. Research for the PhD dissertation is expected to be of the type leading to articles in top-tier statistical journals such as *Biometrics, Biostatistics, Annals of Applied Statistics, Statistics in Medicine, Biometrika, Journal of the American Statistical Association, Journal of the Royal Statistical Society (Series B), Statistica Sinica, Lifetime Data Analysis, Annals of Statistics, American Journal of Human Genetics, Neuroimage, and Genetic Epidemiology.* See the section on Guidelines for the Written Doctoral Dissertation.

Dissertation Advising Guidelines for Students and Faculty

Faculty with a primary appointment in the Department of Biostatistics or with a joint appointment in another department but having at least a 25% funding commitment from the Department of Biostatistics can serve as the dissertation advisor or co-advisor of at most eight PhD students at any given time. Taking on more students will require the authorization of the Department Chair in consultation with the Director of Graduate Studies.

A faculty member with a joint appointment but less than a 25% funding commitment from the Biostatistics Department can be the doctoral dissertation advisor or co-advisor of at most four PhD students at any given time, provided that the joint faculty member fully funds at least all but one of the students. For example, if they advise or co-advise three PhD students, they must fully fund at least two of the students. If they advise or co-advise only one PhD student, they are not required to fund that student.

All Adjunct Faculty members can be the doctoral dissertation advisor or co-advisor of at most three PhD students at any given time, provided that the adjunct faculty member fully funds at least all but one of the students.

The PhD thesis advisor (and co-advisor(s), if applicable) must be fully engaged in the student's dissertation and are expected to make substantial contributions on all papers submitted from the student's dissertation, regardless of the level of their faculty appointment.

A student can schedule a PhD thesis defense only when at least one first-authored paper (i.e., with the student as first author) has been submitted for publication from their dissertation.

Any student who works as a GRA or is funded by a faculty member through a training grant or other funding mechanism is not obligated to work with that faculty member on their doctoral dissertation.

Application for Graduation

Students must notify the Graduate School of their plan to graduate by applying to graduate through the Connect Carolina portal no later than the deadline shown in the University Registrar's Calendar for the semester in which they expect to graduate. Applications should only be submitted when the student realistically intends to graduate that semester and are valid for one semester only. If a student does not graduate in the semester expected, they must submit another application for graduation in a future semester. The department Academic Coordinator will also notify students via email of deadlines.See the List of Websites at the end of this manual for links.

Final Dissertation Defense

When a date for the final dissertation defense (referred to as the Final Oral Examination in the Graduate School Handbook) is chosen, the student will access http://internal.bios.unc.edu, enter their ONYEN and password, click OK, and proceed by clicking on Final Exam Request. The student should enter their room information, upload their abstract and dissertation. The system will notify the doctoral committee, Biostatistics faculty and peers.

At least three weeks after entry into http://internal.bios.unc.edu the candidate takes the final dissertation defense. This includes a public exposition and defense of the dissertation, presented as a seminar or colloquium, at which time the candidate answers questions regarding the dissertation that are raised by the Committee and others present. Immediately after the public meeting, the Committee members meet with the student to conclude the thesis defense, at which time they may also ask questions of the student about the dissertation or other areas of research.

The Graduate School form for reporting the results of the final dissertation defense is sent by the Academic Coordinator to the doctoral committee chair prior to the defense; the completed form is returned to the Academic Coordinator following the defense.

A student must be registered for BIOS 994 for three (3) credit hours to take the final dissertation defense.

Guidelines for the Written Doctoral Dissertation

Detailed instructions for the Graduate School Thesis and Dissertation Guide (Guide) can be accessed at: http://www.gradschool.unc.edu/etdguide/. Please read the Guide carefully before preparing your thesis/dissertation. It is the responsibility of the student to ensure the dissertation meets the highly detailed, rigorous guidelines of the graduate school. Students should be aware that it may take numerous iterations to obtain format approval from the graduate school, and students should anticipate delays. The Graduate School will provide feedback on whether dissertations meet their guidelines. Students who wait until the last minute may be delayed in graduation if their dissertations are not in the appropriate format. The format found on g:\dissertation\templates is an excellent starting place, but students should anticipate having to make formatting changes even with the use of this template, as the Graduate School guidelines may change.

Students are required to provide a PDF file of their dissertation. The student is responsible for ensuring that the electronic version can be converted correctly (i.e., for making sure that graphs, tables, and equations are in the appropriate place and in the correct layout design).

To submit your dissertation, visit http://gradschool.unc.edu/etdguide/submission.html. Only the final document should be submitted after all relevant authorizations and department approvals are received. Once submitted, please patiently allow sufficient time for Graduate School staff to review the document for necessary format revisions. You will be notified if revisions are needed and/or if your document has been approved.

SUPPORTING PROGRAMS

The Department of Biostatistics requires a supporting program of at least 6 semester hours for the MS and the PhD degrees in a field or fields of application. This supporting program typically includes EPID 600 or 710 (or equivalent) and SPHG 600. A field of application is loosely defined as a discipline whose members might reasonably be expected to seek statistical consultation on occasion. Statistics, Mathematics, and Computer Science are excluded. A proposal involving a course in Operations Research is judged on its individual merits.

A supporting program is intended to be more flexible than a minor as defined by the Graduate School Handbook. *All supporting programs must be approved by the Director of Graduate Studies in consultation with the appropriate faculty in the field(s) of the supporting program.*

Alternative to Supporting Program

A student may elect to do a formal minor instead of a supporting program. Students choosing to do so should consult the Graduate School Handbook for requirements.

Representation of Supporting Program (or minor) on Doctoral Committee

The Doctoral Committee must include at least one member from the area of the supporting program or minor.

POLICY ON ENROLLMENT

The policy on enrollment for all degree programs is stated in the Graduate School Handbook and summarized below.

- Students are required to be registered whenever degree progress is being made or University resources (including faculty time) are being used, to appropriately reflect work being done. Students who lapse enrollment lose official student status and recognized University affiliation. Relinquishing formal student status can disadvantage students by eliminating their eligibility for financial aid and student campus services and benefits.

- Each student holding a service (assistantship) or non-service (fellowship) appointment must be registered full-time to hold that position during the fall and spring semesters. Students must be on-campus unless the award requires their presence at another campus or research center.

- A student must be registered during the semester(s) in which any written examinations (MS written examination or PhD written qualifying examinations) are taken and graded. For written examinations taken in the summer, students must be registered for the following fall semester.

- Students must be registered for a minimum of three credit hours of dissertation research (994) during the semesters or summer terms in which the dissertation is proposed and defended.

- Once students have completed all courses, including a minimum of three credit hours of thesis substitute (992) for MS students or a minimum of six credit hours of dissertation (994) for PhD students, they must continue to register for three credit hours of 992/994 each academic semester (fall/spring) until the degree is completed to reflect academic progress and to use University resources (including faculty time).

- Once students successfully defend their dissertation, no further enrollments are necessary or permissible, and graduation should not be delayed.

DEPARTMENT-WIDE WRITTEN EXAMINATIONS

Introductory Statement

The MS written examination (Part I and II) satisfies the Graduate School's requirement that every master's candidate must pass a comprehensive examination covering all course work done for the degree. All master's candidates are required to pass the examination by the deadline established by the Graduate School for the commencement at which they expect to receive the degree.

PhD students are required to take both the theory and applications written qualifying examinations. These written qualifying examinations are different from the Doctoral Written Examination required by the Graduate School that is incorporated as part of the preliminary oral examination in the Biostatistics Department (see Section on Preliminary Doctoral Oral Examination page 25).

The master's examination and the PhD basic written examinations are usually offered in July or August. See the departmental web site for examination dates.

The culminating experiences of these written examinations provide students an opportunity to synthesize, integrate and apply knowledge and skills learned in their coursework and other learning experiences and also require students to demonstrate attainment of program competencies.

Rules on the Maximum Number of Years to Pass the MS and PhD Examinations

PhD Students

1. **Eligibility**
   - PhD Written Qualifying Examination in Applications: The student must (1) be admitted to the PhD program prior to taking the examination (either officially by the University or through a formal conditional admissions offer from the Admissions Committee), (2) be formally registered for the fall semester of the exam year, and (3) have completed BIOS 735, 762, and 767.
   - PhD Written Qualifying Examination in Theory: The student must (1) be admitted to the PhD program prior to taking the examination (either officially by the University or through a formal conditional admissions offer from the Admissions Committee), (2) be formally registered for the fall semester of the exam year, and (3) have completed BIOS 760, 761, 762, and 767.
2. **Timing of exams**
   - PhD students admitted directly to the PhD program: PhD students are expected to take the written qualifying examinations right after they finish the required core courses, which is typically after their 1st or 2nd year in the program. In all cases, they are required to have taken the written qualifying examinations by the end of their 3rd year after they started in the doctoral program. In addition, they must *pass* both written qualifying examinations (theory and applications) by the end of their 4th year in the program.
   - PhD students proceeding from the MS program: PhD students who proceed from the MS program are expected to take the written qualifying examinations at the end of the their 1st year in the doctoral program, and they are required to have taken the written qualifying examinations by the end of their 2nd year in the doctoral program. They are required to *pass* both written qualifying examinations (theory and applications) by the end of their 3rd year in the doctoral program.
3. **Priority funding based on exam status**

- Any PhD student must pass the written qualifying examinations by the end of their 3rd year in order to receive priority for funding. No PhD student should receive more than four years of funding without passing both written qualifying examinations (theory and applications) for their program.

4. Special considerations

- Part time students are allowed to have an extra year for these deadlines if requested.
- Medical leave of absence or other approved leave of absence will stop the clock for these deadlines/guidelines. The Graduate School Handbook (Medical or Personal Issues - Graduate School Handbook (unc.edu)) includes details on requesting leaves of absence for medical or personal issues, including parental leave.

MS students

1. Eligibility

- MS Written Examination Part I (Theory): The student must (1) be admitted to the MS program prior to taking the exam (either officially by the University, or through a formal conditional admissions offer from the Admissions Committee), (2) be formally registered for the fall semester of the exam year, and (3) have completed (or be formally exempted from) BIOS 660 and 661.
- MS Written Examination Part II (Applications): The student must (1) be admitted to the MS program prior to taking the exam (either officially by the University, or through a formal conditional admissions offer from the Admissions Committee), (2) be formally registered for the fall semester of the exam year, and (3) have completed (or be formally exempted from) BIOS 511, 662 and 663.

2. Timing of exams

- MS students are expected to take the MS written examinations immediately after they finish the required core courses, which is typically after their first year in the program. They are required to have taken the MS written examinations by the end of the 2nd year after starting in the MS program. They are also required to pass the MS written examination by the end of the 3rd year/beginning of the 4th year in the program.

3. Special considerations

- Part-time students are allowed to have an extra year for these deadlines if requested.
- Medical leave of absence or other approved leave of absence will stop the clock for these deadlines/guidelines. The Graduate School Handbook (Medical or Personal Issues - Graduate School Handbook (unc.edu)) includes details on requesting leaves of absence for medical or personal issues, including parental leave.

Format and Scheduling

MS and PhD examinations are each composed of two components: Theory and Applications. The exam formats are as follows:

	Theory Exam	**Applications Exam**

MS	Part I of examination: 3 Questions (6 hours, in-class, closed book)*	Part II of examination: 3 Questions (6 hours, in-class, open book)**
PhD	2 Questions, Day 1 (4 hours, in-class, closed book)*** 2 Questions, Day 2 (4 hours, in-class, closed book)***	4 Questions (5 days, take-home, open-book)

*****For the MS Part I (theory) examination, numerical and mathematical distribution tables will be provided. Students can bring one 8"x11" sheet of paper (study guide) with hand-written notes in blue ink on only one side. These specifications of the study guide will be strictly enforced. Study guides not satisfying these specifications will not be allowed in the exam room. Calculators will be provided - students are not allowed to use their own calculators. Other electronic devices (e.g., laptops, tablets, phones) are not allowed.

******Students may only bring four text and reference books to the MS Part II (applications) examination. A printed set of class notes or set of slides counts as one book.

*******Examinations will be proctored remotely, if an in-class exam is not possible (e.g., due to the University's COVID-19 Community Standards).

NOTE: Students who plan to take any of the examinations should sign up with the Academic Program Support Coordinator by the date specified on the departmental website.

Additional instructions regarding the MS written examinations

Part I (theory) of the MS examination (theory) will be proctored remotely if an in-class exam is not permitted (e.g., due to the University's COVID-19 Community Standards). The 3-question exam will be divided into 3 sections of 1 question each, with 2 hours allowed for each section. Students will be asked to scan their answers into a PDF file and submit as instructed at the end of each section. Students will need to prepare the numerical and mathematical distribution tables, a study guide, and a basic calculator prior to the remotely administered examination. A phone equipped with text/voice capability is also required for communication during the remotely administered exam.

For Part II (applications) of the MS written examination, electronic copies, such as PDF files, of instructor-supplied class notes from BIOS classes covered in the respective exams are allowed, and they do not count toward the totals given above. All files should be brought to the classroom on a USB drive; online/cloud storage such as DropBox and Google Drive is not allowed. Electronic copies of course textbooks are also allowed. Internet access is allowed only for online SAS documentation at sas.com, R help files, and dictionary websites (including Google Translate), but no other websites. No other electronic media are permitted. Some specific examples: Access to online calculators, explanations, comments, blogs and forums, examples, courses, videos, instructional material, and class notes is not allowed. Any exceptions must be with explicit approval from the chair of the MS Examinations Committee (for example, a student who had BIOS 663 waived and would like to use class notes in PDF format from a similar class taken at another university).

The MS Applications exam will be taken at home if an in-class exam is not permitted (e.g., due to the University's COVID-19 Community Standards). It will not be proctored remotely. The limitations on resources used imposed for the in-class exam will be lifted for remote administration. Students will be asked to scan their answers into a .pdf file and submit as instructed at the end of the remotely administered exam.

Grading the Department-Wide Written Examinations

The three Examinations Committees (PhD Theory, PhD Applications, and MS) prepare and conduct all department-wide written examinations and handle arrangements for their grading. Papers are coded so that the graders are unaware of the students' identities. A team of two graders is appointed for each question. Where possible, all graders are members of the Department of Biostatistics and of the Graduate Faculty. The student's answer to an individual question is marked independently by each of the two graders on a scale of 0 to 25. The mark awarded reflects the effective proportion of a question correctly answered. After grading, graders will resolve any major discrepancies in their respective marks.

A small committee consisting of the Department Chair and Associate Chair, the Exam Committee Chairs, and the DGS meets to review the grading results and make a recommendation on which students pass or fail. The committee presents the grading results to Biostatistics faculty during a faculty meeting, along with their pass/fail recommendations. The faculty members discuss the results and vote to approve the committee's recommendations or an alternative recommendation. Each student is then given a grade of pass or fail. For MS examinations, a provisional pass can be given. Examination papers are not identified by author (student) until after the decisions of pass and fail (and provisional pass for MS exams) have been made.

The chair of each Examination Committee notifies all students by letter of the pass/fail/provisional pass (MS only) decision and, if applicable, any special commendations. Advisors are also free to notify their advisees of the pass/fail results following the unmasking of student codes at the end of the Biostatistics faculty meeting. No further information will be released to the students (e.g., individual scores or relative rankings).

A student whose performance was not of the standard required may retake the examination at the next regularly scheduled examination time, or at an earlier date set by the Examinations Committee. One retake of an examination is permitted automatically. Petitions for additional retakes may be submitted to the Department Chair or Associate Chair.

Rules for Retaking the MS Examination in Jan/Feb

The purpose of offering an option to retake the MS examination in Jan/Feb of a particular year is to provide students an opportunity to satisfy the MS degree requirements for subsequent May or August graduation that year.

To be eligible for retaking the examination in Jan/Feb, students: (i) must have failed exactly one part of the MS Written Examination; (ii) must not be admitted to the PhD program in Biostatistics; and (iii) must have completed at least one full year of residency in the MS program.

Retaking the examination in Jan/Feb is counted as a second attempt to pass the MS written examination. Students who did not pass the MS written examination are not obligated to retake the examination in Jan/Feb. They may choose instead to retake the examination at the next regularly scheduled time the written MS examination is offered.

Rules for Retaking the PhD Qualifying Examinations in December

An option to retake the PhD written qualifying examination in theory will be offered after final examinations for fall semester courses are completed in December. This retake will count as a second attempt, and only students who fail their first attempt will be eligible to sit for the retake in December. In order to retake the examination in December, students must register for 3 credits of 990 and retake either BIOS 760 or 762 or both, depending on their performance on day 1 and day 2 of the July/August

examination.

Specifically, students who do not pass day 1 of the examination would retake BIOS 760 (by registering for BIOS 990), and students who do not pass day 2 of the examination would retake BIOS 762. For the December retake only, students can retake the day (1 or 2, or both) of the exam for which they did not receive a passing score. Students who do not pass the retake examination in December will need to petition for permission for a third attempt the following year. The December retake is optional; students may elect to wait and retake the entire PhD theory exam again the following July/August. An option to only retake one day of the exam the next July/August is not offered.

The PhD written qualifying examination in applications is only offered once a year in July/August, so students who fail this examination may only retake this examination in July/August of the following year.

Availability of Old Exams

Recent prior examinations are available at: https://www.bios.unc.edu/distrib/exam/

Topics Covered on the MS Written Examinations

The questions in each part of the written examination for the MS degree in Biostatistics may cover topics in the following courses:

BIOS 511	Introduction to Statistical Computing and Data Management
BIOS 660, 661	Probability and Statistical Inference
BIOS 662	Intermediate Statistical Methods
BIOS 663	Intermediate Linear Models

Topics Covered on the PhD Written Qualifying Examinations

The PhD written qualifying examination in theory covers theoretical aspects of statistics at the level and content of the following courses:

BIOS 760, 761, 762, 767 and relevant prerequisites.

The PhD written qualifying examination in applications covers applied aspects of statistics at the level and content of the following courses:

BIOS 762, 767, 735 and relevant prerequisites.

HONOR CODE – WORKING INDEPENDENTLY

Students at UNC-CH are bound by the University's Honor Code, through which UNC-CH maintains standards of academic excellence and community values. It is the student's responsibility to learn about and abide by the Code. Specification of what resources and what communication are allowed for assignments is at the discretion of the instructor. To ensure an effective Honor System at UNC, instructors are expected to specify clearly what resources and what communication are allowed for each assignment. Students need to know specifically what is allowed and what is not allowed for each assignment in each course because these items can vary by instructor and assignment.

Some example statements are provided that instructors could use or modify to capture their intent:

- [Example 1] For homework, students may verbally discuss approaches to the problems with others (including classmates), but each student should independently write up the answer and verify solutions. Students may not access work from previous semesters (for example, graded homework from previous semesters or answer keys).
- [Example 2] For homework, students may verbally discuss approaches to the problems with the instructor or TA only. Students may NOT discuss the homework or related material with other students in the course (past or present) or tutors.
- [Example 3] For take-home tests, students must work completely independently without communicating with other students, tutors, or anyone else (except the instructor) about any material related to the test questions. Students may access textbooks, their own course notes, their own graded homework, and some websites (software documentation for example). Students may not access websites for the particular purpose of finding/copying specific solutions, such as websites that post answer keys such as chegg38.com or coursehero.com. Students may not access work from previous students in the course.
- [Example 4] For in-class tests, students must work completely independently with no access to other individuals, notes, books, or technology (computer/phone). A calculator (with no internet access or capability to store notes) can be used. Students will be allowed to bring a single 5x7 inch index card or paper (writing on the front and back are acceptable) with any information.

Instructors are encouraged to ask students to sign the honor pledge for each assignment. A typical honor pledge is: *"In recognition of and in the spirit of the honor code, I certify that I have neither given nor received aid on this examination."*

To ensure an effective Honor System at UNC, each student is expected to:

- apply the recognized techniques of proper attribution of sources used in written work and identify allowable resource materials or aids to be used during completion of any graded work.
- seek clarification if the student is in doubt about what resources/communication are appropriate. If no direction is given, students should assume that each assignment is required to be completed entirely independently with no access to notes, books, previous materials or technology.

Evidence of violations will be reported directly to the Honor Court (http://honor.unc.edu).

If you have any questions about your rights and responsibilities, consult the Office of Student Conduct or review the following resources: Honor System; Honor System module; UNC Library's plagiarism tutorial; UNC Writing Center's handout on plagiarism.

POLICIES FOR CHANGING DEGREE PROGRAMS

In some cases, the Department of Biostatistics permits students matriculated into a program to switch (or proceed) to a different degree program. Students wishing to change degree programs must submit a formal request to the Graduate Admissions Committee. The Graduate Admissions Committee evaluates these requests and then makes a recommendation to the department Chair to approve/disapprove the degree program change.

Students currently enrolled in the PhD program will be permitted to enroll in the MS degree concurrently with their current training in the doctoral program.

Students currently enrolled in the MPH degree program with a concentration in Public Health Data Science cannot switch to the MS program in Biostatistics. They must instead apply to the MS program and satisfy the pre-requisites for admission.

Requests to Proceed/Bypass to the PHD Program from the MS Program

A student currently enrolled in the MS program and interested in continuing to the PhD program should discuss their interest with their academic advisor early and discuss any supplementary mathematics (real analysis) or biostatistics (BIOS 611, 660, 661, 662, 663, 667 and 680) coursework needed.

Requests to *proceed* to the PhD program may be made by MS students (typically in their 2nd year of the MS program) who intend to satisfy all requirements for the MS degree before proceeding to the PhD program. All proceed requests must be submitted by December 1 to the Graduate Admissions Committee.

Requests to *bypass* the MS program may be made by MS students (typically in their 1st year) who intend to bypass (not receive) the MS degree and proceed to the PhD program. All bypass requests must be submitted by March 15 to the Graduate Admissions Committee. For those who intend to proceed/bypass to the PhD program, it is highly recommended to take the BIOS 672 - 673 sequence instead of the BIOS 660 – 661 sequence during their 1st year of study.

Approval of requests by MS students to proceed/bypass to the PhD is not routine. Successful applicants must demonstrate outstanding performance in coursework and the MS written exams (if already taken). To apply to the PhD program through either a proceed or bypass request, students must provide a one-page statement of purpose that explains what they expect to gain from their PhD level training. In addition, each such student must ask their faculty mentor (or one of their course instructors, if the faculty mentor is the Chair, Associate Chair, Director of Graduate Admissions, or is otherwise conflicted) to provide a letter of support for the requested switch. Comments from faculty mentors on the student's research promise, as evidenced by their course work, will be especially valuable. The committee may also seek recommendations from instructors of the MS core or equivalent courses the student has completed (BIOS 660, 661, 662, 663, 667, and 680). The Department Chair or Associate Chair reviews the Admissions Committee's recommendation for each student to proceed to or bypass the PhD program and notifies each such student of the decision.

Note: A graduate student who plans to switch to a new degree will not be permitted to take the written examinations for the new degree program until they have been formally admitted to the new program. An exception to this rule may be made for students in the dual BSPH/MS degree program who have completed their BSPH course work as well as the first year MS courses. They may be allowed to take the MS written examination before formally matriculating into the MS part of the dual degree, provided approval is received from the Director of Graduate Studies.

Instructional and Research Assistants

Instructional Assistants

Definitions

There are two types of Instructional Assistants (IAs) in Biostatistics:

- Grading Assistants (GAs). These are paid assistants (graders) or students who must satisfy a grading requirement as part of their training grant but do not teach.
- Teaching Assistants (TAs). These are unpaid assistants who have duties associated with course instruction that are beyond just grading and include students formally enrolled in BIOS 850.

Duties and Compensation of IAs

TA positions are only available for service courses (e.g., BIOS 600, BIOS 645, BIOS 650) in the Department of Biostatistics or for non-service courses (e.g., BIOS 662/663/664/665/667/680) if there are more than 20 non-Biostatistics graduate students taking the course (1 TA for 20-39 non-Biostatistics students and 2 TAs for >= 40 non-Biostatistics students). If there are more TA's than service courses require, students may petition the DGS to TA for other non-service Biostatistics courses.

Assignment of GAs is as follows: Biostatistics classes having between 5 and 25 enrolled students will be permitted to have exactly one GA; Biostatistics classes having between 26 and 50 enrolled students will be permitted to have exactly two GAs; and Biostatistics classes having between 51 and 75 enrolled students will be permitted to have exactly three GAs. Every additional 25 enrolled students will be permitted to have one additional GA.

GAs that are not on a training grant will be compensated for their services. Decisions concerning the amount of compensation per course for GAs in any academic year will be made by the Department Chair prior to the start of the academic year. TAs will not be compensated for their services if they are receiving academic credit for BIOS 850 that semester.

BIOS students supported as a pre-doctoral trainee by a federally funded training grant in the Department of Biostatistics will be required to serve without compensation as a GA for one course in each academic year in which that student receives training grant support.

Duties of GAs (graders)

The primary duties of GAs are:

1. Grading of examination questions requiring no subjective judgment (e.g., multiple-choice type) and of homework problems (whether subjective or objective). Policies on work turned in late, turnaround time for grading, and the like, should be negotiated between instructors and GAs in advance.
2. Holding office hours for up to 2 hours per week, during which time students, on a one-on-one basis, may receive further help as necessary. The time for office hours should be negotiated by instructors and GAs in advance. GAs are responsible for securing a suitable place for office hours through the School's on-line room reservation system.
3. Graders are expected to grade roughly 5 hours/week over the course of a semester, though the work is highly variable; students should expect that some weeks may involve no grading while others involve a greater number of hours. **NOTE**: Other duties of benefit to the course (e.g.,

copying, dataset management, maintaining class records) may be assigned to GAs when it is not convenient to use staff personnel instead. However, any such duties are to be at most incidental to the primary duties. Note also that Departmental policy does not permit GAs to grade subjective examination questions, and *GAs are never required to teach classes or give lectures.*

4. Graders for 700 level Biostatistics courses will be selected by the instructor for the course.

Objectives

By serving as GAs, Biostatistics students:

- are stimulated to review and consolidate their knowledge;
- receive a useful introduction to teaching activities, with which most will become involvedas part of their careers;
- acquire skill in communicating with members of other disciplines, which is essential for effectiveness as a biostatistician;
- provide faculty with opportunities to observe their performance, which aid in evaluating the student and in writing effective and convincing recommendations.

Duties of TAs

Although the duties of a TA will necessarily vary depending on the particular faculty member and course, TAs are usually required to perform the following:

1. Conduct weekly laboratory or review sessions. While much of the time spent in the laboratory may be devoted to answering questions arising from the instructor's lectures, homework, or examinations, the TA may be expected to prepare a brief review lecture or demonstration.
2. Meet with the instructor each week, prior to the laboratory session, to ensure that the TA understands the level and emphasis of the current lecture materials and homework assignments.
3. Present 1-2 regular class lectures during the semester, or weekly structured lab session, with the instructor observing and evaluating at least one lecture.

Subject to the limitation on time requirements stated below, the TA may additionally be required by the instructor to perform some or all of the following duties:

1. Maintain computer-based data files for homework and examination problems.
2. Assist in preparation of class materials such as handouts.
3. Assist in the preparation of homework and/or examinations, including solution guides.
4. Attend the instructor's lectures and/or personally do the assigned homework.
5. Read, and/or discuss with the instructor, material on statistical pedagogy.

Time Requirements

TAs must pre-register for 3 hours of BIOS 850. A student can receive credit for BIOS 850 only once. This translates into 10 hours of work per week *on average*. TAs may not be expected to work more than an average of 15 hours per week during the semester**.** The instructor should be notified as soon as it appears that these time restrictions may be exceeded. All doctoral students are *required* to register for BIOS 850 within three years of starting their program.

Resolution of Problems

If TAs cannot resolve problems involving these guidelines with the instructor, they should contact the DGS. All TAs are strongly encouraged to submit an evaluation of their experiences to the DGS at the end of the semester so that these guidelines may be monitored more effectively.

Qualifications of IAs

IAs must be given responsibilities that are commensurate with their qualifications.

1. All IAs must be enrolled graduate students, and in good academic standing (which implies that their academic performance represents reasonable progress toward the degree and warrants continuation in the program).
2. All IAs must have taken the courses in which they assist, or equivalent courses, except for elementary service courses.
3. All TAs must have demonstrated oral proficiency in English, as approved by the instructors of the courses in which they are to assist. Those TAs whose native language is not English must have passed the ETS Test of Spoken English (TSE) or some other formal screening test approved by the University.

Supervision and Mentoring of IAs

IAs must be properly supervised and mentored in their roles.

GAs:

1. The instructor should review and discuss this section of the AIM with the GA prior to the start of the semester.
2. The instructor must provide the GA with at least a rough sketch of acceptable answers for all homework exercises and must also provide instructions regarding how to distribute points among the assigned questions.
3. The instructor should meet with the GA as needed so that the GA is informed about such matters as: progress through the course's text, which parts of the course (i.e., topics) typically require emphasis/explanations in the GA's individual help sessions, coverage of homework assignments, and dates for assigned homework and examinations

TAs:

1. The instructor should review and discuss this section of the AIM with the TA prior to the startof the semester.
2. The instructor should meet with the TA each week so that the TA is informed about such matters as: progress through the course's text, which parts of the course (i.e., topics) typically require emphasis/explanations in the TA's weekly review and individual help sessions, coverage of homework assignments, and dates for assigned homework and examinations. In addition, the instructor should discuss at least the general outline of what is to be covered by the TA in the review/laboratory session so that the TA can provide additional explanations/details regarding what was covered in their lectures.
3. The TA will ordinarily be required to give one or two of the general course lectures during the semester, with the instructor observing and evaluating. In addition, the TA and the instructor should consider the desirability of having the TA's weekly help session observed at least onceduring the semester in order to assess further the TA's overall progress in teaching.

4. The TA experience may be enriched by bringing the TAs together at the end of the semester to facilitate discussions among them and the faculty in order to share their experiences and offer suggestions about how to improve the TA process.

Evaluation of IAs

IAs must be fairly evaluated, with public recognition when performance is outstanding.

The instructor of a class with one or more IAs is expected to survey the class near the end of the semester, as part of the course evaluation process, about the quality of the supplemental instruction and assistance provided to the students by the IAs. The results of the survey should be communicated to the IAs and reported to the DGS.

Assignment of IAs

IAs must be assigned in accordance with procedures that are open, reasonable, and fair.

1. The APSC, in conjunction with faculty input, makes all IA assignments for the entire academic year. Non-service courses are not guaranteed to be assigned an IA unless 5 or more students are enrolled for credit. Any petition by a BIOS faculty member for extra IAs should be submitted in writing to the DGS, who will then review the petition with the Departmental Chair.
2. If more students request enrollment in BIOS 850 than are required by the service courses, these students may be assigned to non-service courses. If there are still too many requests, then priority will be given to students who need BIOS 850 to satisfy degree requirements. Within this group, the more advanced students will be given priority. Other TAs will be assigned only to service courses, when there is an insufficient number of TAs enrolled in BIOS 850 to cover them. Service courses are defined as those for which the primary audience is non-Biostatistics graduate students; currently, these are Biostatistics courses numbered 600 andbelow.
3. For courses that require both GAs and TAs, TAs will always be given priority in being offered the position.

Research Assistants

Many of our graduate students receive financial support through graduate research assistantships (GRAs) funded by NIH grants, industry contracts, and other funding sources. Students with a GRA must be notified at least 3 months in advance, except in extenuating circumstances, by their supervising faculty member if their funding will be discontinued for any reason. Likewise, students planning to discontinue working as a GRA (e.g., due to graduation) must notify their supervising faculty member at least 3 months in advance, except in extenuating circumstances.

DEPARTMENTAL LIBRARY AND PUBLICATIONS

Kuebler Library

McGavran-Greenberg Room 3102 is named the Roy R. Kuebler Jr. Conference Room & Library in honor of the late Professor Kuebler (1911-1990), who was Deputy Chair of the Department for many years and recognized as a distinguished teacher of statistics. Here are housed two parts of the Departmental Library: the Archives and the Journal Collection. The Archives include Master's Papers and Doctoral Dissertations from the Department up to spring 2019 (including some early ones by students who were considered members of the Department ours before we had a formal major in Biostatistics); these are bound in black with gold imprinting. There are also bound volumes of the collected papers of three of the Department's illustrious faculty members: Professors Bernard Greenberg, Regina Elandt-Johnson, and Mindel Sheps. The Journal Collection includes current issues, and many back issues of the most important scientific journals for biostatisticians. More extensive online collections of statistical journals can be found on JSTOR or through Health Sciences Library - University of North Carolina at Chapel Hill (unc.edu) . The Kuebler Library is available as a reading room except when conferences are in progress. The materials in the Archives and Journal Collection are not to be removed except briefly for copying, unless by express permission of the Department Librarian.

BIOSTATISTICS COURSES

500H INTRODUCTION TO BIOSTATISTICS (3). Prerequisites, Math 231 and 232. Co-requisite BIOS 511 recommended. Access to SAS software and MS Excel is required. A previous course in statistics (such as AP Statistics or STOR 151) is helpful but not required. Permission of the instructor is required for non-majors. An introductory course in probability, data analysis, and statistical inference designed for the background of BSPH Biostatistics students. Topics include sampling design, descriptive statistics, probability, confidence intervals, tests of hypotheses, chi-square distribution, sets of 2-way tables, power, sample size, ANOVA, non-parametric tests, correlation, and linear regression. Fall. Monaco

511 INTRODUCTION TO STATISTICAL COMPUTING AND DATA MANAGEMENT (4). Prerequisite, previous or concurrent course in applied statistics or permission of the instructor. Introduction to use of computers to process and analyze data, concepts and techniques of research data management, and use of statistical programming packages and interpretation. Focus is on the use of SAS for data management, with an introduction to use of SAS for reporting and analysis. Fall. Eslinger

512 DATA SCIENCE BASICS (3). Prerequisites, must be a MPH student with concentration in Public Health Data Science, appropriate for master's student in quantitative fields. This course will be an introductory course to data science and is required for MPH students with concentration in Public Health Data Science. The goals of the courseare to (i) achieve proficiency in the R programming language, with particular emphasis on tidyverse; (ii) gain familiarity with a suite of data science tools; and (iii) master the practices of good data science; and (iv) learn how toapply the methods and tools to public health datasets. Fall. Pepe-Ranney

540 PROBLEMS IN BIOSTATISTICS (1 or more). Prerequisites to be arranged with the faculty in each case. Acourse for students of public health who wish to make a study of some special problem in the statistics of the lifesciences and public health. Fall, spring, and summer.

600 PRINCIPLES OF STATISTICAL INFERENCE (3). Prerequisite, knowledge of basic descriptive statistics. Major topics include elementary probability theory, probability distributions, estimation, tests of hypotheses, chi-squared procedures, regression, and correlation. Fall and spring. Herman-Giddens

610 BIOSTATISTICS FOR LABORATORY SCIENTISTS (3). Prerequisite, elementary calculus. Introduces the basic concepts and methods of statistics, focusing on applications in the experimental biological sciences. Not offered 2022-23.

611 INTRODUCTION TO DATA SCIENCE (4). Topics will include gaining proficiency with R, tidyverse tools, data wrangling, data quality control and cleaning, data visualization, exploratory data analysis, introductory applied optimization, with an overall emphasis on the principles of good data science—particularly reproducible research and effective communication. Some emphasis will be given to large data settings such as genomics or claims data. The course will also develop familiarity with other common languages such as Python, and software tools for data science best practices, such as Git, Docker, Jupyter and Nextflow. Fall. Toups

635 INTRODUCTION TO MACHINE LEARNING (3). Prerequisite, BIOS 512, 650, or equivalents. Description: This course will be an introductory course to machine learning and statistical learning. While some technical details will be covered, emphasis will be made on understanding the models, intuitions, and strengths and weaknesses of the various approaches. The goal is to equip students with knowledge of existing tools for data analysis and to get students prepared for more advanced courses in machine learning. Programming language will be R – students will learn how to use the free and powerful software

R in connection with each of the methods exposed in the class.Spring. TBA

641 QUANTITATIVE METHODS FOR HEALTH CARE PROFESSIONALS I (4). Prerequisite, permission of instructor. Course is designed to meet the needs of health care professionals who need to be able to critically appraise the design and analysis of medical and health care studies and intend to pursue academic research careers. Basics of statistical inference, analysis of variance, multiple regression, categorical data analysis, and an introduction to logistic regression and survival analysis. Emphasis is on applied data analysis of major health care studies. Fall. Miller

642 QUANTITATIVE METHODS FOR HEALTH CARE PROFESSIONALS II (4). Prerequisites, BIOS 541 and permission of instructor. Continuation of BIOS 541; main emphasis is on logistic regression; other topics include exploratory data analysis and survival analysis. Spring. Boynton645 PRINCIPLES OF EXPERIMENTAL ANALYSIS (3). Prerequisites, BIOS 600 or equivalent; a basic familiarity with a statistical software package (preferably SAS) that has the capacity to do multiple linear regression analysis; permission of the instructor except for majors in Gillings School of Global Public Health. Continuation of Biostatistics 600; the analysis of experimental and observational data, including multiple regression, and analysis ofvariance and covariance. Spring. Laux

650 BASIC ELEMENTS OF PROBABILITY AND STATISTICAL INFERENCE I (GNET 150) (3). Prerequisite, MATH 232 or equivalent. Fundamentals of probability, discrete and continuous distributions; functions of randomvariables; descriptive statistics; fundamentals of statistical inference, including estimation and hypothesis testing. Fall. Truong

660 PROBABILITY AND STATISTICAL INFERENCE I (3). Prerequisite, MATH 233 or equivalent. Probability theory; discrete and continuous random variables; expectation theory; bivariate and multivariate distribution theory; regression and correlation; linear functions of random variables; theory of sampling. Fall. Ivanova

661 PROBABILITY AND STATISTICAL INFERENCE II (3). Prerequisite, BIOS 660. Distribution of functions of random variables; Helmert transformation theory; central limit theorem and other asymptotic theory; estimation theory; maximum likelihood methods; hypothesis testing; power; Neyman-Pearson Theorem, likelihood ratio, score,and Wald tests; noncentral distributions. Spring. FC Lin

662 INTERMEDIATE STATISTICAL METHODS (4). Corequisites, BIOS 511, 650, or equivalents. Principles of study design, descriptive statistics, and sampling from finite and infinite populations, with particular attention to inferences about location and scale for one, two, or k sample situations. Both distribution-free and parametric approaches are considered. Gaussian, binomial, and Poisson models, one-way and two-way contingency tables, as well as related measures of association, are treated. Fall. Couper

663 INTERMEDIATE LINEAR MODELS (4). Prerequisite, BIOS 662 or equivalent. Matrix-based treatment of regression, one-way and two-way ANOVA, and ANCOVA, emphasizing the general linear model and hypothesis, as well as diagnostics and model building. The course begins with a review of matrix algebra, and it concludes withsome treatment of statistical power for the linear model and with binary response regression methods. Spring. Love

664 SAMPLE SURVEY METHODOLOGY (4). Prerequisite, BIOS 650 or equivalent or permission of the instructor. Fundamental principles and methods of sampling populations, with primary attention given to simple random sampling, stratified sampling, and cluster sampling. Also, the calculation of sample weights, dealing with sources of nonsampling error, and analysis of data from complex sample designs are covered. Practical experience in sampling is provided by student participation in the design, execution, and analysis of a sampling project. Spring. Shook-Sa

665 ANALYSIS OF CATEGORICAL DATA (3). Prerequisites, BIOS 650, 662, and 663 or equivalent. Introduction to the analysis of categorized data: rates, ratios, and proportions; relative risk and odds ratio; Cochran- Mantel-Haenszel procedure; survivorship and life table methods; linear models for categorical data. Applications indemography, epidemiology, and medicine. Fall. Koch and Schwartz

667 APPLIED LONGITUDINAL DATA ANALYSIS (3). Prerequisite: analysis of variance and (multiple) linear regression at the level of Bios 545 and/or BIOS 663. Familiarity with matrix algebra is also useful. Univariate and multivariate repeated measures analysis of variance, general linear model for longitudinal data, linear mixed model,generalized linear and population-averaged models for non-normal responses. Estimation and inference, maximum and restricted maximum likelihood, fixed and random effects, balanced and unbalanced data. Fall. Qaqish

668 DESIGN OF PUBLIC HEALTH STUDIES (3). Prerequisites, BIOS 511, 545, 650, or equivalents. Statistical concepts in basic public health study designs: cross-sectional, case-control, prospective, and experimental (includingclinical trials). Validity, measurement of response, sample size determination, matching and random allocation methods. Spring. Tan

669 WORKING WITH DATA IN A PUBLIC HEALTH RESEARCH SETTING (3). Prerequisite, BIOS 511, EPID 700, or permission of the instructor. This course provides a conceptual foundation and practical training to students who will be working with data from clinical trials or other public health research studies. Topics include SQL, producing, checking, and using analysis data sets, advanced reporting tools, using metadata, look-up tables, webscraping, regular expressions, and doing simulation with SAS. Spring. Helton

670 DEMOGRAPHIC TECHNIQUES I (3). Source and interpretation of demographic data; rates and ratios, standardization, complete and abridged life tables; estimation and projection of fertility, mortality, migration, and population composition. Not offered 2022-23

672 PROBABILITY AND STATISTICAL INFERENCE I (4). Prerequisite, MATH 233 or equivalent. Introduction to probability; discrete and continuous random variables; expectation theory; bivariate and multivariate distribution theory; regression and correlation; linear functions of random variables; theory of sampling; introduction to estimation and hypothesis testing. Taylor's series, Riemann, Stieltjes and Lebesgue integration, complex variables and Laplace transforms. Fall. Ivanova

673 PROBABILITY AND STATISTICAL INFERENCE II (4). Prerequisite, BIOS 660. Permission of the instructor for students lacking the prerequisite. Distribution of functions of random variables; central limit theorem and other asymptotic theory; estimation theory; hypothesis testing; Neyman-Pearson Theorem, likelihood ratio, score, and Wald tests; noncentral distributions. Advanced problems in statistical inferences, including information inequality, best unbiased estimators, Bayes estimators, asymptotically efficient estimation, nonparametric estimation and tests, simultaneous confidence intervals. Spring. FC Lin

680 INTRODUCTORY SURVIVORSHIP ANALYSIS (3). Prerequisite, BIOS 661 or permission of the instructor. Introduction to concepts and techniques used in the analysis of time to event data, including censoring, hazard rates,estimation of survival curves, regression techniques, applications to clinical trials. Spring. Zhou

691 FIELD OBSERVATIONS IN BIOSTATISTICS (1). Field visits to, and evaluation of, major nonacademic biostatistical programs in the Research Triangle area. (Field fee $25). Fall. Chen

735 STATISTICAL COMPUTING (4). Prerequisites, BIOS 660, 661, 662, and 663; one programming class at

theundergraduate level or equivalent training; prior R experience. This class teaches important concepts and skills forstatistical computing, numerical optimization, and machine learning using case studies. Topics include: writing efficient R code, building R packages, handling large datasets, general optimization, EM and variants, linear and quadratic programming, numerical integration, general and advanced MCMC, machine learning essentials, SVMs, random forests, gradient boosting, and deep learning. Spring. Rashid

740 INTRODUCTION TO PRECISION MEDICINE (3). Prerequisites, BIOS 661 or equivalent, a graduate course in advanced statistical methodology (BIOS 663 or equivalent), and familiarity with programming in R. seeks to maximize the quality of healthcare by individualizing the healthcare process to the uniquely evolving health status and circumstances of each patient. This endeavor spans many scientific disciplines, including biomedical science, genetics, statistical science, machine learning, psychology, and many other areas, all in support of evidence-based, data-driven decision support. In this course, we will address precision medicine from a statistical and machine learning perspective with numerous examples of application. We will develop a working knowledge of the following inter-related areas in the context of precision medicine and precision health: dynamic treatment regimes, causal inference for precision medicine; basic machine learning tools including support vector machines and randomforests; the single decision setting, outcome weighted learning and extensions of outcome weighted learning; the multi decision setting, reinforcement learning, sequential multiple assignment randomized trials (SMARTs), mobile health, micro-randomized trials, and Markov decision processes; advanced machine learning including deep learning, Gaussian processes, and adversarial learning; relevant statistical inference issues; and several topics on the frontiers of the area. Not offered 2022-23

740 (002) INTRODUCTION TO MULTIVARIATE SURVIVAL ANALYSIS AND STUDY DESIGN (3). Prerequisites, BIOS 780 or permission of the instructor. This course will introduce statistical methods for analyzing correlated failure time data. Topics will include bivariate survival function estimation, various models for analyzing correlated failure time data (intensity models, marginal models, and frailty models), recurrent events, competing risks, cost-effective study designs involving survival outcomes (case-cohort study design, nested case-control sampling, other outcome-dependent sampling design), and joint modeling of survival and longitudinal outcomes. Thecourse will cover recent developments in the literature and highlight potential areas for further research. Not offered 2022-23.

740 (003) INTRODUCTION TO REGULATORY SCIENCE (3). Prerequisites, BIOS 668 OR 752, or EPID 733, or permission of instructor. This course will introduce regulatory science as it pertains to clinical trials conducted as part of drug development programs, with an emphasis on regulatory guidelines impacting statistical aspects of trial design, analysis, conduct, and reporting. Regulatory considerations of both pre-market and post-market studies will be reviewed. A brief history of drug regulation in the US will be provided, including the evolution of thought concerning what constitutes substantial evidence to support drug approval and marketing. International harmonization of regulatory requirements will also be discussed. Example topics include multi-regional clinical trials; estimands, missing data and sensitivity analyses; complex innovative trial designs; pharmacometric analyses; statistical methods for dose finding and dose-response estimation; meta-analysis for drug safety; post-market safety surveillance; and use of real-world data to support regulatory decisions. The class will cover recent advancements in regulatory science at FDA and highlight potential areas where further statistical research is needed. Not offered 2022-23.

740 (004) INTRODUCTION TO STATISTICAL LEARNING AND PERSONALIZED MEDICINE (3) The first part of the course gives an introduction to statistical learning methods, including a complete review of supervised learning methods (discriminant analysis, kernel methods, nearest neighborhood, tree

methods, neural network, support vector machine, random forest, and boosting methods) and unsupervised learning methods (principal component analysis, factor analysis, cluster analysis, multidimensional scaling, self-organizing map). R- functions and real data demo are used for illustration. It also includes learning theory for supervised learning methods such as Bayesian error, concentration inequalities, VC-theory, risk bound, etc. The second part of the course focuses on recent development of statistical methods for personalized medicine, with particular emphasis on using statistical learning methods. This part starts with potential outcome framework and concepts of dynamic treatment regimes, discusses the use of observational studies and sequentially randomized trials for this context, then introduces the methods based on reinforcement learning, Q-learning, A-learning, G-computation, and O-learning foroptimal dynamic treatment regimes in personalized medicine. Spring. Zeng

752 DESIGN AND ANALYSIS OF CLINICAL TRIALS (3) Prerequisites, BIOS 660, and 661 or permission of the instructor. This course will introduce the methods used in clinical trials. Topics include dose-finding trials, allocation to treatments in randomized trials, sample size calculation, interim monitoring, and non-inferiority trials. Not offered 2022-2023.759 APPLIED TIME SERIES ANALYSIS (3). Prerequisites, BIOS 661 and 663 or equivalents, and permission ofthe instructor. Topics include correlograms, periodograms, fast Fourier transforms, power spectra, cross-spectra, coherences, ARMA and transfer-function models, spectral-domain regression. Real and simulated data sets are discussed and analyzed using popular computer software packages. Not offered 2022-23.

760 ADVANCED PROBABILITY AND STATISTICAL INFERENCE I (4). Prerequisite, BIOS 673 or permission of the instructor. Measure space, sigma-field, Lebesgue measure, measureable functions, integration, Fubini-Tonelli theorem, Radon-Nikodym theorem, probability measure, conditional probability, independence, distribution functions, characteristic functions, exponential families, convergence almost surely, convergence in probability, convergence in distribution, Borel-Cantelli lemma, strong law of large numbers, central limit theorem, the Cramer-Wold device, delta method, U-statistics, martingale central limit theorem. Least squares estimation, uniformly minimal variance and unbiased estimation, estimating functions, maximum likelihood estimation, Cramer-Rao lower bound, information bounds, LeCam's lemmas, consistency, asymptotic efficiency, expectation-maximization algorithm, nonparametric maximum likelihood estimation. Fall. Kosorok

761 ADVANCED PROBABILITY AND STATISTICAL INFERENCE II (4). Prerequisite, BIOS 760 or permission of the instructor. Elementary decision theory, utility, admissibility, minimax rules, loss functions, Bayesian decision theory, likelihood ratio, Wald, and score tests, Neyman-Pearson tests, UMP and unbiased tests, rank tests, contiguity theory, confidence sets, parametric and nonparametric bootstrap methods, jackknife and cross-validation, asymptotic properties of resampling methods. Penalized likelihood, regularization methods, and classification. Spring. Q. Li

762 THEORY AND APPLICATIONS OF LINEAR AND GENERALIZED LINEAR MODELS (4). Prerequisites, BIOS 661 and 663, MATH 547, MATH 422or 577. Topics include matrix theory, the multivariate normal distribution, quadratic forms, estimability for linear models, estimation theory for linear and generalized linear models, weighted least squares, multivariate tests of linear hypotheses for linear and generalized linear models, multiple comparisons, confidence regions, analysis of variance, categorical data and contingency tables, case control studies, over-dispersion, quasi-likelihood, and generalized estimating equations. Fall. Ibrahim

764 ADVANCED SURVEY SAMPLING METHODS (3). Prerequisite, BIOS 664 or equivalent. Continuation of Biostatistics 664 for advanced students: stratification, special designs, multistage sampling, cost studies, nonsampling errors, complex survey designs, employing auxiliary information, and other miscellaneous topics. Not offered 2022-23.

765 MODELS AND METHODOLOGY IN CATEGORICAL DATA (3). Prerequisites, BIOS 661, 663, 665, or equivalents. Theory and application of methods for categorical data including maximum likelihood, estimatingequations and chi-square methods for large samples, and exact inference for small samples. Not offered 2022-2023.

767 LONGITUDINAL DATA ANALYSIS (4). Prerequisite, BIOS 762. Presents modern approaches to the analysisof longitudinal data. Topics include linear mixed effects models, generalized linear models for correlated data (including generalized estimating equations), computational issues and methods for fitting models, and dropout or other missing data. Spring. Garcia

771 DEMOGRAPHIC TECHNIQUES II (3). Prerequisites, BIOS 670 and integral calculus. Life table techniques;methods of analysis when data are deficient; population projection methods; interrelations among demographic variables; migration analysis; uses of population models. Not offered 2022-23.

772 STATISTICAL ANALYSIS OF MRI IMAGES (3). Prerequisite, BIOS 761and762. This course reviews major statistical methods for the analysis of MRI data and its applications in various studies. Fall. Zhu

773 STATISTICAL ANALYSIS WITH MISSING DATA (3). Prerequisite BIOS 761 and 762. This course will examine fundamental concepts in missing data, including classifications of missing data, missing covariate and/orresponse data in linear models, generalized linear models, models for longitudinal data, and survival models. Several missing data methodologies will be discussed including maximum likelihood methods, multiple imputation,fully Bayesian methods and weighted estimating equations. Applications in the biomedical sciences will be presented in detail and several cases studies will be examined. Software packages for analyzing missing data include WinBUGS, SAS and R. Not offered 2022-23.

775 STATISTICAL METHODS IN DIAGNOSTIC MEDICINE (3). Prerequisites Bios 761, 762. Material will involve statistical concepts and techniques for evaluating medical diagnostic tests and biomarkers for the detection of disease. Measures for quantifying test accuracy will be discussed. Statistical procedures will be presented for estimating and comparing these quantities, including regression modelling. Worked examples of real data will be used to illustrate the methods. Recent developments in the literature will be covered, with potential areas for further research highlighted and presented for discussion in class. Not offered 2022-23.

776 CAUSAL INFERENCE IN BIOMEDICAL RESEARCH (3). Prerequisite BIOS 661 and 663, or permission of instructor. This course will consider drawing inference about causal effects in a variety of settings using the potential outcomes framework. Topics covered include causal inference in randomized experiments and observational studies, bounds and sensitivity analysis, propensity scores, graphical models, and other areas. Not offered 2022-2023.777 MATHEMATICAL MODELS IN DEMOGRAPHY (3). Prerequisite, permission of the instructor. A detailed presentation of natality models, including necessary mathematical methods, and applications; deterministic and stochastic models for population growth, migration. Not offered 2022-23.

779 BAYESIAN STATISTICS (4). Prerequisite, BIOS 762 or equivalent. Description: This course examines basic aspects of the Bayesian paradigm. Topics include Bayes' theorem, the likelihood principle, prior distributions, posterior distributions, and predictive distributions. General topics include Bayesian modeling (including linear, generalized linear, and hierarchical models for longitudinal data using non-parametric and semiparametric methods, and survival models), informative prior elicitation, model comparisons, Bayesian diagnostic methods, variable subset selection, and Bayesian computational methods. Markov chain Monte Carlo methods for computation are discussed in detail. Spring. Ibrahim

780 THEORY AND METHODS FOR SURVIVAL ANALYSIS (3). Prerequisites, BIOS 760 and 761 or permission

of the instructor. Counting process-martingale theory, Kaplan-Meier estimator, weighted log-rank statistics, Cox proportional hazards model, nonproportional hazards models, multivariate failure time data. Fall. Cai

781 STATISTICAL METHODS IN GENETIC MAPPING (4). Prerequisites, BIOS 661 and 663 or permission of the instructors. An introduction to statistical methods commonly used in analyzing animal, plant and human genetic data, with a focus on decomposition of trait variation, linkage analysis, disease mapping and association studies. Specifically, the course covers 1) basic population and quantitative genetic principles, including classical genetics, chromosomal theory of inheritance, and meiotic recombination; 2) QTL mapping methods of complex quantitative traits and linkage methods to detect co-segregation with disease; 3) methods for assessing marker- disease linkage disequilibrium, including case-control approaches, and 4) methods for genome-wide association andstratification control. Not offered 2022-2023

782 STATISTICAL METHODS IN GENETIC ASSOCIATION STUDIES (3) Prerequisites, permission of the instructor. 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 molecular and population genetics, candidate-gene and genome-wide association studies, likelihood inference and EM algorithm, case-controlsampling 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, trait-dependent sampling, variable selection, and risk prediction. This course is targeted primarily at PhD students and will be taught at a rigorous statistical level. The students will learn the theoretical justifications for the methods as well as the skills to apply them to real studies. They will also be exposed to current research topics and open problems. Fall. Lin and Li

784 INTRODUCTION TO COMPUTATIONAL BIOLOGY (3). Prerequisites, BIOS 661 and 663, or permission of the instructor. Description: basics of molecular biology and how high-throughput genomic and epigenomics datasets are used to answer biological or biomedical questions. Topics include: reproducible computational biology using gitand Rmarkdown, R and Bioconductor for genomic data analysis, high-dimensional data analysis, distances and clustering, batch effects, factor analysis, multiple testing frameworks, EM algorithm, sequence motif analysis, dynamic programming, Bayesian hierarchical models, HMM, and network analysis. Fall. Love

785 STATISTICAL METHODS FOR GENE EXPRESSION ANALYSIS (3). Prerequisites, BIOS 661 and 663, or permission of the instructor. Description: This course is designed to provide students interested in statistical geneticsand genomics with an opportunity to gain or enhance knowledge in gene expression and regulation. The course includes four modules: transcription by bulk RNA sequencing, single-cell transcriptomics, gene expression regulation, and integrative analysis. Each module starts with biological background, followed by statistical and computational methods, and finishes with biological interpretations and follow-ups. Topics include: normalization, measurement of error models, dimensionality reduction, zero-inflated factor analysis, clustering algorithms, peak calling, deconvolution, data integration, network analysis, etc. Spring. Jiang

791 EMPIRICAL PROCESSES AND SEMIPARAMETRIC INFERENCE (3). Prerequisites: BIOS 761 or consent of instructor. Description: Theory and applications of empirical process methods to semiparametric estimation and inference for statistical models with both finite and infinite dimensional parameters. Topics include the bootstrap, Z-estimators, M-estimators, semiparametric efficiency. Not offered 2022-23.

841 PRINCIPLES OF STATISTICAL CONSULTING (3). Instructor consent if not a major in the department.

Familiarity with either SAS and/or R will be assumed. Students must have completed all courses required for their current degree program or be currently enrolled in remaining required courses. An introduction to the statistical consulting process, the goal of this course is to develop in each student the skills necessary for being a statistical collaborator/consultant of the highest caliber. Emphasized topics include problem solving, study design, data analysis, ethical conduct, teamwork, career paths, data management, and both written and oral communication with scientists and other potential collaborators. Spring. Anstrom and Truong

842 PRACTICE IN STATISTICAL CONSULTING (3). Prerequisites, BIOS 511, 545, 650 or equivalents, and permission of the instructor. Bios 841 is a co-requisite. Under supervision of a faculty member, the student interacts with research workers in the health sciences, learning to abstract the statistical aspects of substantive problems, to provide appropriate technical assistance, and to communicate statistical results. *The practicum provides students an opportunity to apply the knowledge and skills being acquired through their coursework and further develop and demonstrate attainment of program competencies.* Fall, spring, and summer.

International students and BIOS 842: note that F-1 visa-holding students will need to apply for CPT (Curricular Practical Training) authorization from the UNC OISSS (Office of International Student and Scholar Services) in order to complete an internship at a company while on a F-1 visa. The UNC OISSShas a rule that F-1 visa-holding students are typically *ineligible* for CPT authorization if they have completed all coursework and have been approved to register for thesis or dissertation credits only. Therefore, it is suggested to use BIOS 842 enrollment as a mechanism for requesting CPT authorization *before* registering for thesis or dissertation credits, if the F-1 visa-holding student isinterested in pursuing an internship. For more details, consult this link: http://isss.unc.edu/student- employment/cpt/

843 SEMINAR IN BIOSTATISTICS (1). Prerequisites, (PHD) can be taken only if you have taken theory and applications written qualifying exams and (MS) can only be taken during second year of study. Fall and spring. Staff

844 LEADERSHIP IN BIOSTATISTICS (3). Prerequisites, BIOS 841. Using lectures, guest speakers and group exercises, students are taught fundamentals of leadership, plus where and how biostatisticians can offer leadership inboth academic and non-academic public health settings. Topics include leadership styles, 1-on-1 communication, strategic planning, motivation, team management, presentation skills, financial leadership, negotiation, decision making, work-life balance, and more. Guest speakers are biostatisticians in prominent leadership roles in industry, government, academia, and service. Not offered 2022-23.

850 TRAINING IN STATISTICAL TEACHING IN THE HEALTH SCIENCES (3). Prerequisite, a minimum of one year of graduate work in statistics. Principles of statistical pedagogy. Students assist with teaching elementary statistics to students in the health sciences. Students work under the supervision of the faculty, with whom they have regular discussions of methods, content, and evaluation of performance. Fall, spring, and summer.

889 RESEARCH SEMINAR IN BIOSTATISTICS (1-3). Prerequisite, permission of the instructor. Seminar on newresearch developments in selected biostatistical topics. Fall and spring.

990 RESEARCH IN BIOSTATISTICS (2 or more). Individual arrangements may be made by the advanced studentto spend part or all of his or her time in supervised investigation of selected problems in statistics. Fall, spring, and summer.

992 MASTER'S PAPER (3). This course is an introduction to research tools and methods in biostatistics.

Topics include literature reviews, introduction to computational facilities in R and SAS, document preparation and writing skills. Students will write and present a proposal for a master's paper project, carry out the project, present it, and document it in the form of a master's paper that satisfies the School's requirements. Spring. Qaqish and Zou

994 DOCTORAL DISSERTATION (Minimum of 3). Fall, spring, and summer.

BIOSTATISTICS FACULTY

Robert Agans
Associate Professor and Director, Carolina Survey Research Laboratory (CSRL)
PHD 1992 – Texas A&M University
Interests: Population-based Research Methods, Multi-mode Data Collection Procedures Questionnaire Development, Standardization and Validation, Hard-to-reach Populations & Minorities

Jianwen Cai
Cary Boshamer Distinguished Professor
PhD 1992 - University of Washington
Interests: Survival Analysis, Regression Models, Clinical Trials, Analysis of Correlated Responses

David Couper
Professor and Deputy Director, Collaborative Studies Coordinating Center (CSCC)
PhD 1994 - University of Washington
Interests: Epidemiological Methods, Longitudinal Data, Data Quality Clinical Trials, Observational Studies

Jamie L. Crandell
Associate Professor (Joint with School of Nursing)
PhD 2006 – University of North Carolina at Chapel Hill
Interests: Bayesian Methods, Longitudinal Data

Tanya P. Garcia
Associate Professor
PhD 2011 – Texas A&M University
Interests: High-Dimensional Variable Selection, Longitudinal Data Analysis, Neurodegenerative Diseases,Nonparametric Models, Prediction Models, Semiparametric Models, Survival Analysis

Annie Green Howard
Associate Professor
PHD 2012-University of North Carolina at Chapel Hill
Interests: Missing Data, Longitudinal and Correlated data, Latent variables, Structural Equation Models,Cardiovascular Disease, Global Health

Michael G. Hudgens
Professor and Department Associate Chair
PhD 2000 – Emory University
Interests: Causal Inference, Epidemiology, Infectious Diseases, Survival Analysis

Joseph G. Ibrahim
Alumni Distinguished Professor, Director of Graduate Studies, Director of the Center for Innovative Clinical Trials, and Director of the Lineberger Comprehensive Cancer Center (LCCC) Biostatistics Core (Joint with Statistics and Operations Research-STOR)
PhD 1988 – University of Minnesota
Interests: Bayesian Inference, Missing Data Problems, Survival Analysis, Generalized Linear Models

Anastasia Ivanova
Professor
PhD 1992 – St. Petersburg State University, Russia
PhD 1998 – University of Maryland
Interests: Adaptive designs, Clinical trials

Yuchao Jiang
Assistant Professor
PhD 2017 – University of Pennsylvania
Interests: Statistical modeling, methods development, and data analysis in genetics/genomics

Gary G. Koch
Professor and Director, Biometric Consulting Laboratory (BCL)
PhD 1968 - University of North Carolina at Chapel Hill
Interests: Categorical Data Analysis, Nonparametric Methods

Michael R. Kosorok
W. R. Kenan, Jr. Distinguished Professor (Joint with Statistics and Operations Research-STOR)
PhD 1991 - University of Washington
Interests: Biostatistics, Data Science, Machine Learning, Precision Medicine

Lisa LaVange
Professor and Department Chair
PhD 1983 – University of North Carolina at Chapel Hill
Interests: Biostatistical practice and data science, clinical trials, regulatory issues, analysis of complex survey data

Didong Li
Assistant Professor
PhD 2020 – Duke University
Interests: Geometric data analysis, information geometry, nonparametric Bayes, spatial statistics.

Quefeng Li
Associate Professor
PhD 2013 – University of Wisconsin at Madison
Interests: Classification, variable selection, robust estimation and inference of high dimensional data, meta-analysis, personalized medicine

Yun Li
Professor (Joint with Department of Genetics)
PhD 2009 – University of Michigan
Interests: Statistical Genetics

Danyu Lin
Dennis Gillings Distinguished Professor
PhD 1989 – University of Michigan
Interests: Statistical Genetics, Survival Analysis, Design and Analysis of Medical Studies

Feng-Chang Lin
Professor
PhD 2008 – University of Wisconsin, Madison
Interests: Point Process Models, Survival Analysis, Longitudinal Analysis, Neuroscience, Madison Cardiovascular Disease

Yufeng Liu
Professor (Joint with Statistics and Operations Research-STOR)
PhD 2004 – The Ohio State University
Interests: Statistical machine learning and data mining, bioinformatics

Michael Love
Associate Professor (Joint with Department of Genetics)
Dr. rer. . Nat. 2013, Freie Universitat, Berlin
Interests: Computational Biology, Statistical Methods for Investigating High-dimensional Biological Datasets

Jane H. Monaco
Associate Professor and Director of Undergraduate Studies
DrPH 2003 – University of North Carolina at Chapel Hill
Interests: Survival Analysis, Statistics Education

James S. Marron
Amos Hawley Distinguished Professor, (Joint with Statistics and Operations Research-STOR)
PhD 1982 – University of California at Los Angeles
Interests: Smoothing Methods for Curve Estimation

Andrew B. Nobel
Professor (Joint with Statistics and Operations Research-STOR)
PhD 1992 – Stanford University
Interests: Statistical Analysis of Gene Expression Data Analysis and Simulation of Internet Traffic Pattern Recognition and Machine Learning Data Mining

John S. Preisser, Jr
Professor
PhD 1995 - University of North Carolina at Chapel Hill
Interests: Categorical Data, Longitudinal Data Analysis, Oral Health, Cluster-randomized Trials

Bahjat Qaqish
Professor
PhD 1990 - Johns Hopkins University
Interests: Generalized Linear Models, Correlated Discrete Data, Survival Analysis, Statistical Computing, Statistical Methods in Epidemiology

Naim Rashid
Associate Professor and Associate Director of the Lineberger Comprehensive Cancer Center (LCCC) Biostatistics Core
PhD 2013 – University of North Carolina at Chapel Hill
Interests: High Dimensional Data Analysis, Probabilistic Deep Learning, Variable Selection, Genomics, Cancer, Next Generation Sequencing Data Analysis (RNA-seq, ChIP-seq), Classification

Todd A. Schwartz
Professor and Director of Masters Programs
(Joint with School of Nursing)
DrPH 2004 – University of North Carolina at Chapel Hill
Interests: Mixed Models, GEE, Categorical Data Analysis, Clinical Trials

Bonnie Shook-Sa
Assistant Professor
DrPH 2020 – University of North Carolina at Chapel Hill
Interests: Causal Inference Methods, Survey Sampling

Richard L. Smith
Mark L. Reed Distinguished Professor (Joint with Statistics and Operations Research-STOR)
PhD 1979 – Cornell University
Interests: Spatial Statistics, Time Series Analysis, Extreme Value Theory and Bayesian Statistics

Daniela Sotres-Alvarez
Associate Professor and Associate Director of the Collaborative Studies Coordinating Center (CSCC)
DrPH 2010 - University of North Carolina at Chapel Hill
Interests: Linear Mixed Models, Latent Variable Models, Dietary and Physical Activity Patterns

Xianming Tan
Associate Professor
PhD 2005 – Nankai University
Interests: Design and Analysis of Clinical Trails, Model-based Clustering, Longitudinal Data Analysis, Survival DataAnalysis

Kinh N. Truong
Professor
PhD 1985 - University of California at Berkeley
Interests: Extended Linear Models, Functional Modeling, Hazard Regression, Time Series, Neuro Modeling, and Biochemical Epidemiology

Di Wu
Associate Professor (Joint with School of Dentistry)
PhD 2011 – Walter and Eliza Institute of Medical Research, University of Melbourne, Australia
Interests: Statistical Methods for High Dimensional Omics Data

Donglin Zeng
Professor
PhD 2001 – University of Michigan
Interests: High dimensional data, Survival Analysis

Haibo Zhou
Professor
PhD 1992 - University of Washington
Interests: Missing/auxiliary Data, Survival Analysis, Human Fertility, Statistical Methods in Epidemiology,Toxicology Risk Assessment

Hongtu Zhu
Professor
PhD 2000 – The Chinese University of Hong Kong
Interests: Imaging Statistics, Latent Variable Models

Baiming Zou
Associate Professor (joint with School of Nursing)
PhD 2013 – University of North Carolina at Chapel Hill
Interests: Robust Modeling of Data with Complex Structures, Machine Learning Methods for Large Scale Electronic Health Record Data Analysis.

Fei Zou
Professor and Director of Graduate Admissions
PhD 2001 – University of Wisconsin
Interests: Statistical Genetics, Empirical Likelihood, Bioinformatics

LISTS OF IMPORTANT WEBSITES

- Calendars Fall 2022 and Spring 2023 and UNC Academic Calendars
  http://registrar.unc.edu/academic-calendar/

- Graduate School Handbook
  http://handbook.unc.edu/

- Graduate School Forms
  https://gradschool.unc.edu/academics/resources/forms.html

- UNC Graduate School and Student Life
  https://gradschool.unc.edu/
  http://gradschool.unc.edu/studentlife/

- Residency
  http://gradschool.unc.edu/studentlife/resources/residency/

- Cost to attend and funding
  http://gradschool.unc.edu/funding/

- University Registrar (links to graduation info, courses, residency, etc.)
  http://registrar.unc.edu/

- Departmental Committees and Members for 2022 - 2023
  Committees_2022-2023-Final.pdf

- Graduation Information and Deadlines
  http://gradschool.unc.edu/academics/resources/graddeadlines.html

- Office of Student Conduct-Honor System
  https://studentconduct.unc.edu/