DEPARTMENT OF BIOSTATISTICS (GRAD)

Contact Information

Department of Biostatistics
Visit Program Website (http://www.sph.unc.edu/bios)

Michael R. Kosorok, Chair

Biostatistics is a department within the Gillings School of Global Public Health.

Following the faculty member's name is a section number that students should use when registering for independent studies, reading, research, and thesis and dissertation courses with that particular professor.

Professors

Jianwen Cai (93), Survival Analysis and Regression Models, Clinical Trials, Analysis of Correlated Responses
Ding-Geng Chen (joint with the School of Social Work)
Jason P. Fine (54), Medical Diagnostic Imaging, Survival Analysis and Competing Risks
Michael Hudgens (42), Nonparametric Estimation, Group Testing, Causal Inference, Infectious Diseases
Joseph G. Ibrahim (11), Bayesian Inference, Missing Data Problems, Bayesian Survival Analysis, Generalized Linear Models, Genomics
Gary G. Koch (14), Categorical Data Analysis, Nonparametric Methods
Michael R. Kosorok (88), Biostatistics, Bioinformatics, Empirical Processes, Statistical Learning, Data Mining, Semiparametric Inference, Monte Carlo Methods, Survival Analysis, Clinical Trials, Personalized Medicine, Cancer, Cystic Fibrosis
Lisa M. LaVange, Data Science, Clinical Trials, Regulatory Issues, Analysis of Complex Survey Data
Danyu Lin (31), Survival Analysis, Semiparametric Statistical Methods, Clinical Trials
Yufeng Liu (joint with the Department of Statistics and Operations Research), Statistical Machine Learning and Data Mining, High-Dimensional Data Analysis, Nonparametric Statistics and Functional Estimation, Bioinformatics, Design and Analysis of Experiments
James Stephen Marron (joint with the Department of Statistics and Operations Research), High Dimension Low Sample Size (HDLSS), Data and/or Data, Exotic Data Types such as Manifold and Tree-Structural Data
Andrew Nobel (joint with the Department of Statistics and Operations Research), Data Mining, Statistical Data of Genomic Data, Machine Learning
Bahjat Qaqish (94), Generalized Linear Models, Survival Analysis, Statistical Computing
Richard Smith (joint with the Department of Statistics and Operations Research), Spatial Statistics, Time Series Analysis, Extreme Value Theory, Bayesian Statistics
Chirayath M. Suchindran (29), Statistical Demography
Kinh N. Truong (90), Time Series Analysis, Nonparametric Regression, Bootstrap Methods, Hazard Regression, Splines
Donglin Zeng (5), High Dimensional Data, Survival Analysis
Haibo Zhou (40), Missing/Auxiliary Data, Survival Analysis, Human Fertility
Hongtu Zhu (48), Neuroimaging Statistics, Structural Equation Models, Statistical Computing, Diagnostic Methods
Fei Zou (4), Statistical Genetics

Associate Professors

Anastasia Ivanova (83), Clinical Trials Design, Sequential Design of Binary Response Experiments, Statistical Methodology in Biostatistics
Yun Li (59) (joint with the Department of Genetics), Statistical Genetics

Assistant Professors

Yuchao Jiang, Statistical Modeling, Method Development and Data Analysis in Genetics and Genomics
Quefeng Li, High Dimensional Data Analysis, Integrative Analysis of Omics Data, Robust Statistics, Factor Models
Michael I. Love (joint with the Department of Genetics), Statistical Modeling of Genetics Data, High-Throughput Sequencing, RNA Sequencing (RNA-seq), Empirical Bayes Methods

Research Professors

Richard E. Bilsborrow (30), Economic Demography, Demography, Economic Development, Environment
John S. Preisser Jr. (89), Categorical Data, Longitudinal Data Analysis
Paul W. Stewart (84), Linear Models, Distribution Theory, Statistical Inference, Longitudinal Data

Clinical Professor

David J. Couper (77), Epidemiological Methods, Longitudinal Data, Data Quality

Research Associate Professors

Eric Bair (61) (joint with the School of Dentistry), Cancer, Disabilities, Reproductive Health, Women's Health, Chronic Pain, Temporomandibular Disorders
Feng-Chang Lin, Survival Analysis, Generalized Linear Models, Longitudinal Analysis, Hearth Disease and Stroke, Infectious Disease, Neuroscience
Todd A. Schwartz (13), Categorical Data, Clinical Trials
Xianming Tan, Finite Mixture Models, Design of Clinical Studies, Variable Selection for Zero-Inflated Models, Non-Parametric Regression

Research Assistant Professors

Jamie B. Crandell (64) (joint with the School of Nursing), Bayesian Methods, Longitudinal Analysis and Measurement Error Modeling
Matthew A. Psioda, Bayesian Trial Design, Computational and Statistical Epigenomics, Bayesian Computation
Naim Rashid, Cancer, Genomics, High Throughput Sequencing, High Dimensional Data Analysis, Variable Selection
Daniela T. Sotres-Alvarez, Global Health, Nutrition, Obesity
Mark A. Weaver (46) (joint with the Department of Medicine), Frequentist Statistical Inference

Clinical Associate Professors

Robert Agans, Population-Based Research Methods, Multimode Data Collection Procedures, Questionnaire Development, Standardization and Validation, Hard-to-Reach Populations and Minorities
Jane Monaco (43), Survival Analysis, Correlated Failure Time Data

Clinical Assistant Professors

Annie Green Howard, Cardiovascular Disease, Global Health
Matthew Loop,Spatial statistics, cardiovascular disease, heart failure

Research Instructor

Katherine J. Roggenkamp (3), Statistical Computing

Adjunct Professors

Alan F. Karr
Herman E. Mitchell
Shyamal D. Peddada
Sonia Thomas
Clarice R. Weinberg

Adjunct Associate Professors

Georgiy Bobashev
Brian Neelon
Wei Sun
William Valdar

Adjunct Assistant Professors

Matthew Biggs
Liddy Chen
Eric B. Laber
Jean Orelien
Sean L. Simpson
Shanshan Zhao
Richard Zink

Professors Emeriti

Shrikant I. Bangdiwala
Lloyd Chambless
Clarence E. Davis
James E. Grizzle
Ronald W. Helms
Lawrence L. Kupper
Keith E. Muller
Dana E. Quade
Pranab K. Sen
Michael J. Symons
Craig D. Turnbull

BIOS

Advanced Undergraduate and Graduate-level Courses

BIOS 500H. Introduction to Biostatistics. 3 Credits.
Access to SAS, Excel required. Permission of instructor for nonmajors. Introductory course in probability, data analysis, and statistical inference designed for B.S.P.H. biostatistics students. Topics include sampling, descriptive statistics, probability, confidence intervals, tests of hypotheses, chi-square distribution, 2-way tables, power, sample size, ANOVA, non-parametric tests, correlation, regression, survival analysis.
Requisites: Prerequisite, MATH 231 and 232; corequisite, BIOS 511.
Grading status: Letter grade.

BIOS 511. Introduction to Statistical Computing and Data Management. 4 Credits.
Required preparation, previous or concurrent course in applied statistics. Permission of instructor for nonmajors. 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 use of SAS for data management and reporting.
Grading status: Letter grade.

BIOS 512. Data Science Basics. 3 Credits.
Students will gain proficiency with R, data wrangling, data quality control and cleaning, data visualization, exploratory data analysis, with an overall emphasis on the principles of good data science, particularly reproducible research. The course will also develop familiarity with several software tools for data science best practices, such as Git, Docker, Jupyter, Make, and Nextflow.
Requisites: Pre- or corequisite, BIOS 600.
Grading status: Letter grade.

BIOS 540. Problems in Biostatistics. 1-15 Credits.
Arrangements to be made with the faculty in each case. A course for students of public health who wish to make a study of some special problem in the statistics of the life sciences and public health. Honors version available
Repeat rules: May be repeated for credit. 15 total credits. 4 total completions.
Grading status: Letter grade.

BIOS 540H. Problems in Biostatistics. 1-15 Credits.
Arrangements to be made with the faculty in each case. A course for students of public health who wish to make a study of some special problem in the statistics of the life sciences and public health.
Repeat rules: May be repeated for credit. 15 total credits. 4 total completions.
Grading status: Letter grade.

BIOS 545. Principles of Experimental Analysis. 3 Credits.
Required preparation, basic familiarity with statistical software (preferably SAS able to do multiple linear regression) and introductory biostatistics, such as BIOS 600. Continuation of BIOS 600. Analysis of experimental and observational data, including multiple regression and analysis of variance and covariance. Permission of the instructor for nonmajors.
Requisites: Prerequisites, BIOS 600 or SPHG 711.
Grading status: Letter grade.

BIOS 600. Principles of Statistical Inference. 3 Credits.
Required preparation, knowledge of basic descriptive statistics. Major topics include elementary probability theory, probability distributions, estimation, tests of hypotheses, chi-squared procedures, regression, and correlation.
Grading status: Letter grade.

BIOS 611. Introduction to Data Science. 4 Credits.
Topics will include gaining proficiency with R and Python, data wrangling, data quality control and cleaning, data visualization, exploratory data analysis, and introductory applied optimization, with an overall emphasis on the principles of good data science, particularly reproducible research. Some emphasis will be given to large data settings such as genomics or claims data. The course will also develop familiarity with software tools for data science best practices, such as Git, Docker, Jupyter, and Nextflow.
Requisites: Prerequisites, MATH 232 and 416, and STOR 151.
Grading status: Letter grade.

BIOS 635. Introduction to Machine Learning. 3 Credits.
This course will be an introductory course to machine learning. 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. This course is restricted to SPH Master of Public Health students.
Requisites: Prerequisite, BIOS 512 or 650; permission of the instructor for students lacking the prerequisite.
Grading status: Letter grade.

BIOS 650. Basic Elements of Probability and Statistical Inference I. 4 Credits.
Required preparation, two semesters of calculus (such as MATH 231, 232). Fundamentals of probability; discrete and continuous distributions; functions of random variables; descriptive statistics; fundamentals of statistical inference, including estimation and hypothesis testing.
Grading status: Letter grade.

BIOS 660. Probability and Statistical Inference I. 3 Credits.
Required preparation, three semesters of calculus (such as MATH 231, 232, 233). 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.
Grading status: Letter grade.

BIOS 661. Probability and Statistical Inference II. 3 Credits.
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.
Requisites: Prerequisite, BIOS 660; permission of the instructor for students lacking the prerequisite.
Grading status: Letter grade.

BIOS 662. Intermediate Statistical Methods. 4 Credits.
Principles of study design, descriptive statistics, sampling from finite and infinite populations, inferences about location and scale. Both distribution-free and parametric approaches are considered. Gaussian, binomial, and Poisson models, one-way and two-way contingency tables.
Requisites: Pre- or corequisites, BIOS 511 and 550.
Grading status: Letter grade.

BIOS 663. Intermediate Linear Models. 4 Credits.
Required preparation, BIOS 662. 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. Reviews matrix algebra. Includes statistical power for linear models and binary response regression methods.
Grading status: Letter grade.

BIOS 664. Sample Survey Methodology. 4 Credits.
Fundamental principles and methods of sampling populations, with emphasis on simple, random, stratified, and cluster sampling. Sample weights, nonsampling error, and analysis of data from complex designs are covered. Practical experience through participation in the design, execution, and analysis of a sampling project.
Requisites: Prerequisite, BIOS 550; permission of the instructor for students lacking the prerequisite.
Gen Ed: EE- Field Work.
Grading status: Letter grade
Same as: STOR 358.

BIOS 665. Analysis of Categorical Data. 3 Credits.
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 in demography, epidemiology, and medicine.
Requisites: Prerequisites, BIOS 545, 550, and 662; permission of the instructor for students lacking the prerequisites.
Grading status: Letter grade.

BIOS 667. Applied Longitudinal Data Analysis. 3 Credits.
Analysis of variance and multiple linear regression course at the level of BIOS 545 or 663 required. Familiarity with matrix algebra recommended. Univariate and multivariate repeated measures ANOVA, GLM for longitudinal data, linear mixed models. Estimation and inference, maximum and restricted maximum likelihood, fixed and random effects.
Grading status: Letter grade.

BIOS 668. Design of Public Health Studies. 3 Credits.
Statistical concepts in basic public health study designs: cross-sectional, case-control, prospective, and experimental (including clinical trials). Validity, measurement of response, sample size determination, matching and random allocation methods.
Requisites: Prerequisites, BIOS 545 and 550.
Grading status: Letter grade.

BIOS 669. Working with Data in a Public Health Research Setting. 3 Credits.
Provides a foundation and training for working with data from clinical trials or research studies. Topics: issues in study design, collecting quality data, using SAS and SQL to transform data, typical reports, data closure and export, and working with big data.
Requisites: Prerequisite, BIOS 511 or EPID 700; permission of the instructor for students lacking the prerequisite.
Grading status: Letter grade.

BIOS 670. Demographic Techniques I. 3 Credits.
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.
Grading status: Letter grade.

BIOS 672. Probability and Statistical Inference I. 4 Credits.
Required preparation, three semesters of calculus. Introduction to probability; discrete and continuous random variables; combinatorics; expectation; random sums, multivariate distributions; functions of random variables; theory of sampling; convergence of sequences, power series, types of convergence, L'Hopital's rule, differentiable functions, Lebesgue integration, Fubini's theorem, convergence theorems, complex variables, Laplace transforms, inversion formulas.
Grading status: Letter grade.

BIOS 673. Probability and Statistical Inference II. 4 Credits.
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.
Requisites: Prerequisite, BIOS 660; permission of the instructor for students lacking the prerequisite.
Grading status: Letter grade.

BIOS 680. Introductory Survivorship Analysis. 3 Credits.
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.
Requisites: Prerequisite, BIOS 661; permission of the instructor for students lacking the prerequisite.
Grading status: Letter grade.

BIOS 690. Special Topics in Biostatistics. 1-3 Credits.
Field/topical/research seminar. Instructors use this course to offer instruction in particular topics or approaches.
Repeat rules: May be repeated for credit; may be repeated in the same term for different topics; 6 total credits. 6 total completions.
Grading status: Letter grade.

BIOS 691. Field Observations in Biostatistics. 1 Credit.
Field visits to, and evaluation of, major nonacademic biostatistical programs in the Research Triangle area. Field fee: $25.
Grading status: Letter grade.

BIOS 693H. Honors Research in Biostatistics. 3 Credits.
Directed research. Written and oral reports required.
Gen Ed: EE- Mentored Research.
Grading status: Letter grade.

BIOS 694H. Honors Research in Biostatistics. 3 Credits.
Directed research. Written and oral reports required.
Gen Ed: EE- Mentored Research.
Grading status: Letter grade.

Graduate-level Courses

BIOS 700. Research Skills in Biostatistics. 1 Credit.
Permission of the department for students with passing grade of either doctoral qualifying examination in biostatistics. BIOS 700 will introduce doctoral students in biostatistics to research skills necessary for writing a dissertation and for a career in research.
Requisites: Prerequisites, BIOS 760, 761 or 758, 762, 763, and 767.
Grading status: Letter grade.

BIOS 735. Statistical Computing - Basic Principles and Applications. 4 Credits.
Required preparation, one undergraduate-level programming class. Teaches important concepts and skills for statistical software development using case studies. After this course, students will have an understanding of the process of statistical software development, knowledge of existing resources for software development, and the ability to produce reliable and efficient statistical software.
Requisites: Prerequisites, BIOS 660, 661, 662, and 663.
Grading status: Letter grade.

BIOS 740. Specialized Methods in Health Statistics. 1-21 Credits.
Permission of the instructor. Statistical theory applied to special problem areas of timely importance in the life sciences and public health. Lectures, seminars, and/or laboratory work, according to the nature of the special area under study.
Grading status: Letter grade.

BIOS 745. Intercellular Signaling in Development and Disease. 1 Credit.
This graduate-level course concentrates on up-to-date views of intercellular signal processing, with emphasis on signal transduction mechanisms as they relate to cellular/physiological responses in both normal development and disease. Signaling mechanisms that will be discussed include autocrine, paracrine, juxtacrine signaling and cell-matrix interactions.
Grading status: Letter grade
Same as: PHCO 745.

BIOS 752. Design and Analysis of Clinical Trials. 3 Credits.
This course will introduce the methods used in clinical. Topics include dose-finding trials, allocation to treatments in randomized trials, sample size calculation, interim monitoring, and non-inferiority trials.
Requisites: Prerequisites, BIOS 600 and 661.
Grading status: Letter grade.

BIOS 756. Advanced Nonparametric Methods in Biometric Research. 3 Credits.
Theory and application of nonparametric methods for various problems in statistical analysis. Includes procedures based on randomization, ranks and U-statistics. A knowledge of elementary computer programming is assumed.
Requisites: Prerequisite, BIOS 661.
Grading status: Letter grade.

BIOS 759. Applied Time Series Analysis. 3 Credits.
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.
Requisites: Prerequisites, BIOS 661 and 663; Permission of the instructor for students lacking the prerequisites.
Grading status: Letter grade.

BIOS 760. Advanced Probability and Statistical Inference I. 4 Credits.
Measure space, sigma-field, measurable functions, integration, conditional probability, distribution functions, characteristic functions, convergence modes, SLLN, CLT, Cramer-Wold device, delta method, U-statistics, martingale central limit theorem, UMVUE, estimating function, MLE, Cramer-Rao lower bound, information bounds, LeCam's lemmas, consistency, efficiency, EM algorithm.
Requisites: Prerequisite, BIOS 661; permission of the instructor for students lacking the prerequisite.
Grading status: Letter grade.

BIOS 761. Advanced Probability and Statistical Inference II. 4 Credits.
Elementary decision theory: admissibility, minimaxity, loss functions, Bayesian approaches. Hypothesis testing: Neyman-Pearson theory, UMP and unbiased tests, invariance, confidence sets, contiguous alternatives. Elements of stochastic processes: Poisson processes, renewal theory, Markov chains, martingales, Brownian motion.
Requisites: Prerequisite, BIOS 760; permission of the instructor for students lacking the prerequisite.
Grading status: Letter grade.

BIOS 762. Theory and Applications of Linear and Generalized Linear Models. 4 Credits.
Linear algebra, matrix decompositions, estimability, multivariate normal distributions, quadratic forms, Gauss-Markov theorem, hypothesis testing, experimental design, general likelihood theory and asymptotics, delta method, exponential families, generalized linear models for continuous and discrete data, categorical data, nuisance parameters, over-dispersion, multivariate linear model, generalized estimating equations, and regression diagnostics.
Requisites: Prerequisites, BIOS 661 and 663, MATH 547, and 416 or 577; Co-requisite, BIOS 760.
Grading status: Letter grade.

BIOS 764. Advanced Survey Sampling Methods. 3 Credits.
Continuation of BIOS 664 for advanced students: stratification, special designs, multistage sampling, cost studies, nonsampling errors, complex survey designs, employing auxiliary information, and other miscellaneous topics.
Requisites: Prerequisite, BIOS 664.
Grading status: Letter grade.

BIOS 765. Models and Methodology in Categorical Data. 3 Credits.
Theory of statistical methods for analyzing categorical data by means of linear models; multifactor and multiresponse situations; interpretation of interactions.
Requisites: Prerequisites, BIOS 661, 663, 665, and 666.
Grading status: Letter grade.

BIOS 767. Longitudinal Data Analysis. 4 Credits.
Presents modern approaches to the analysis of 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.
Requisites: Prerequisites, BIOS 661 and 762; Permission of the instructor for nonmajors.
Grading status: Letter grade.

BIOS 771. Demographic Techniques II. 3 Credits.
Required preparation, 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.
Requisites: Prerequisite, BIOS 670.
Grading status: Letter grade.

BIOS 772. Statistical Analysis of MRI Images. 3 Credits.
The course will review major statistical methods for the analysis of MRI and its applications in various studies.
Grading status: Letter grade.

BIOS 773. Statistical Analysis with Missing Data. 3 Credits.
Fundamental concepts, including classifications of missing data, missing covariate and/or response data in linear models, generalized linear models, longitudinal data models, and survival models. Maximum likelihood methods, multiple imputation, fully Bayesian methods, and weighted estimating equations. Focus on biomedical sciences case studies. Software packages include WinBUGS, SAS, and R.
Requisites: Prerequisites, BIOS 761 and 762.
Grading status: Letter grade.

BIOS 774. Statistical Learning and High Dimensional Data. 3 Credits.
Introductory overview of statistical learning methods and high-dimensional data analysis. Involves three major components: supervised or unsupervised learning methods, statistical learning theory, and statistical methods for high-dimensional data including variable selection and multiple testing. Real examples are used.
Requisites: Prerequisite, BIOS 661; permission of the instructor for students lacking the prerequisite.
Grading status: Letter grade.

BIOS 775. Statistical Methods in Diagnostic Medicine. 3 Credits.
Statistical concepts and techniques for evaluating medical diagnostic tests and biomarkers for detecting disease. Measures for quantifying test accuracy. Statistical procedures for estimating and comparing these quantities, including regression modeling. Real data will be used to illustrate the methods. Developments in recent literature will be covered.
Requisites: Prerequisites, BIOS 761 and 762.
Grading status: Letter grade.

BIOS 776. Causal Inference in Biomedical Research. 3 Credits.
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.
Requisites: Prerequisites, BIOS 661 and 663; permission of the instructor for students lacking the prerequisites.
Grading status: Letter grade.

BIOS 777. Mathematical Models in Demography. 3 Credits.
Permission of the instructor. A detailed presentation of natality models, including necessary mathematical methods, and applications; deterministic and stochastic models for population growth, migration.
Grading status: Letter grade.

BIOS 779. Bayesian Statistics. 4 Credits.
Topics include Bayes' theorem, the likelihood principle, prior distributions, posterior distributions, predictive distributions, Bayesian modeling, informative prior elicitation, model comparisons, Bayesian diagnostic methods, variable subset selection, and model uncertainty. Markov chain Monte Carlo methods for computation are discussed in detail.
Requisites: Prerequisite, BIOS 762; permission of the instructor for students lacking the prerequisite.
Grading status: Letter grade.

BIOS 780. Theory and Methods for Survival Analysis. 3 Credits.
Counting process-martingale theory, Kaplan-Meier estimator, weighted log-rank statistics, Cox proportional hazards model, nonproportional hazards models, multivariate failure time data.
Requisites: Prerequisites, BIOS 760 and 761; permission of the instructor for students lacking the prerequisites.
Grading status: Letter grade.

BIOS 781. Statistical Methods in Human Genetics. 4 Credits.
An introduction to statistical procedures in human genetics, Hardy-Weinberg equilibrium, linkage analysis (including use of genetic software packages), linkage disequilibrium and allelic association.
Requisites: Prerequisites, BIOS 661 and 663; permission of the instructor for students lacking the prerequisites.
Grading status: Letter grade.

BIOS 782. Statistical Methods in Genetic Association Studies. 3 Credits.
This course provides a comprehensive survey of the statistical methods for the designs and analysis of genetic association studies, including genome-wide association studies and next-generation sequencing studies. The students will learn the theoretical justifications for the methods as well as the skills to apply them to real studies.
Requisites: Prerequisite, BIOS 760.
Grading status: Letter grade.

BIOS 784. Introduction to Computational Biology. 3 Credits.
Molecular biology, sequence alignment, sequence motifs identification by Monte Carlo Bayesian approaches, dynamic programming, hidden Markov models, computational algorithms, statistical software, high-throughput sequencing data and its application in computational biology.
Requisites: Prerequisites, BIOS 661 and 663; Permission of the instructor for students lacking the prerequisites.
Grading status: Letter grade.

BIOS 785. Statistical Methods for Gene Expression Analysis. 3 Credits.
Clustering algorithms, classification techniques, statistical techniques for analyzing multivariate data, analysis of high dimensional data, parametric and semiparametric models for DNA microarray data, measurement error models, Bayesian methods, statistical software, sample size determination in microarray studies, applications to cancer.
Requisites: Prerequisites, BIOS 661 or 673, and 663; Permission of the instructor for students lacking the prerequisites.
Grading status: Letter grade
Same as: BCB 785.

BIOS 791. Empirical Processes and Semiparametric Inference. 3 Credits.
Theory and applications of empirical process methods to semiparametric estimation and inference for statistical models with both finite and infinite dimensional parameters. Topics include bootstrap, Z-estimators, M-estimators, semiparametric efficiency.
Requisites: Prerequisite, BIOS 761; permission of the instructor for students lacking the prerequisite.
Grading status: Letter grade.

BIOS 841. Principles of Statistical Collaboration and Leadership. 3 Credits.
An introduction to the statistical collaborative process and leadership skills. Emphasized topics include problem solving, study design, data analysis, ethical conduct, teamwork, career paths, data management, written and oral communication with scientists and collaborators.
Grading status: Letter grade.

BIOS 842. Practice in Statistical Consulting. 1-21 Credits.
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.
Requisites: Prerequisites, BIOS 511, 545, 550, and 841; Permission of the instructor for students lacking the prerequisites.
Grading status: Letter grade.

BIOS 843. Seminar in Biostatistics. 1 Credit.
This seminar course is intended to give students exposure ot cutting edge research topics and hopefully help them in their choice of a thesis topic. It also allows the student to meet and learn from major researchers in the field.
Repeat rules: May be repeated for credit.
Grading status: Letter grade.

BIOS 844. Leadership in Biostatistics. 3 Credits.
Using lectures and group exercises, students are taught where and how biostatisticians can offer leadership in both academic and nonacademic public health settings.
Requisites: Prerequisite, BIOS 841.
Grading status: Letter grade.

BIOS 850. Training in Statistical Teaching in the Health Sciences. 1-21 Credits.
Required preparation, 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.
Grading status: Letter grade.

BIOS 889. Research Seminar in Biostatistics. 0.5-21 Credits.
Permission of the instructor. Seminar on new research developments in selected biostatistical topics.
Grading status: Letter grade.

BIOS 990. Research in Biostatistics. 1-21 Credits.
Individual arrangements may be made by the advanced student to spend part or all of his or her time in supervised investigation of selected problems in statistics.
Grading status: Letter grade.

BIOS 992. Master's (Non-Thesis). 3 Credits.

BIOS 994. Doctoral Research and Dissertation. 3 Credits.

Master of Public Health (M.P.H.) Public Health Data Science Concentration Description

The Public Health Data Science concentration (https://sph.unc.edu/resource-pages/master-of-public-health-2/public-health-data-science-concentration), one of the first applied data science programs situated within a school of public health, gives students the skills and knowledge to employ cutting-edge data science tools and respond to pressing public health issues with effective solutions. Data science combines 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. 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. Steeped in the public health context, our program 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.

Requirements

Requirements for the **M.P.H.** Degree in the **Public Health Data Science** Concentration

Code	Title	Hours
M.P.H. Integrated Core		
BIOS 650	Basic Elements of Probability and Statistical Inference I Fall 1, *	4
EPID 711	Clinical Measurement and Evaluation Fall 1, **	3
SPHG 713	Understanding Public Health Issues Fall 1	2
SPHG 721	Conceptualizing Public Health Solutions Spring 1	2
SPHG 722	Developing, Implementing, and Evaluating Public Health Solutions Spring 1	4
M.P.H. Concentration		
BIOS 512	Data Science Basics	3
BIOS 635	Introduction to Machine Learning	3
BIOS 545	Principles of Experimental Analysis	3
Advanced, graduate-level, Data Science course		3
M.P.H. Practicum		
SPHG 701	MPH Practicum Preparation Spring 1	2
Practicum: 200 minimum hours Summer 1		
SPHG 702	MPH Practicum Reflection Fall 2	1
M.P.H. Electives		
Elective (Graduate-level courses)		3
Elective (Graduate-level courses)		3
Elective (Graduate-level courses)		3
M.P.H. Culminating Experience		

BIOS 992	Master's (Non-Thesis) Spring 2	3
Total Hours		42

* Approved substitute for SPHG 711 for students in this concentration.

** Approved substitute for SPHG 712 for students in this concentration.

Competencies

Students will develop the following **Public Health Data Science competencies**, building on the foundational public health knowledge they attain in the Gillings M.P.H. Integrated Core courses.

PHDS01.	Manipulate data from a variety of sources to support statistical and epidemiological analysis and prepare data summaries.
PHDS02.	Select and use data visualization methods to interpret and communicate research results, with the overall objective of conducting reproducible research, both individually and in project teams.
PHDS03.	Select and utilize appropriate data analysis and machine learning methods to solve problems and make improvements in a given public health context.
PHDS04.	Understand, evaluate, and constructively address potential sources of sampling bias and other biases and key sources of uncertainty in data driven health research.
PHDS05.	Provide tools that facilitate the expansion of complex statistics and methods to public health contexts traditionally reticent to move away from more traditional approaches, thereby extending the reach of quantitative and methodological innovations in public health.

Admissions

Please visit Applying to the Gillings School (https://sph.unc.edu/students/how-to-apply) first for details and information. Application to the residential M.P.H. is a two-step process. Please apply separately to (1) SOPHAS and (2) UNC–Chapel Hill (via the Graduate School application). Visit https://gradschool.sites.unc.edu/master-of-public-health/ for more details. If you are interested in the online M.P.H., please visit the M.P.H.@UNC (https://onlinemph.unc.edu) Web site and fill out an inquiry form.

Practicum

This 200 (minimum) hour planned, mentored, and evaluated work experience (paid or unpaid) gives students the real-world opportunity to integrate and apply knowledge, skills, and values from Year One of their Gillings M.P.H. training in a professional public health setting such as a nonprofit organization, hospital, local or state health department, or for-profit firm (public or private sectors). Please visit the M.P.H. Practicum Web site (https://sph.unc.edu/resource-pages/master-of-public-health-2/mph-practicum) for additional information. In order to meet graduation requirements, a Gillings M.P.H. practicum must:

1. Occur after a student has completed the Gillings M.P.H. Core courses, the M.P.H. practicum preparation course (SPHG 701), and at least one concentration-required course from the student's declared concentration. In extenuating circumstances and with the approval from the student's declared concentration, some exceptions may apply.
2. Yield a least two student-generated products, produced in the practicum setting for the practicum setting, that allow for attainment of at least three (CEPH) M.P.H. Foundational and two concentration-specific competencies (Appendix A). In extenuating circumstances and with the approval from the concentration, students can petition to substitute up to two CEPH Foundational competencies for the concentration-specific competencies.
3. Be mentored by a supervisor (preceptor) with an advanced degree in public health or equivalent experience with expertise in the practicum project area.
4. Comprise a *minimum* of 200 hours (equivalent to five weeks of full-time work) in a location approved for student travel (UNC Travel Policy (https://global.unc.edu/files/2018/02/UNC-Travel-Policy-Final.pdf)), and the student must complete *UNC Gillings International Pre-Departure Travel Requirements* prior to travel.

Culminating Experience

Each student completes a 3-credit culminating experience and produces a high-quality written product that is completed near the end of the program of study. This culminating experience ideally is delivered in a manner that is useful to external stakeholders, such as nonprofit or governmental organizations, and could take the form of a course-based capstone project or master's paper, but will be tailored to the concentration a student chooses.

Academic Advising and Faculty Mentoring

We are committed to providing quality academic advising and mentoring for all students. We ensure that M.P.H. students get the guidance they need with several components: 1) an orientation program that provides an overview of the types and sources of M.P.H. advising; 2) cohort advising sessions to disseminate information that is relevant to course planning and registration; 3) faculty mentoring that provides students with tailored support for their academic, professional, personal development, and practicum support.

M.P.H. students will complete a 2-semester, 12-credit-hour **Integrated Core** taught by an interdisciplinary team of instructors. The 6-credit first semester (fall) focuses on understanding public health issues, and the second semester (6-credit spring courses) focuses on creating solutions to those issues.

All M.P.H. students take **COMPASS (Core Online Modules to Promote and Accelerate Student Success).** These brief, self-paced online modules are open for students prior to their first academic year. Students can complete any and all parts of COMPASS up to and including the first week of class.

Electives: For the remaining 9 credits, students are free to choose elective courses from any of the 12 concentration areas listed above or from other courses in the Gillings School.

For information on policies and procedures, please visit the Gillings School Student Handbook (https://sph.unc.edu/students/gillings-school-student-handbook) Web site.