



THE GEORGE
WASHINGTON
UNIVERSITY
WASHINGTON DC

**Columbian College of Arts and Sciences
and
School of Public Health and Health Services**

**Master of Science (MS) in Biostatistics
2009-2010**

Note: All curriculum revisions will be updated immediately on the website <http://www.gwumc.edu/sphhs>

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The Master of Science (MS) degree program in Biostatistics is a 33 credit degree program jointly administered by the Department of Statistics in the Columbian College of Arts and Sciences (CCAS) and the Department of Epidemiology and Biostatistics in the School of Public Health and Health Services (SPHHS), and its associated research facility, The Biostatistics Center. This degree program is accredited by the Middle States Council on Higher Education through the CCAS and by the Council on Education for Public Health through the SPHHS. Regulations and requirements for this graduate degree have been designed to be compatible with policies and scholarship requirements of both the CCAS and SPHHS. The degree is conferred by the CCAS.

At the completion of the MS program in Biostatistics students will be able to:

- Understand and the theory and principles behind statistical methods most commonly used in biomedical research (contingency tables, survival analysis, mixed models, and missing data).
- Understand and apply the underlying principles and methods to design, plan, and conduct biomedical studies.
- Provide biostatistical advice as a member of a team engaged in a biomedical research project. Includes manipulation and analysis of data.

Admissions Requirements

Applicants must hold an undergraduate degree from an accredited institution of higher learning. Applicants should have academic backgrounds of excellence, usually with majors, or equivalent, in the fields in which they intend to study for advanced degrees. Normally, a B average (or equivalent) from an accredited college is required. With evidence of special promise, such as high Graduate Record Examination scores, an applicant whose academic record falls short of a B average may be accepted on a conditional basis. Meeting the minimum requirements does not assure acceptance. The departments may, and often do, set higher admission standards. Moreover, the number of spaces available for new graduate students limits the number who can be accepted. Students who apply in their senior year must provide evidence of the completion of their baccalaureate work before registration in Columbian College is permitted. Applicants should be aware that graduate courses taken prior to admission while in non-degree status are not used in assessing admissibility to degree programs and may not be transferable into those programs.

If desired, a student may complete the M.S. program prior to admission to the Ph.D. degree program, in which case no more than 24 credit hours from the M.S. degree may be applied to the Ph.D. course work requirements. In this instance the student will be required to take a minimum of 27 additional credit hours of coursework. The distribution of these courses between statistics and public health would depend on the nature of the Master's degree and whether the transferred credit hours would be used to defray statistics or public health course work. Full information is available in the online Graduate Admissions Application at www.gwu.edu/~gradinfo. A detailed description of admissions policies is also available online at <http://columbian.gwu.edu/grad/>.

Minimum Prerequisite Courses for Admission Consideration (or equivalents to these GW courses)

The courses listed below (or equivalents) are prerequisites for admission consideration, and **MUST** appear on your transcript. Submit your MS Biostatistics program admission application only after you have completed all of the following courses:

MATH	031	Single-Variable Calculus I	3	Limits and continuity. Differentiation and integration of algebraic and trigonometric functions with applications.
MATH	032	Single-Variable Calculus II	3	The calculus of exponential and logarithmic functions. Techniques of integration. Infinite series and Taylor series. Polar coordinates. Prerequisite: MATH 031
STAT	118	Regression Analysis	3	Lecture 3 credits, laboratory 1 hour. Simple and multiple linear regression, partial correlation, residual analysis, stepwise model building, multicollinearity, and diagnostic methods, indicator variables. Prerequisite: Introductory Statistics

Additional Course Requirements

The courses listed below are “Additional Course Requirements.” Applicants lacking these courses (or equivalents to these GW courses) will be considered for admission, but, if admissible, will be admitted conditionally with the expectation that these courses will be satisfactorily completed within two semesters following matriculation in the program. These credits do not count as credit toward the 33 credit graduation requirement, nor are grades earned in these additional courses reflected in the overall grade point average.

MATH	033	Multivariable Calculus III	3	Partial derivatives and multiple integrals. Vector-valued functions. Topics in vector calculus, including line and surface integrals and the theorems of Gauss, Green, and Stokes. Prerequisite: MATH 032
MATH	84	Linear Algebra I	3	Linear equations, matrices, inverses, and determinants. Vector spaces, rank, eigenvalues, and diagonalization. Applications to geometry and ordinary differential equations. Prerequisite: MATH 031
STAT or	129	Introduction to Computing	3 or	Introduction to personal and mainframe computers and their operating system, spreadsheets with simple statistical applications, and programming with applications to technology. Fall and Spring
STAT or	183	Intermediate Statistical Laboratory: Statistical Computing Packages	3 or	Application of program packages (e.g., SAS, SPSS) to the solution of one-, two- and k-sample parametric and nonparametric statistical problems. Basic concepts in data preparation, modification, analysis and interpretation of results. Prerequisite: an introductory statistics course. Fall and Spring
PubH	249	Use of Statistical Packages: Data Management and Data Analysis	3 cr	This course familiarizes the student with one of the most widely used database management systems and statistical analysis software packages, the SAS System, operating in a Windows environment. Throughout the course, several database management system techniques and data analytical strategies for the appropriate analysis of datasets obtained from a variety of studies will be presented. Statistical techniques covered include linear regression, analysis of variance, logistic regression, and survival analysis. Fall and Spring.

MS Biostatistics Degree Requirements

Course Distribution Summary	Credits
Core Courses <ul style="list-style-type: none"> • Statistics (18 Credits) • Public Health (7 Credits) Note: Each student must enroll in a public health topics course (PubH 209) that covers a public health topic in environmental and occupational health, health administration, health policy or social behavioral sciences.	25
Approved Elective Courses (See Advisor)	6
Consulting	2
Total Credits	33
The Master's Comprehensive Examination The Master's Comprehensive Examination is a <u>written comprehensive examination</u> in the field of Biostatistics and is based on the course content PubH 266- Biostatistical Methods.	
Professional Enhancement Requirement (8 hours) Professional enhancement activities supplement the academic curriculum and help prepare students to participate actively in the professional community. They enhance practical knowledge and awareness of public health issues – either in general or in a student's specific area of study. Students can fulfill this requirement by attending workshops, seminars, or other relevant professional meetings, which are often held at SPHHS and in the metropolitan Washington, DC area. Examples of conference sponsors include the National Academy for State Health Policy, the Pan American Health Organization, the American Public Health Association, the American College of Healthcare Executives, the Area Health Education Center, the American College of Sports Medicine, and the National Athletic Trainer's Association. Opportunities for professional enhancement are regularly publicized via the SPHHS Listserv and through your department or advisor. Students must submit documentation of Professional Enhancement activities to the Office of Student Records. The documentation consists of the Professional Enhancement Form (see www.gwumc.edu/sphhs/sacd/forms.htm), which includes a <u>prior</u> approval signature from the student's advisor, a description of the program agenda, and proof of attendance. Remember to submit your documentation <i>before</i> you apply to graduate!	



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Program-at-a-Glance
2009-2010

Required Core Courses (25 Total Credits)

Required Statistics Core Courses (18 Credits)		Credits	Semester Offered	Grade
STAT 201	Mathematical Statistics I	3	Fall	
STAT 202	Mathematical Statistics II	3	Spring	
STAT 210	Data Analysis	3	Spring	
STAT 227	Survival Analysis	3	Fall	
PubH 265	Design of Medical Studies	3	Spring	
PubH 266	Biostatistical Methods <i>Basis for Master's Comprehensive Examination</i>	3	Fall	
Required Public Health Core Courses (7 Credits)				
PubH 201	Biological Concepts for Public Health	2	Summer, Fall, Spring	
PubH 203	Principles and Practice of Epidemiology	3	Fall, Spring, Summer 10 week	
PubH 209	Electives - Take two credits of elective/topics courses	2	Summer, Fall, Spring	
Approved Elective Courses (6 Total Credits)				
Approved Statistics Elective Courses		Credits	Semester Offered	Grade
STAT 181	Applied Time Series Analysis	3	Spring	
STAT 187	Introduction to Sampling	3	Fall	
STAT 188	Nonparametric Statistical Inference	3	Fall, even years	
STAT 215	Applied Multivariate Analysis I	3	Alternate years	
STAT 216	Applied Multivariate Analysis II	3	Alternate years	
STAT 217	Design of Experiments	3	Fall, alternate years	
STAT 223	Bayesian Statistics: Theory and Applications	3	Spring, alternate years	
STAT 226	Advanced Biostatistical Methods	3	Spring	
STAT 231	Categorical Data Analysis	3	Fall, alternate years	
STAT 242	Regression Graphics/Nonparametric Regression	3	Spring, alternate years	
STAT 265	Multivariate Analysis	3	Fall, alternate years	
STAT 273	Stochastic Processes I	3	Alternate years	
STAT 281	Advanced Time Series Analysis	3	Spring	
Approved Public Health Elective Courses				
PubH 204	Environmental and Occupational Health in a Sustainable World	2	Summer 1, Fall, Spring	
PubH 207	Social and Behavioral Approaches to Public Health	2	Summer 1, Fall, Spring	
PubH 221	Environmental and Occupational Epidemiology	3	Spring	
PubH 242	Clinical Epidemiology and Decision Analysis	2	Spring	
PubH 244	Cancer Epidemiology	2	Spring	
PubH 245	Infectious Disease Epidemiology	2	Spring	
PubH 246	Injury Epidemiology and Prevention	2	Fall	
PubH 248	Epidemiologic Methods in Older Populations	2	Fall	
PubH 250	Epidemiology of HIV/AIDS	2	Fall	
Consulting (2 Credits)				
PubH 209.58	Consulting Practicum and	1	Summer, Fall, Spring	
PubH 258	Advanced Topics in Biostatistical Consulting	1	Spring	



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Statistics Course Descriptions

STAT	181	Applied Time Series Analysis	3	Autoregressive integrated moving average (ARIMA) modeling and forecasting of univariate time series. Estimation of spectral density functions, white noise tests, and tests for periodicities. Theory and applications using SAS. Prerequisite: MATH 33, STAT 157-158 or STAT 118. Spring
STAT	187	Introduction to Sampling	3	Problems of sampling and sample design. Simple random, stratified, systematic, cluster, and multi-stage designs. Control of sampling and non-sampling errors. Prerequisite: STAT 91 or equivalent. Fall
STAT	188	Nonparametric Statistical Inference	3	Statistical inference when the form of the underlying distribution is not fully specified. Nonparametric procedures for estimation and testing hypotheses. An introduction to robust procedures. Prerequisite: STAT 91 or equivalent. Fall, Even Years
STAT	201-2	Mathematical Statistics I-II	3-3	Probability, distribution theory, sampling theory, estimation, sufficient statistics, hypothesis testing, analysis of variance, multivariate normal distribution. Prerequisite: MATH 033, 84. Academic Year
STAT	210	Data Analysis	3	Review of statistical principles of data analysis, using computerized statistical procedures. Multiple regression and the general linear model, analysis of contingency tables and categorical data, logistic regression for qualitative responses. Prerequisite: STAT 118, either STAT 183 or demonstrated proficiency in computer programming, and one semester of mathematical statistics STAT 157 or STAT 201). Spring
STAT	215	Applied Multivariate Analysis I	3	Application of multivariate statistical techniques to multidimensional research data from the behavioral, social, biological, medical and physical sciences. Prerequisite: STAT 119, 157-158; MATH 84. Alternate academic years
STAT	216	Applied Multivariate Analysis II	3	Application of multivariate statistical techniques to multidimensional research data from the behavioral, social, biological, medical and physical sciences. Prerequisite: STAT 119, 157-158; MATH 84. Alternate academic years
STAT	217	Design of Experiments	3	Design and analysis of the single- and multiple-factor experiments. Includes block designs, repeated measures, factorial and fractional factorial experiments, response surface experimentation. Prerequisite: STAT 119, 157-58; MATH 84 Fall Alternate Years
STAT	223	Bayesian Statistics: Theory and Applications	3	An overview of Bayesian statistics, including its foundational issues, decision under uncertainty, linear models, expert opinion, and computational issues. Prerequisite: STAT 201-2 Spring, Alternate Years
STAT	226	Advanced Biostatistics Methods	3	Statistical methods for the analysis of longitudinal data: nonparametric, fixed effects, mixed effects, generalized estimating equations. Methods for the analysis of emerging data: group sequential analysis, Brownian motion, Bayesian methods, and stochastic curtailment. Other advanced topics of current research in biostatistics. Prerequisite: STAT 201-2 or permission of instructor. Spring
STAT	227	Survival Analysis	3	Parametric and nonparametric methods for the analysis of events observed in time (survival data),

				including Kaplan-Meier estimate of survival functions, logrank and generalized Wilcoxon tests, the Cox proportional hazards model and an introduction to counting processes. Prerequisite: STAT 201-2 or permission of instructor. Fall
STAT	231	Categorical Data Analysis	3	A study of the theoretical bases underlying the analysis of categorical data. Measures and tests of association; mantel- Haenszel procedure; weighted least squares and maximum likelihood estimators in linear models; estimating equations; logistics regression; loglinear models. Prerequisite: STAT 201-2. Fall, alternate years
STAT	242	Regression Graphics /Nonparametric Regression	3	Linear regression, nonparametric regression, smoothing techniques, additive models, regression trees, neural networks, and dimension reduction methods. Prerequisite: Stat 118; Math 33, 84, or equivalent. Spring, alternate years
PubH	265	Design of Medical Studies	3	Design of medical investigations, including the randomized clinical trial, observational cohort study, and the retrospective case-control study. Specific methods regarding sample size, power and precision and statistical procedures for randomization and sampling. Ethics of clinical trials and the intention-to-treat principle. Prerequisite: PubH 202, Spring
PubH	266	Biostatistical Methods	3	Biostatistical methods for asymptotically efficient tests and estimates of relative risks and odds ratios from prospective and retrospective matched and unmatched studies. Fixed and random effects models. Logistic regression, conditional logistic regression. Poisson regression. Maximum likelihood and efficient scores. Prerequisites: STAT 202 or Instructor's permission, Fall <i>Basis for Master's Comprehensive Examination</i>
STAT	273	Stochastic Processes I	3	Fundamental notions of Markov chains and processes, generating functions, recurrence, limit theorems, random walks, Poisson processes, birth and death processes, applications. Prerequisite: STAT 189-90, and 201-2. Alternate academic years
STAT	281	Advanced Time Series Analysis	3	Autoregressive integrated moving average (ARIMA) modeling and forecasting of univariate and multivariate time series. Statespace or Kalman filter models, spectral analysis of multiple time series. Theory and applications using the University computer. Prerequisite: Math 33, Stat 201—2 or equivalent. (Spring)

Public Health Course Descriptions

PubH	201	Biological Concepts for Public Health	2	Provides an overview of current knowledge about biological mechanisms of major diseases causing death and disability in the US and globally; understanding and interpreting the reciprocal relationships of genetic, environmental, and behavioral determinants of health and disease in an ecologic context; analyzing, discussing, and communicating biologic principles of disease from a public health perspective. Summer, Fall, Spring
PubH	203	Principles and Practice of Epidemiology	3	General principles, methods, and applications of epidemiology. Outbreak investigations, measures of disease frequency, standardization of disease rates, study design, measures of association, hypothesis testing, bias, effect modification, causal inference, disease screening, and surveillance. Case studies apply these concepts to a variety of infectious, acute, and chronic health conditions affecting the population. Fall, Spring, Summer 10 week
PubH	204	Environmental and Occupational Health in a	2	Examines the connection between population health and exposures to chemical, physical, and biological agents in the environment. Through the use of problem-solving frameworks, students will become familiar

		Sustainable World		with data sources, methodologies and policy approaches being used to address the public health impacts of environmental and occupational health hazards, including the consequences of climate change, natural resource degradation, and industrial chemicals. The course will integrate key concepts of environmental health with principles of sustainability to illustrate how public policies and practices on the local, national and global level affect population health. Summer I, Fall, Spring
PubH	207	Social and Behavioral Approaches to Public Health	2	This course will emphasize social and behavioral science theories, models, and concepts that can be applied to public health problems and interventions. This course will describe the role of social and community factors, including race/ethnicity and culture, in both the onset and solution of public health problems and describe the inter-relationship between the social/behavioral science. Summer 1, Fall, Spring
PubH	209	Topics	1 to 3	In-depth examination of a particular facet of public health. Topics and prerequisites vary. Summer, Fall, Spring
PubH	209.58	Consulting Practicum	1	In this course students gain experience in applying their biostatistical skills to assist in projects being conducted by Medical Center researchers. The course director assigns projects to students according to their background and provides individual supervision. Prerequisite: Pubh 258. Summer, Fall, Spring
PubH	221	Environmental and Occupational Epidemiology	3	Epidemiologic methods for the study of environmental and occupational health problems. Epidemiologic exposure assessment methods and methods relevant to cohort, case-control, cross-sectional, and cluster investigation studies. Sources of and evaluation of biases and confounding, as well as survey and questionnaire design. Prerequisites: PubH 203, 202, Spring
PubH	242	Clinical Epidemiology and Decision Analysis	2	Quantitative and qualitative approaches to decision making, including risk- benefit analysis, decision analysis, and cost-effective analysis. Applications to technology assessment; development of clinical guidelines. Prerequisites: PubH 202,203, Spring
PubH	244	Cancer Epidemiology	2	Epidemiology of specific cancers, with an emphasis on molecular and genetic epidemiology. Current research in the field. Prerequisites: PubH 202,203, Spring
PubH	245	Infectious Disease Epidemiology	2	The role and conduct of laboratory and field investigations in the epidemiology of infectious diseases. Prerequisite, PubH 203, Spring
PubH	246	Injury Epidemiology and Prevention	2	Epidemiologic knowledge and prevention strategies for intentional and unintentional injuries, including those occurring in transportation, occupational, home, and recreational environments. Research methods, sources of data, and application to injury prevention. Prerequisite, PubH 203, Fall
PubH	258	Advanced Topics in Biostatistical Consulting	1	Principles and practice of biostatistical consulting in public health and medical research environments. Spring