

# Biostatistics

## Head

- Joseph E. Cavanaugh

**Graduate degrees:** M.S. in biostatistics; Ph.D. in biostatistics

**Graduate certificate:** biostatistics

**Faculty:** <https://www.public-health.uiowa.edu/biostatistics-faculty-list/>

**Website:** <https://www.public-health.uiowa.edu/biostat/>

The Department of Biostatistics prepares students for professional and academic careers in biostatistics. Graduates find positions in pharmaceutical, health care, and research companies and institutions; in universities and government agencies; and as consultants. The department also provides training for non-biostatistics students.

Current research interests in the Department of Biostatistics include computer intensive statistics, Bayesian methods, design and analysis of clinical trials, longitudinal data analysis, survival analysis, spatial modeling, analysis of data subject to missingness, time series, model selection, quality control, survey sampling, statistical genetics, and public health statistics. Biostatistics faculty members work closely with both clinical and basic science investigators on the University of Iowa health sciences campus in the design and analysis of research projects.

In addition to the M.S. and the Ph.D. degrees in biostatistics, the department offers a subprogram for the Master of Public Health (M.P.H.) degree in quantitative methods. See "M.P.H. Subprogram" below.

## M.P.H. Subprogram

The Department of Biostatistics offers the quantitative methods subprogram for the Master of Public Health degree. The subprogram is designed to train public health professionals for leadership in the analysis of public health data and the design of studies for public health investigations. See Master of Public Health in the Catalog.

## Programs

### Graduate Programs of Study

#### Majors

- (Quantitative methods subprogram for the Master of Public Health degree)
- Master of Science in Biostatistics
- Doctor of Philosophy in Biostatistics

#### Certificate

- Certificate in Biostatistics

## Facilities

Department of Biostatistics resources and activities include three centers. The Biostatistics Consulting Center provides opportunities for students to gain valuable experience working with faculty and staff in the health sciences at the University of Iowa. The Clinical Trials Statistical and Data Management Center serves the statistical design, data management, and analysis needs of a variety of multicenter clinical trials, and among those are Clinical Islet Transplantation

(CIT) Consortium, Network of Excellence in Neuroscience Clinical Trials (NeuroNEXT), and the Parkinson's Progression Markers Initiative (PPMI). The Center for Public Health Statistics facilitates the collection, statistical analyses, and dissemination of health data in support of the University's research, teaching, and service missions and in partnership with the Iowa Department of Public Health.

## Courses

### Biostatistics Courses

#### **BIOS:4110 General Biostatistics** **3 s.h.**

Biostatistics and biostatistical computation; biostatistical aspects of health-related problems; clinical trials; statistical issues in big data problems; disease modeling; disease mapping; genetics and epidemiology; brief introduction to survival and longitudinal analyses.

#### **BIOS:4120 Introduction to Biostatistics** **3 s.h.**

Application of statistical techniques to biological data including descriptive statistics, probability and distributions, sampling distributions, nonparametric methods, hypothesis tests, confidence intervals, analysis of categorical data, and simple linear regression; designed for non-biostatistics majors and M.P.H. students. Requirements: college algebra or ALEKS score of 65% or higher.

#### **BIOS:4710 Biostatistical Methods Laboratory** **1 s.h.**

Computational aspects of one-sample and two-sample problems; analysis of frequency data, linear regression, and correlation analysis; examples using these computational methods in public health. Offered fall semesters. Prerequisites: STAT:3200 and STAT:2010.

#### **BIOS:5120 Regression Modeling and ANOVA in the Health Sciences** **3 s.h.**

Continuation of BIOS:4120; correlation, simple and multiple linear regression, confounding, interactions, model selection, single and multiple factor ANOVA (analysis of variance) models, contrasts, multiple comparisons, nested and block designs, and an introduction to mixed models; designed for non-biostatistics majors. Offered spring semesters and summer sessions. Prerequisites: BIOS:4120. Same as IGPI:5120, STAT:5610.

#### **BIOS:5310 Research Data Management** **3 s.h.**

Introduction to data management techniques and problems encountered in gathering and processing data from biomedical investigations; introduction to SAS, techniques taught in SAS; designed for non-biostatistics majors. Offered fall and spring semesters. Recommendations: prior programming experience with C, C++, Python, Java, or other. Same as IGPI:5310, STAT:5810.

#### **BIOS:5510 Biostatistical Computing** **2 s.h.**

Introduction to computer programming using SAS and R statistical software packages; programming language syntax, constructs, procedures, and techniques for data management, data analysis, and statistical programming commonly encountered in biostatistics. Designed for first-year biostatistics majors. Offered fall semesters. Corequisites: BIOS:5710. Same as IGPI:5510.

#### **BIOS:5710 Biostatistical Methods I** **4 s.h.**

Probability distributions, moments, estimation, parametric and nonparametric inference for one-sample and two-sample problems, analysis of frequency data; emphasis on use of computers; designed for first-year biostatistics majors. Offered fall semesters. Requirements: two semesters of calculus. Same as IGPI:5710.

- BIOS:5720 Biostatistical Methods II** 4 s.h.  
Continuation of BIOS:5710; multi-factor ANOVA (analysis of variance), multiple comparisons, orthogonal contrasts, linear regression and correlation, regression diagnostics and remedial measures, model selection, and mixed models; designed for first-year biostatistics majors. Offered spring semesters. Prerequisites: BIOS:5710. Requirements: one semester of linear algebra. Same as IGPI:5720.
- BIOS:5730 Biostatistical Methods in Categorical Data** 3 s.h.  
Estimation of proportions, rates, risks, relative risks, and odds ratios; Mantel-Haenszel method; logistic regression (including ordinal logistic regression and multi-category nominal logistic regression); Poisson regression and negative binomial regression; methods for correlated or clustered data (conditional logistic regression, generalized estimating equations, and mixed effects models); special topics include an introduction to generalized linear models and likelihood-based inferential techniques in this framework; designed for first-year biostatistics majors. Offered spring semesters. Prerequisites: BIOS:5510 and BIOS:5710. Corequisites: BIOS:5720. Same as IGPI:5730.
- BIOS:6110 Applied Categorical Data Analysis** 3 s.h.  
Analysis of proportions, risk measures, and measures of association; Mantel-Haenszel method; logistic regression for binary responses and for matched data; logistic regression for multi-category responses; analysis of count data (Poisson regression and negative binomial regression); analysis of clustered data (generalized estimating equations and generalized linear mixed effects model); special topics include the application of propensity score methods; designed for non-biostatistics majors. Offered fall semesters. Prerequisites: BIOS:5120. Same as IGPI:6110.
- BIOS:6210 Applied Survival Analysis** 3 s.h.  
Nonparametric, parametric, and semi-parametric methods for time-to-event data; types of censoring; Kaplan-Meier estimation; Cox proportional hazards models, including methods for assessing adequacy of the proportional hazards assumption; time varying covariates; sample size calculations for comparison of two or more groups; focus on analysis of real data sets and examples using statistical software. Offered spring semesters. Prerequisites: BIOS:5120 or BIOS:5720. Same as IGPI:6210.
- BIOS:6310 Introductory Longitudinal Data Analysis** 3 s.h.  
Introduction to statistical models and estimation methods for outcome variables (normal and non-normal) clustered or measured repeatedly in time or space; focus on applications and computer software methods for ANOVA based methods, hierarchical linear models, linear mixed models, correlated regression models, generalized estimating equations, and generalized linear mixed models. Offered fall semesters. Prerequisites: BIOS:5120 or STAT:3200. Same as IGPI:6310, STAT:6550.
- BIOS:6420 Survey Design and Analysis** 3 s.h.  
Methodological issues regarding design, sampling approach, implementation, analysis, and interpretation of surveys and questionnaires in public health research. Offered spring semesters of even years. Prerequisites: EPID:4400 and BIOS:5120. Same as EPID:6420.
- BIOS:6610 Statistical Methods in Clinical Trials** 3 s.h.  
Survey of statistical methods commonly used in clinical trials; primary focus on methodologic perspective for the design, conduct, analysis, and interpretation of all phases of clinical trials; logistical and operational aspects of conducting multisite clinical trials; designed for biostatistics majors. Offered spring semesters. Prerequisites: BIOS:5720. Requirements: familiarity with SAS and R programming. Same as IGPI:6610.
- BIOS:6650 Comparative Effectiveness Research Methods for Observational Data** 3 s.h.  
Concepts of causal inference, counterfactuals, confounding, causal graphs, internal/external validity, heterogeneity of treatment effect; methods covered include propensity score matching (optimal pair, multiple control and full matching; near-exact, fine-balance, and risk set matching) and stratification; covariate balance checks; sensitivity analysis; inverse probability of treatment weighted estimation; doubly robust estimators; mediation analysis; marginal structural models. Offered fall semesters of odd years. Prerequisites: BIOS:5720 and BIOS:5730 and ((STAT:4100 and STAT:4101) or (STAT:5100 and STAT:5101)). Same as IGPI:6650.
- BIOS:6720 Statistical Machine Learning for Biomedical and Public Health Data** 3 s.h.  
Statistical machine learning techniques for analysis of biomedical and public health data; methodology and application of unsupervised learning, supervised learning for regression and classification, ensemble learning, model assessment, feature selection, and high-dimensional inference. Prerequisites: BIOS:5510 and BIOS:5720 and (STAT:4100 and STAT:4101) or (STAT:5100 and STAT:5101). Requirements: BIOS:5510 with topic of programming with R.
- BIOS:6810 Bayesian Methods and Design** 3 s.h.  
Theory and application of Bayesian methods in biomedical research; foundations of Bayesian statistics including decision theory, study design, model development, inference and implementation of computational algorithms; designed for biostatistics majors. Offered spring semesters of odd years. Prerequisites: BIOS:5510 and BIOS:5720 and BIOS:5730 and STAT:4100 and STAT:4101.
- BIOS:7110 Theory of Biostatistics I** 4 s.h.  
Intermediate-level treatment of the theoretical foundation of mathematical statistics including conditional distributions, models, prediction, sufficiency, exponential families, methods of estimation and performance of estimators, uniform minimum variance unbiasedness, information inequalities, likelihood theory, confidence intervals, asymptotic theory and its applications; designed for biostatistics majors. Offered fall semesters. Prerequisites: (BIOS:5720 and STAT:5100 and STAT:5101) or (STAT:4100 and STAT:4101).
- BIOS:7120 Theory of Biostatistics II** 4 s.h.  
Asymptotic likelihood theory for estimation and hypothesis testing with and without nuisance parameters; generalized linear models; numerical optimization; model and data deficiencies, (e.g., misspecified models, missing data, robust variance estimation); alternative likelihoods (e.g., profile, conditional, marginal, pseudo, partial, quasi likelihoods); EM algorithm; topics may include bootstrap, rank-based methods, propensity scores, double-robust estimators, generalized linear mixed models and numerical quadrature methods; designed for biostatistics majors. Offered spring semesters. Prerequisites: BIOS:7110.

- BIOS:7210 Survival Data Analysis** 3 s.h.  
Types of censoring and truncation; survival function estimation; parametric inference using exponential, Weibull, and accelerated failure time models; nonparametric tests; sample size calculation; Cox regression with stratification and time-dependent covariates; regression diagnostics; competing risks; topics may include analysis of correlated survival data and/or recurrent events; designed for biostatistics and statistics majors. Offered fall semesters. Prerequisites: BIOS:5720 and ((STAT:4100 and STAT:4101) or (STAT:5100 and STAT:5101)). Same as IGPI:7210, STAT:7570.
- BIOS:7230 Advanced Clinical Trials** 3 s.h.  
Modules that address advanced topics and issues encountered when conducting a clinical trial; discussions of recent publications and FDA guidance documents dealing with current topics in clinical trials. Prerequisites: (STAT:4101 or STAT:5101) and BIOS:6610. Requirements: familiarity with SAS and R programming.
- BIOS:7270 Scholarly Integrity in Biostatistics** 1 s.h.  
Responsible conduct of research training; emphasis on issues of particular relevance to biostatisticians including authorship, communication, student/mentor relationships, plagiarism, fabrication and falsification of data, bias, Type I/II errors, reproducible research, data confidentiality and security, conflicts of interest, and human/animal subjects. Requirements: graduate standing in biostatistics.
- BIOS:7310 Longitudinal Data Analysis** 3 s.h.  
Statistical models and estimation methods for outcome variables (normal and non-normal) clustered or measured repeatedly in time or space; includes ANOVA based methods, hierarchical linear models, linear mixed models, error structures, generalized estimating equations, and generalized linear mixed models; may include Bayesian approaches; designed for biostatistics and statistics majors. Offered spring semesters of odd years. Prerequisites: (BIOS:5720 and STAT:4100 and STAT:4101) or (STAT:5100 and STAT:5101). Same as IGPI:7310.
- BIOS:7410 Analysis of Categorical Data** 3 s.h.  
Models for discrete data, distribution theory, maximum likelihood and weighted least squares estimation for categorical data, tests of fit, models selection. Offered spring semesters. Prerequisites: (BIOS:5720 or STAT:5200) and (STAT:5101 or STAT:4101). Same as STAT:7510.
- BIOS:7500 Preceptorship in Biostatistics** arr.  
Work experience using knowledge and skill acquired in classroom; arranged in conjunction with ongoing departmental or collegiate activities or with governmental agencies or private industry; preparation of prospectus and presentation of research results in a department seminar.
- BIOS:7600 Advanced Biostatistics Seminar** 0-3 s.h.  
Current topics; supervised experience in reading and interpreting biostatistical literature. Offered spring semesters. Same as IGPI:7600.
- BIOS:7604 Scholarly Integrity in Biostatistics for Postdocs** 0 s.h.  
Responsible conduct of research training; emphasis on issues of particular relevance to biostatisticians and statisticians including authorship, communication, student/mentor relationships, plagiarism, fabrication and falsification of data, bias, Type I/II errors, reproducible research, data confidentiality and security, conflicts of interest, human/animal subjects. Requirements: postdoctoral research scholar/fellow standing in biostatistics or statistics.
- BIOS:7700 Problems/Special Topics in Biostatistics** arr.  
Didactic material in biostatistics; may include tutorials, seminars, faculty-directed independent work (e.g. literature search, project, short research project).
- BIOS:7800 Independent Study in Biostatistics** arr.  
In-depth pursuit of an area of special interest in biostatistics requiring substantial creativity and independence.
- BIOS:7850 Research in Biostatistics** arr.  
Research that may lead to a dissertation.
- BIOS:7900 Thesis/Dissertation** arr.