Biostatistics

Head
• Joseph E. Cavanaugh

Deputy head
• William R. Clarke

Graduate degrees: M.S. in biostatistics; Ph.D. in biostatistics
Graduate certificate: biostatistics
Faculty: http://www.public-health.uiowa.edu/biostatistics-faculty-list/
Web site: http://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.

Graduate Programs of Study
• Master of Science in biostatistics
• Doctor of Philosophy in biostatistics
• Certificate in Biostatistics

In addition to offering graduate degree programs in biostatistics, the department offers the quantitative methods subprogram for the Master of Public Health; see "M.P.H. Subprogram" below.

Master of Science

The Master of Science program in biostatistics requires a minimum of 38 s.h. of graduate credit. The program provides training in the design of experiments and in analysis of data related to biomedical or public health problems. It emphasizes mathematical, statistical, and computer methods for dealing with quantitative information and provides opportunities for students to gain statistical consulting experience with a variety of problems.

Graduates find career opportunities in many areas, including pharmaceutics, health care, research companies and institutions, consulting firms, universities, and government agencies.

All M.S. students are required to complete an in-depth preceptorship under the direction of a departmental faculty member and a final comprehensive-style examination.

Graduate students in biostatistics must maintain a g.p.a. of at least 3.00. Those who receive a grade of C on 7 s.h. of course work may be dismissed from the program.

The Master of Science in biostatistics requires the following course work.

**CORE COURSES**

All of these:
- BIOS:5510 Biostatistical Computing 3 s.h.
- BIOS:5710 & BIOS:5720 Biostatistical Methods I-II 8 s.h.
- BIOS:5730 Biostatistical Methods in Categorical Data 3 s.h.
- BIOS:6610 Statistical Methods in Clinical Trials 3 s.h.
- BIOS:7500 Preceptorship in Biostatistics 3 s.h.
- EPID:4400 Epidemiology I: Principles 3 s.h.

One of these sequences:
- STAT:4100-STAT:4101 Mathematical Statistics I-II 6 s.h.
- STAT:5100-STAT:5101 Statistical Inference I-II (preferred for students who intend to earn a Ph.D.) 6 s.h.

Public health requirement:
- MPH:6100 Essentials of Public Health 1 s.h.

**ELECTIVES**

One of these:
- BIOL:4213 Bioinformatics 4 s.h.
- CBH:4105 Introduction to Health Promotion and Disease Prevention 3 s.h.
- ECE:5220 Computational Genomics 3 s.h.
- GENE:7191 Human Molecular Genetics 3 s.h.
- HMP:4000 Introduction to the U.S. Health Care System 3 s.h.
- OEH:4240 Global Environmental Health 3 s.h.
- PATH:8133 Introduction to Human Pathology for Graduate Students 4 s.h.
- PCOL:2120 Drugs: Their Nature, Action, and Use 2 s.h.

Another approved biology/public health course

At least 6 s.h. from these:
- BIOS:5310 Research Data Management 3 s.h.
- BIOS:6210 Applied Survival Analysis 3 s.h.
- BIOS:6310 Introductory Longitudinal Data Analysis 3 s.h.
- BIOS:6810 Bayesian Methods and Design 3 s.h.
- BIOS:7110 Theory of Biostatistics I 4 s.h.
- BIOS:7120 Theory of Biostatistics II 4 s.h.
- BIOS:7210 Survival Data Analysis 3 s.h.
- BIOS:7310 Longitudinal Data Analysis 3 s.h.
- BIOS:7410 Analysis of Categorical Data 3 s.h.
- BIOS:7700 Problems/Special Topics in Biostatistics 1 s.h.
- CS:3110 Introduction to Informatics 3 s.h.
- STAT:4520 Bayesian Statistics 3 s.h.
- STAT:6540 Applied Multivariate Analysis 3 s.h.
- STAT:7200 Linear Models 4 s.h.
### M.P.H. Subprogram

The Department of Biostatistics offers the quantitative methods subprogram for the Master of Public Health. 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 Program in the Catalog.

### Doctor of Philosophy

The Doctor of Philosophy program in biostatistics requires a minimum of 79 s.h. of graduate credit, including credit from a master's degree. The program prepares students for professional and academic careers in biostatistics, especially for positions that emphasize developing and applying statistical methodology to solve important biological and public health problems.

All Ph.D. students must successfully complete a qualifying examination, a comprehensive examination, and a dissertation. The research topic and content, which vary depending on the program of study, must be approved by the student's dissertation committee. Other degree requirements include approved electives chosen from Department of Biostatistics and other University of Iowa courses.

Graduate students in biostatistics must maintain a g.p.a. of at least 3.00. Those who receive a grade of C on 7 s.h. of course work may be dismissed from the program.

The Doctor of Philosophy in biostatistics requires the following work.

### MASTER OF SCIENCE BACKGROUND

Ph.D. students must take the following courses (26 s.h.) required for the Master of Science in biostatistics. Students who have completed equivalent course work at other institutions may request waivers and/or transfers of credit.

Students who earned a Master of Science in biostatistics at the University of Iowa automatically receive credit for these courses.

One of these sequences:

<table>
<thead>
<tr>
<th>Course Sequence</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>STAT:4100-STAT:4101 Mathematical Statistics</td>
<td>6</td>
</tr>
<tr>
<td>STAT:5100-STAT:5101 Statistical Inference I-II</td>
<td>6</td>
</tr>
<tr>
<td>BIOS:5710 &amp; BIOS:5720 Biostatistical Methods I-II</td>
<td>8</td>
</tr>
<tr>
<td>BIOS:5730 Biostatistical Methods in Categorical Data</td>
<td>3</td>
</tr>
<tr>
<td>BIOS:7500 Preceptorship in Biostatistics</td>
<td>3</td>
</tr>
<tr>
<td>EPID:4400 Epidemiology I: Principles</td>
<td>3</td>
</tr>
<tr>
<td>MPH:6100 Essentials of Public Health</td>
<td>1</td>
</tr>
</tbody>
</table>

One approved biology/public health course

### CORE COURSES

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOS:7110 Theory of Biostatistics I</td>
<td>4</td>
</tr>
<tr>
<td>BIOS:7120 Theory of Biostatistics II</td>
<td>4</td>
</tr>
<tr>
<td>BIOS:7210 Survival Data Analysis</td>
<td>3</td>
</tr>
<tr>
<td>BIOS:7310 Longitudinal Data Analysis</td>
<td>3</td>
</tr>
</tbody>
</table>

BIOS:7410 Analysis of Categorical Data | 3 | s.h. |

STAT:7200 Linear Models | 4 | s.h. |

### ELECTIVES

With approval of their advisor, students choose 15-22 s.h. of graduate-level courses in biostatistics, statistics, genetics, microbiology, among others. They may count a maximum of 5 s.h. earned in nonquantitative courses (e.g., community and behavioral health, epidemiology, microbiology) toward the requirement. They also may count courses required for the Master of Science that are not listed under "Master of Science Background," above, toward the requirement.

Ph.D. students may take the following courses.

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOS:6210 Applied Survival Analysis</td>
<td>3</td>
</tr>
<tr>
<td>BIOS:6220 Cohort Data Analysis</td>
<td>1</td>
</tr>
<tr>
<td>BIOS:7500 Preceptorship in Biostatistics (in addition to the Master of Science preceptorship)</td>
<td>3</td>
</tr>
<tr>
<td>BIOS:7600 Advanced Biostatistics Seminar</td>
<td>0-3</td>
</tr>
<tr>
<td>BIOL:4213 Bioinformatics</td>
<td>4</td>
</tr>
<tr>
<td>STAT:4520 Bayesian Statistics</td>
<td>3</td>
</tr>
<tr>
<td>STAT:6300 Probability and Stochastic Processes I</td>
<td>3</td>
</tr>
<tr>
<td>STAT:6540 Applied Multivariate Analysis</td>
<td>3</td>
</tr>
<tr>
<td>STAT:6560 Applied Time Series Analysis</td>
<td>3</td>
</tr>
<tr>
<td>STAT:7400 Computer Intensive Statistics</td>
<td>3</td>
</tr>
<tr>
<td>STAT:7520 Bayesian Analysis</td>
<td>3</td>
</tr>
</tbody>
</table>

### DISSERTATION

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOS:7900 Thesis/Dissertation (at least two semesters in residence)</td>
<td>10-17</td>
</tr>
</tbody>
</table>

### Certificate

The Certificate in Biostatistics requires a minimum of 15 s.h. of graduate credit. It is designed for students who would like to add a formal biostatistics emphasis to their graduate programs. Completion of the certificate is noted on the student's transcript.

The certificate program is open to students enrolled in a University of Iowa graduate degree program outside biostatistics. It is also open to individuals who hold graduate degrees in science disciplines or professional degrees in the health sciences and are admitted to the Graduate College as nondegree students (contact the Department of Biostatistics for more information).

Enrollment is limited; applicants who have completed at least one of the certificate's required courses and whose research will be advanced by biostatistics training are given priority for admission. Visit the Certificate in Biostatistics web site for an application form.

The certificate requires two core courses (6 s.h.) and three electives (9 s.h.). Students should work with an advisor to plan their course work carefully, since some certificate courses have prerequisites, require permission for enrollment, or are not offered every year. Students must earn a grade of at least B-minus in each certificate course and must maintain a cumulative g.p.a. of at least 3.00 in order to earn the certificate. They must complete at least 6 s.h. of the required course work after being admitted to the certificate program, and they may count a maximum of 9 s.h. of certificate credit toward a degree or
another certificate earned at the University. At least 6 s.h. of the certificate plan of study must be exclusively applied to the certificate.

The Certificate in Biostatistics requires the following course work.

**CORE COURSES**
Both of these:
- BIOS:5110 Introduction to Biostatistics (BIOS:4120 effective Spring 2016) 3 s.h.
- BIOS:5120 Design and Analysis of Biomedical Studies 3 s.h.

**ELECTIVES**
Three of these (total of 9 s.h.):
- BIOS:5310 Research Data Management 3 s.h.
- BIOS:6110 Applied Categorical Data Analysis 3 s.h.
- BIOS:6210 Applied Survival Analysis 3 s.h.
- BIOS:6220 Cohort Data Analysis 1 s.h.
- BIOS:6310 Introductory Longitudinal Data Analysis 3 s.h.
- BIOS:6610 Statistical Methods in Clinical Trials 3 s.h.
- BIOS:7850 Research in Biostatistics arr.

Other courses may be approved as electives by the Department of Biostatistics director of graduate studies.

**Admission**
Applicants to the M.S. and Ph.D. programs in biostatistics must apply through the Schools of Public Health Application Service (SOPHAS); they also must apply for admission to the Graduate College through the University of Iowa Office of Admissions. For detailed application information, visit Prospective Students/Application Process on the Department of Biostatistics web site.

The biostatistics faculty considers several factors when evaluating applications for admission, including Graduate Record Examination (GRE) General Test scores, grade-point averages, letters of recommendation, intent and motivation for graduate study, and research interests.

All M.S. and Ph.D. program applicants must hold a bachelor's degree, have a cumulative g.p.a. of at least 3.00, and have taken the Graduate Record Examination (GRE) General Test. Applicants whose first language is not English and who do not hold a bachelor's degree from an accredited institution in the United States, the United Kingdom, Canada (except Quebec), Australia, or New Zealand must score at least 100 (Internet-based) on the Test of English as a Foreign Language (TOEFL). Applicants with lower scores are not considered for admission. In place of TOEFL scores, the department accepts International English Testing System (IELTS) scores of 7.0 or higher, with no subscore below 6.0.

All biostatistics applicants are required to have strong written and oral communication skills.

All M.S. applicants must be competent in at least one computer programming language. They also must have mathematical sciences training in methods and techniques of single variable and multivariable differential and integral calculus, and in linear algebra.

Completion of an M.S. program in statistics or biostatistics generally is required for admission to the Ph.D. program.

Applicants must meet the admission requirements of the Graduate College; see the Manual of Rules and Regulations of the Graduate College.

Students may enter the M.S. and Ph.D. programs in fall; the priority application deadline for both programs is December 1.

**Financial Support**
A limited number of teaching and research assistantships are available. Assistantships offer financial support and tuition assessed at the resident tuition rate along with a tuition scholarship. They also provide valuable on-the-job training experience.

For information on financing education through jobs, grants, and loans, contact the University's Office of Student Financial Aid.

**Resources**
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 (NEXT), and the Parkinson's Progress 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**

**BIOS:4110 General Biostatistics** 4 s.h.
Biostatistics and biostatistical computation; biostatistical aspects of health-related areas—clinical trials, 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; normal, binomial, and Poisson distributions; sampling distributions; tests of significance; confidence intervals; analysis of frequency data; simple linear regression. Requirements: college algebra.

**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:2010 and STAT:3200.

**BIOS:5050 Biostatistics for Biomedical Research** 1 s.h.
Application of statistical techniques to biological data analysis; normal distribution, sampling distribution of the mean, variance, nonparametric methods, linear regression, power, and sample size. Same as BISC:5204.

**BIOS:5110 Introduction to Biostatistics** 3 s.h.
Application of statistical techniques to biological data, including descriptive statistics; probability; normal, binomial, and Poisson distributions; sampling distributions; tests of significance; confidence intervals; analysis of frequency data; simple linear regression. Requirements: college algebra.

**BIOS:5120 Design and Analysis of Biomedical Studies** 3 s.h.
Simple and multiple linear regression and correlation; one- and two-way layout considerations in planning experiments; factorial experiments; multiple comparison techniques; orthogonal contrasts. Offered spring semesters. Prerequisites: BIOS:5110. Same as STAT:5610.

**BIOS:5310 Research Data Management** 3 s.h.
Overview of problems encountered in gathering and processing data from biomedical investigations; introduction to data management techniques useful in biomedical studies; introduction to Microsoft Access. Offered fall semesters. Prerequisites: BIOS:5110. Same as STAT:5810.

**BIOS:5510 Biostatistical Computing** 3 s.h.
Groundwork in SAS and R programming; emphasis on data management, Monte Carlo simulations, and expectation maximization techniques. Offered fall semesters. Corequisites: BIOS:5710. Recommendations: C and C++ skills.

**BIOS:5710 Biostatistical Methods I** 4 s.h.
Problem-oriented probability distributions, moments, estimation, parametric and nonparametric inference for one-sample and two-sample problems, analysis of frequency data, linear regression, and correlation analysis, with emphasis on use of computers. Offered fall semesters. Requirements: two semesters of calculus.

**BIOS:5720 Biostatistical Methods II** 4 s.h.
Continuation of BIOS:5710; linear regression and correlation, multiple linear regression, multiple factor experiments, multiple comparisons, orthogonal contrasts, block and split-plot designs, confounding interactions, and mixed models. Offered spring semesters. Prerequisites: BIOS:5710.

**BIOS:5730 Biostatistical Methods in Categorical Data** 3 s.h.
Introduction to methods for allied categorical data analysis; estimation of proportions, rates, and risks; measures of relative risk and odds ratios, stratified analysis, case control studies, logistic regression. Offered spring semesters. Prerequisites: BIOS:5510 and BIOS:5710. Corequisites: BIOS:5720 and (STAT:4101 or STAT:5101). Same as STAT:5610.

**BIOS:6110 Applied Categorical Data Analysis** 3 s.h.
Overview of methods to analyze categorical data from health science investigations; estimation of rates and risks, measures of relative risk, stratified analysis, logistic regression analysis. Offered fall semesters. Prerequisites: BIOS:5120.

**BIOS:6210 Applied Survival Analysis** 3 s.h.
Nonparametric, parametric, and semi-parametric methods for time to event data; censoring of event times into analysis; types of censoring; Kaplan-Meier estimation; Weibull model estimation; Cox proportional hazards models, including methods for assessing adequacy of 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:5710 or BIOS:6110.

**BIOS:6220 Cohort Data Analysis** 1 s.h.
Methods of comparing direct standardized rates and standardized mortality ratios; Poisson regression for cohort data. Offered spring semesters of odd years. Prerequisites: BIOS:6110.

**BIOS:6310 Introductory Longitudinal Data Analysis** 3 s.h.
Statistical models and estimation methods used to analyze correlated data (e.g., same subject measured repeatedly); emphasis on use of statistical software. Offered fall semesters of odd years. Prerequisites: STAT:3200 or STAT:6510 or BIOS:5730 or BIOS:6110. Same as STAT:6550.

**BIOS:6610 Statistical Methods in Clinical Trials** 3 s.h.
Survey of statistical methods commonly used in clinical trials; methodologic perspective on the design, conduct, and analysis of trials; emphasis on Phase III randomized controlled clinical trials. Offered spring semesters. Prerequisites: BIOS:5720 and (STAT:3101 or STAT:4101 or STAT:5101).

**BIOS:6650 Comparative Effectiveness Research Methods for Observational Data** 3 s.h.
Concepts of internal/external validity, counterfactuals, confounding, causal inference, and heterogeneity of treatment effect; methods including propensity scores, graphical models, inverse probability weighting, double robustness, marginal structural models, direct and indirect effects, instruments. Prerequisites: BIOS:5710 and BIOS:5720 and BIOS:5730 and ((STAT:4100 and STAT:4101) or (STAT:5100 and STAT:5101)).

**BIOS:6810 Bayesian Methods and Design** 3 s.h.
Theory and application of Bayesian methods in biomedical research; foundations of Bayesian statistics, including axiomatic development of subjective probability and decision theory, study design, model development, inference, and implementation of computational algorithms. 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 study of sufficiency, exponential families, methods of estimation, uniform minimum variance unbiasedness, information, likelihood theory, confidence intervals, the Neyman-Pearson lemma, asymptotic theory and its applications. Offered fall semesters of even years. Prerequisites: BIOS:5720 and (STAT:4101 or STAT:5101).

BIOS:7120 Theory of Biostatistics II 4 s.h.
Nonparametric hypothesis tests, semiparametric estimation, generalized linear models, generalized estimation equations, generalized linear mixed models, EM algorithm, computer-intensive methods; application of theory learned in BIOS:7110 to classical and new methods in biostatistics. Offered spring semesters of odd years. Prerequisites: BIOS:7110.

BIOS:7210 Survival Data Analysis 3 s.h.
Types of censoring and truncation; survival function estimation; life tables; 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; analysis of correlated survival data. Offered fall semesters. Prerequisites: BIOS:5720 and (STAT:4101 or STAT:5101). Same as STAT:7570.

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, human/animal subjects. Requirements: graduate standing in biostatistics.

BIOS:7310 Longitudinal Data Analysis 3 s.h.
Introduction to statistical methodology for analyzing data from observational and experimental studies in which the response variable from each subject is measured repeatedly; emphasis on use of statistical software packages and specialized programs. Offered spring semesters of odd years. Prerequisites: BIOS:5720 and (STAT:4101 or STAT:5101).

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: (STAT:4101 or STAT:5101) and (STAT:5200 or BIOS:5720). Same as STAT:7510.

BIOS:7500 Preceptorship in Biostatistics
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.

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.