# Biostatistics

Many issues in the health, medical, and biological sciences are addressed by collecting and exploring relevant data. The development and application of techniques to better understand such data is the fundamental concern of the Group in Biostatistics. The program offers training in theory of statistics and biostatistics, the computer implementation of analytic methods, and opportunities to use this knowledge in areas of biological/medical research. The curriculum is taught principally by members of the Division of Biostatistics (School of Public Health) and the Department of Statistics (College of Letters & Science) and provides a wide range of ideas and approaches to the analysis of data.

Established in 1955, the Graduate Group in Biostatistics curriculum offers instruction in statistical theory and computing, as well as opportunities to rigorously apply this knowledge in biological and medical research. The degree programs offered (listed below) are appropriate for students who have either a strong mathematical and statistical background with a focus in the biomedical sciences, or degrees in the biological sciences with a focus in mathematics and statistics. (The MA degree can be obtained under Plan I or Plan II. The PhD dissertation is administered according to Plan B.)

## Master of Arts (MA)

The Masters of Arts Degree in Biostatistics is completed in 4 semesters. Candidates for this degree are expected to earn 48 units with courses in biostatistics, statistics, public health, and biology. Students pursuing the MA degree in Biostatistics will be expected, upon completion of the program, to be well-versed in the following areas:

- Understand the foundations of statistical inference, e.g., maximum likelihood estimation, regression.
- Have grounding in theoretical framework and ability to apply existing estimators in following categories:
  - Computational statistics
  - Multivariate analysis
  - Categorical data analysis
  - Survival analysis
  - Longitudinal data analysis
  - Causal inference
  - Clinical trials
  - Statistical genomics
  - Statistical computing
- Have fluency in statistical programming languages for both analysis using classic methods and implementation of novel methods.
- Identify and apply sound and pertinent methods to address statistical inference questions in biological, public health, and medical research.
- Effectively communicate research findings, orally and in writing.

## Doctor of Philosophy (PhD)

All Biostatistics PhD students are required to hold a master's degree in Biostatistics or a related field. The PhD degree requires 4-6 semesters of course work in biostatistics, statistics, and at least one other subject area (e.g., biology, environmental health, epidemiology). There are no unit or course requirements for the PhD, so a program of courses appropriate to a student's background and interests may be developed. Courses cover traditional topics as well as recent advances in biostatistics and in statistics. Those completing the PhD will have acquired a deep knowledge and understanding of these subject areas. Since graduates with doctorates often assume academic careers in research and teaching, a high degree of mastery in research design, theory, methodology, and execution is expected as well as the ability to communicate and present research findings and area of expertise in a clear, understandable manner.

Many doctoral graduates accept faculty positions in schools of public health, medicine, and statistics and/or math departments at colleges and universities, both in the United States and abroad. Some graduates take research positions, including with pharmaceutical companies, hospital research units, non-profits, and within the tech sector.

## Biostatistics Doctor of Philosophy (PhD) with Designated Emphasis (DE)

Students enrolled in the UC Berkeley Biostatistics doctoral (PhD) program are eligible to apply for interdisciplinary study in a Designated Emphasis (DE), which we refer to as the Associated Programs. At UC Berkeley, acquiring a DE is like earning a "minor" with a PhD degree. Applications for Designated Emphasis are reviewed on a rolling basis throughout the year. However, students must apply prior to taking the qualifying exam and are strongly encouraged to begin the application process early in the third semester of graduate study. To be accepted to a Designated Emphasis, you must be a PhD candidate in one of the Associated Programs (e.g., Biostatistics). The two DE programs offered in biostatistics are:

- Designated Emphasis in Computational and Genomic Biology (DE-CGB) (http://qb3.berkeley.edu/ccb/)
- Designated Emphasis in Computational Science and Data Science and Engineering (DE-CSDE) (https://data.berkeley.edu/decdse/)

The goal of the DE-CGB program is to train a new generation of computational biology researchers by enhancing and facilitating interactions between faculty, postdoctoral scholars and students in the Associated Programs through a flexible and integrated research and teaching environment which transcends traditional departmental boundaries. Upon successful completion of all requirements and dissertation, your transcript and diploma will read, "PhD in Biostatistics with a Designated Emphasis in Computational & Genomic Biology."

The DE in Computational Science and Engineering (CSE) promises to bring a new paradigm to interdisciplinary research and education. The team-oriented approach provides our students with a solid foundation in the different facets of genomic research and ensuing competitive edge for the most desirable jobs in academia and industry, which increasingly require interdisciplinary training by combining high-performance computing, mathematical modeling, scientific and engineering theory, and analysis of large scale databases of observations. Upon successful completion of all requirements and dissertation, your transcript and diploma will read, "PhD in Biostatistics with a Designated Emphasis in Computational Science and Engineering."

# Admission to the University

## Applying for Graduate Admission

Thank you for considering UC Berkeley for graduate study! UC Berkeley offers more than 120 graduate programs representing the breadth and depth of interdisciplinary scholarship. The Graduate Division hosts a complete list (https://grad.berkeley.edu/admissions/choosing-your-program/list/) of graduate academic programs, departments, degrees offered, and application deadlines can be found on the Graduate Division website.

Prospective students must submit an online application to be considered for admission, in addition to any supplemental materials specific to the program for which they are applying. The online application and steps to take to apply can be found on the Graduate Division website (https://grad.berkeley.edu/admissions/steps-to-apply/).

## Admission Requirements

The minimum graduate admission requirements are:

1. A bachelor's degree or recognized equivalent from an accredited institution;
2. A satisfactory scholastic average, usually a minimum grade-point average (GPA) of 3.0 (B) on a 4.0 scale; and
3. Enough undergraduate training to do graduate work in your chosen field.

For a list of requirements to complete your graduate application, please see the Graduate Division's Admissions Requirements page (https://grad.berkeley.edu/admissions/steps-to-apply/requirements/). It is also important to check with the program or department of interest, as they may have additional requirements specific to their program of study and degree. Department contact information can be found here (https://guide.berkeley.edu/graduate/degree-programs/).

## Where to apply?

Visit the Berkeley Graduate Division application page (http://grad.berkeley.edu/admissions/apply/).

## Unit Requirements

Candidates for this degree are expected to complete 48 units, in four semesters.

**New MA Students should take the following courses (for a letter-grade):**

| | | |
|---|---|---|
| STAT 201A | Introduction to Probability at an Advanced Level | 4 |
| STAT 201B | Introduction to Statistics at an Advanced Level | 4 |
| PB HLTH C240A | Introduction to Modern Biostatistical Theory and Practice | 4 |
| PB HLTH W200 | Course Not Available (Required for students beginning their MA program in Fall 2023 unless they have a previous Master's (MA, MS, MPH) or Doctoral (DrPH or PhD) from an accredited School of Public Health. Recommended for continuing students. ) | 1 |

**Additionally, students should take the following courses:**

| | | |
|---|---|---|
| PB HLTH 252D | Introduction to Causal Inference | 4 |
| PB HLTH W252 | Course Not Available [4] (Students have the option to take 252D or W252A. ) | |

**Choose at least two of the following courses:**

| | | |
|---|---|---|
| PB HLTH C240 | Biostatistical Methods: Survival Analysis and Causality [4] | |
| PB HLTH C240 | Machine Learning and Biostatistics in Healthcare [4] | |
| PB HLTH C240F | Statistical Genomics | 4 |
| PB HLTH C242 | Longitudinal Data Analysis [4] | |
| PB HLTH 244 | Big Data: A Public Health Perspective [3] | |
| PB HLTH 243A | Targeted Learning | 4 |
| PB HLTH 243B | Targeted Learning in Practice | 2-3 |

**For 2-year + students opting for a thesis:**

| | | |
|---|---|---|
| PB HLTH 252E | Advanced Topics in Causal Inference [4] | |
| PB HLTH 292 | Seminars for M.P.H. Students [2] (7: Biostat MA Spring Seminar, S/U grading Basis) | |

## MA Comprehensive Examination

The examination for the MA degree is designed to test a candidate's breadth and depth of understanding and knowledge and the ability to articulate and explain the basic concepts gained from the curriculum. The examination committee consists of two faculty members representing both biostatistics and statistics. Candidates are asked to select three topics and write a description of each. Topics are presented during the exam period of 90 minutes. Examiners are free to ask for clarification or elaboration through requests for more background, detail or examples.

## MA Thesis

Note that the decision to submit a thesis rather than take the oral comprehensive examination must be made early in the final semester of the program.

## Normative Time Requirements

Since there are no unit or course requirements for the PhD, a program of courses appropriate to a student's background and interests may be developed.

All students in the Biostatistics PhD program hold a master's degree in Biostatistics or a related field and those applying for PhD study who do not already hold a masters degree are considered for admission to the Biostatistics MA. This practice does not prolong the time to the doctorate since the first two years of both the MA and PhD programs for students coming from the baccalaureate are identical.

Normative time to advancement: 2-3 years.
Normative time in candidacy: 1-2 years.
**Total normative time: 3-5 years.**

## Time to Advancement

### Curriculum

| | | |
|---|---|---|
| PB HLTH W200 | Course Not Available (Required for students who do not have a Master's (MA, MS, MPH) or Doctoral (PhD, DrPH) degree from an accredited School of Public Health. ) | 1 |
| STAT 210A | Theoretical Statistics | 4 |

| | | |
|---|---|---|
| STAT 210B | Theoretical Statistics [4] (Students take either STAT 210A or B; if they have already completed this course or an equivalent, please work with your faculty advisor to identify an alternative.) | |
| PB HLTH C240A | Introduction to Modern Biostatistical Theory and Practice | 4 |
| PB HLTH C240B | Biostatistical Methods: Survival Analysis and Causality [4] (Students take C240A or C240B; if both classes were completed as a Master's student, students work with their faculty advisors to identify an alternative.) | |
| PB HLTH 252D | Introduction to Causal Inference | 4 |
| PB HLTH W252A | Course Not Available [4] | |
| PB HLTH 252E | Advanced Topics in Causal Inference [4] (Students are required to take one class in the causal inference series (252D, W252A, 252E); if all of these courses were taken as a Master's student, students work their faculty advisor to identify an alternative.) | |
| Graduate Statistics Electives: 4-6 semesters, students work with their faculty advisor to determine an approved study list based on their research interests and background | | |
| Graduate Biostatistics Electives: 4-6 semesters, students work with their faculty advisor to determine an approved study list based on their research interests and background | | |
| Graduate Electives in another approved subject area (e.g., biology, environmental health, epidemiology): 4-6 semesters, students work with their faculty advisor to determine an approved study list based on their research interests and background | | |

## The Qualifying Examination

The oral qualifying examination is scheduled for three hours. The primary purpose of the exam is to test both a candidate's general competence in the field of biostatistics and the ability to apply biostatistical methods to a broad research area. The exam is designed to measure the candidate's breadth of knowledge as well as provide a determination of the candidate's readiness to enter the research phase of study.

To assure the examining committee that the candidate has a firm grasp of both basic areas and a familiarity with current problems in the field, the exam is conducted as follows:

1. The candidate is expected to begin with a 30 minute presentation of a proposed dissertation topic that includes a sound research strategy that the candidate can defend.
2. Following this presentation, the candidate will be asked to demonstrate an ability to synthesize the methods and techniques learned through course work and to apply this knowledge to areas and problems suggested by the committee members. To achieve this goal, committee members are likely to ask questions that delve into subjects that go beyond the chosen area of dissertation research.

Students are encouraged to take the qualifying exam *after they have identified a dissertation adviser and a research topic*. In preparation for the exam, the candidate should meet with the chair of the qualifying examination committee to discuss the details of the structure of the exam and any other pertinent issues.

# Time in Candidacy

## Dissertation

After completion of course work and the oral comprehensive examination, a doctoral student advances to candidacy for the PhD. Before this is possible, a student must have identified:

1. A dissertation topic
2. A dissertation adviser
3. A committee

Advisers and committee members are particularly interested in working with candidates who have demonstrated an ability to perform original research, and doctoral students are encouraged to explore dissertation research topics early in the program. Topics for research are selected from biostatistics and statistics, public health, biology, computing and other areas (see dissertation topics (https://www.stat.berkeley.edu/biostat/degrees/dissertation.htm) of some recent graduates).