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.

Master of Arts/Doctor of Philosophy (MA/PhD)

Students who ultimately want to earn the Biostatistics PhD but do not already hold a master's degree (only in rare circumstances are applicants coming from the baccalaureate program admitted straight into the PhD program) should apply to the MA/PhD program. Rather than passing a formal qualifying exam, MA students interested in continuing into the UC Berkeley Biostatistics doctoral program immediately following their MA degree apply to the new degree program during the first semester of their second year. This does not prolong the time to the doctorate since the coursework completed in the first two years is the same for the Biostatistics MA and PhD degrees.

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.

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

Minimum Requirements for Admission

The following minimum requirements apply to all graduate programs and will be verified by the Graduate Division:

1. A bachelor's degree or recognized equivalent from an accredited institution;
2. A grade point average of B or better (3.0);
3. If the applicant has completed a basic degree from a country or political entity (e.g., Quebec) where English is not the official language, adequate proficiency in English to do graduate work, as evidenced by a TOEFL score of at least 90 on the iBT test, 570 on the paper-and-pencil test, or an IELTS Band score of at least 7 on a 9-point scale (note that individual programs may set higher levels for any of these); and
4. Sufficient undergraduate training to do graduate work in the given field.

Applicants Who Already Hold a Graduate Degree

The Graduate Council views academic degrees not as vocational training certificates, but as evidence of broad training in research methods, independent study, and articulation of learning. Therefore, applicants who already have academic graduate degrees should be able to pursue new subject matter at an advanced level without the need to enroll in a related or similar graduate program.

Programs may consider students for an additional academic master's or professional master's degree only if the additional degree is in a distinctly different field.

Applicants admitted to a doctoral program that requires a master's degree to be earned at Berkeley as a prerequisite (even though the applicant already has a master's degree from another institution in the same or a closely allied field of study) will be permitted to undertake the second master's degree, despite the overlap in field.

The Graduate Division will admit students for a second doctoral degree only if they meet the following guidelines:

1. Applicants with doctoral degrees may be admitted for an additional doctoral degree only if that degree program is in a general area of knowledge distinctly different from the field in which they earned their original degree. For example, a physics PhD could be admitted to a doctoral degree program in music or history; however, a student with a doctoral degree in mathematics would not be permitted to add a PhD in statistics.
2. Applicants who hold the PhD degree may be admitted to a professional doctorate or professional master's degree program if there is no duplication of training involved.

Applicants may apply only to one single degree program or one concurrent degree program per admission cycle.

Required Documents for Applications

1. **Transcripts:** Applicants may upload *unofficial* transcripts with your application for the departmental initial review. Unofficial transcripts must contain specific information including the name of the applicant, name of the school, all courses, grades, units, & degree conferral (if applicable).
2. **Letters of recommendation:** Applicants may request online letters of recommendation through the online application system. Hard copies of recommendation letters must be sent directly to the program, by the recommender, not the Graduate Admissions.
3. **Evidence of English language proficiency:** All applicants who have completed a basic degree from a country or political entity in which the official language is not English are required to submit official evidence of English language proficiency. This applies to institutions from Bangladesh, Burma, Nepal, India, Pakistan, Latin America, the Middle East, the People's Republic of China, Taiwan, Japan, Korea, Southeast Asia, most European countries, and Quebec (Canada). However, applicants who, at the time of application, have already completed at least one year of full-time academic course work with grades of B or better at a US university may submit an official transcript from the US university to fulfill this requirement. The following courses will not fulfill this requirement:
    - courses in English as a Second Language,
    - courses conducted in a language other than English,
    - courses that will be completed after the application is submitted, and
    - courses of a non-academic nature.

Applicants who have previously applied to Berkeley must also submit new test scores that meet the current minimum requirement from one of the standardized tests. Official TOEFL score reports must be sent directly from Educational Test Services (ETS). The institution code for Berkeley is 4833 for Graduate Organizations. Official IELTS score reports must be sent electronically from the testing center to University of California, Berkeley, Graduate Division, Sproul Hall, Rm 318 MC 5900, Berkeley, CA 94720. TOEFL and IELTS score reports are only valid for two years prior to beginning the graduate program at UC Berkeley. Note: score reports can not expire before the month of June.

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

Additionally, students should take the following courses:

PB HLTH 252D	Introduction to Causal Inference	4
Choose at least two of the following courses:		
PB HLTH C240A	Introduction to Modern Biostatistical Theory and Practice [4]	
COMPSCI 294	Special Topics [1-4] (Section 150: Machine Learning and Statistics Meet Biology)	
PB HLTH C240B	Biostatistical Methods: Survival Analysis and Causality [4]	
PB HLTH C240	Biostatistical Methods: Computational Statistics with Applications in Biology and Medicine [4]	
PB HLTH C242	Longitudinal Data Analysis [4]	
PB HLTH 244	Big Data: A Public Health Perspective [3]	
PB HLTH 252E	Advanced Topics in Causal Inference [4]	
PB HLTH 290	Health Issues Seminars [1-4] (X: Targeted Learning in Biomedical Big Data)	
For 2-year + students opting for a thesis:		
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

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 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 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
Also recommended:
Biostatistical Methods courses (PUB HLTH 240 series)
Intro to Advanced Probability & Statistics (STAT 200 series)

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).