

## **Doctor of Philosophy in Biostatistics**

Program Director: Somnath Datta, Ph.D.  
Emphasis Coordinators: Susmita Datta, Ph.D.                      Bioinformatics  
   Steven J. McCabe, M.D., M.Sc.      Decision Science  
Administrative Assistant: Lynne Dosker  
Website: <http://louisville.edu/sphis/bb/academics>

### *Introduction*

Biostatistics involves the development and application of statistical techniques to scientific research in health-related fields, including medicine, epidemiology, and public health. Students in the Ph.D. program receive state-of-the-art training in the latest statistical methodology in order to tackle the challenges associated with the study design and data analysis of modern research conducted in the health sciences. The Ph.D. program provides advanced training in biostatistical theory and methods, with the goal of enabling the student to carry out original research. In addition, students may elect to train with an emphasis on decision science or on bioinformatics.

Biostatistics involves the development and application of statistical methods in research in health-related fields, including public health, medicine, dentistry, and nursing. This program is designed to train students in biostatistics for carrying our research in biomedical fields and in statistical methods used in biomedical research.

Decision science, or formal decision analysis, is an emerging, cutting edge discipline that provides researchers with additional tools with which to develop the clinical and health-care policies and guidelines that affect public health. The decision science emphasis goes beyond traditional decision science programs by providing a mathematically rigorous, interdisciplinary approach to decision-making that is capable of adapting to the ever-changing health care environment. The decision science emphasis provides advanced training in the theory and methods of formal decision analysis, with the goal of enabling students to carry out original research. The focus of is on training a well-qualified biostatistician to work within the specialized field of decision science.

Bioinformatics requires the development and application of statistical methods for many of the areas covered by the field, including genomics, proteomics, statistical genetics, and metabolomics. Current biomedical research technologies generate high volumes of data that require extension of existing statistical methodologies and development of new methodologies in order to extract important information regarding biological processes. The emphasis on bioinformatics is designed to fulfill the expanding need for biostatisticians with advanced training in this area. Students in the bioinformatics emphasis gain a basic understanding of molecular and cellular biology, genetics, and

bioinformatics and an in-depth knowledge of statistical theory and methods. Graduates are able to carry out original statistical research in genomics, proteomics, metabolomics, and evolving areas of systems biology.

Students who complete the M.S. program in biostatistics with the Department of Bioinformatics and Biostatistics or who already possess the equivalent of an M.S. in statistics, biostatistics, decision science, or a related discipline may apply for admission to the Ph.D. program.

The Ph.D. program in biostatistics is located in the Department of Bioinformatics and Biostatistics.

### **Program of Study**

Upon admission to the Ph.D. program, a program of study is developed for each student by the faculty advisor and approved by the program director and department chair. Students who did not complete the M.S. program in biostatistics with the Department of Bioinformatics and Biostatistics may be required to complete additional coursework normally offered in the M.S. program. Decisions regarding additional coursework are made by the student's assigned faculty advisor and such courses become part of the program of study. This approach gives maximum flexibility for addressing differing student qualifications and interests.

### **Curriculum and Degree Requirements**

The Ph.D. program in biostatistics is a 34 credit-hour program (minimum beyond a master's degree) including the dissertation. Additional hours may be needed for completion of the program.

Completion of the coursework is the prelude to sitting for the comprehensive examination. Successful completion of the comprehensive examination allows the student to enter doctoral candidacy. A doctoral candidate must then develop and successfully defend a dissertation proposal that describes an original and independent research project. Upon successful defense of the proposal, a student may then proceed to continue dissertation research. Upon successful completion of the research, defense of the dissertation, and demonstration of the required competencies listed below, a student is awarded the Ph.D. degree.

#### Coursework

34 total credit-hours

25 credit-hours of required coursework

9 credit-hours of elective courses

<b>Required Coursework</b>				
<b>Emphasis (if any)</b>	<b>Course #</b>	<b>Course Title</b>	<b>Credit- Hours</b>	
All	PHST-710	Advanced Statistical Computing I	3	
	PHST-762	Advanced Statistical Inference	3	
	PHST-781	Advanced Linear Models	3	
	various	Electives	9	
	PHST-703	Doctoral Practicum in Consulting	1	
	Subtotal			19
No emphasis	PHST-691	Bayesian Statistics	3	
	PHST-724	Advanced Clinical Trials	3	
	PHST-780	Advanced Nonparametrics	3	
	PHST-782	Generalized Linear Models	3	
	PHST-783	Advanced Survival Analysis	3	
	Subtotal			15
Emphasis on decision science	PHDA-690	Utility Theory and Assessment	3	
	PHST-691	Bayesian Statistics	3	
	PHDA-701	Advanced Medical Decision Making	3	
	PHDA-663	Decision Analysis	3	
	PHDA-705	Statistical Methods for Cost-Effectiveness Analysis	3	
	Subtotal			15
Emphasis on bioinformatics	PHBI-751	High-Throughput Data Analysis	3	
	CECS-660	Introduction to Bioinformatics	3	
	BIOC-545	Advanced Biochemistry I	3	
	-OR- MBIO-667	Graduate Cell Biology	3	
	PHBI-750	Statistics for Bioinformatics	3	
	PHBI-752	Statistical Genetics	3	
	Subtotal			15
	Degree Total			34

The student may be required to take one or more prerequisite courses for a required course if the student does not meet the prerequisites. These prerequisite courses become part of the program of study but are in addition to the number of coursework credit-hours presented above.

### Electives

The student must take electives from the following list. The student's program of study specifies the particular courses to be taken.

<b>Electives</b>					
<b>Emphasis *</b>			<b>Course #</b>	<b>Course Title</b>	<b>Credit- Hours</b>
<b>--</b>	<b>D</b>	<b>B</b>			
x	x		PHBI-750	Statistics for Bioinformatics	3
x	x		PHBI-751	High-Throughput Data Analysis	3
x	x	x	PHST-682	Multivariate Analysis	3
x	x	x	PHST-711	Advanced Statistical Computing II	3
x	x	x	PHST-725	Design of Experiments	3
x	x	x	PHST-785	Nonlinear Regression	3
x	x	x	PHST-675	Independent Study in Biostatistics	1-3
x	x		PHBI-752	Statistical Genetics	3
x			PHDA-705	Statistical Methods for Cost-Effectiveness Analysis	3
	x		PHST-724	Advanced Clinical Trials	3
	x	x	PHST-782	Generalized Linear Models	3
		x	PHST-691	Bayesian Statistics	3
		x	PHST-780	Advanced Nonparametrics	3
x	x	x	PHST-704	Mixed Effect Models and Longitudinal Data Analysis	3
		x	CECS-632	Data Mining	3

\*Key for emphasis: -- = no emphasis  
D = emphasis on decision science  
B = emphasis on bioinformatics

The student may be required to take one or more prerequisite courses for an elective course if the student does not meet the prerequisites. These prerequisite courses become part of the program of study but are in addition to the number of coursework credit-hours presented above.

### Comprehensive Examination

Upon completion of the required coursework for the Ph.D. degree, a student is eligible to sit for the doctoral comprehensive examinations. Each student must take two exams.

- Exam 1 covers the following topics:
  - Statistical inference
  - Linear models

- Exam 2 covers the following topics, depending on the student's emphasis, if any:
  - No emphasis
    - Student choice of any two of the following:
      - Statistical computing
      - Clinical trials
      - Generalized linear models
      - Survival analysis
  - Emphasis on decision Science
    - Utility theory, assessment, and medical decision making
    - Student choice of one of the following:
      - Bayesian analysis
      - Cost-effectiveness analysis
  - Emphasis on bioinformatics
    - Statistical methods in bioinformatics (including high-throughput methods) and statistical genetics
    - Student choice of one of the following:
      - Bayesian analysis
      - Statistical computing

### Dissertation

In order to complete the degree, a candidate must submit and successfully defend a dissertation on a topic approved by his or her major professor and the dissertation committee. Dissertation work may be started following successful completion of doctoral comprehensive examinations.

### *Dissertation Committee*

The dissertation committee is formed by the candidate's proposing a major professor (or principal advisor) and at least four other committee members. One member of the dissertation committee must be external to the Department of Bioinformatics and Biostatistics. The committee is appointed by the dean of the school upon the recommendation of the program director and chair of the department.

### *Dissertation Proposal (Pre-Dissertation Essay)*

A dissertation proposal or pre-dissertation essay is submitted to the major professor and the dissertation committee. The proposal must be approved by a majority vote of the dissertation committee before the candidate undertakes further work on the dissertation.

The dissertation proposal is a typed document not exceeding 25 pages in length excluding topics (v) to (viii), below. The following formatting is used: Times New Roman 12-point font, margins of 1 inch on all sides and 1.5-line spacing throughout the

body of the document. The Graduate School dissertation guidelines for citing references must be followed. The document is divided into the following sections and in the following sequence:

- (i) Introduction and Literature Reviews – general introduction to the area of proposed research and relevant literature reviews
- (ii) Specific Aims and Significance – short section describing the specific aims of the proposed research and their potential importance in the field
- (iii) Preliminary Results – summary of the research findings the student already has (e.g., simulation results) towards one or more of the specific aims. This is an important component of the proposal that demonstrates the feasibility of the proposed research by the student.
- (iv) Research Plan – detailed description of the research towards the specific aims to be undertaken during the rest of the doctoral study period
- (v) References – complete references to all the cited literature. Journal names should not be abbreviated
- (vi) Tables – including table headings
- (vii) Figures – one figure per page
- (viii) Appendix – copies (in PDF format) of published articles and preprints that are most relevant to the proposed research

### *Dissertation Preparation*

The dissertation is to be prepared in format and binding according to the guidelines established by the School of Interdisciplinary and Graduate Studies.

### *Dissertation Approval*

The dissertation is submitted in completed form to the dissertation committee at least thirty days before the end of the term in which the candidate expects to be graduated. A candidate is not eligible for the final oral examination until the dissertation has been accepted by the committee.

The dissertation committee schedules an oral examination of the candidate. All faculty and students of the school are invited to attend the presentation portion. The defense is scheduled at the convenience of the members of the dissertation committee. The dissertation must be approved by the full committee.

### *Dissertation Distribution*

One unbound copy of the dissertation, signed by the dissertation committee members, must be deposited with the School of Interdisciplinary and Graduate Studies before graduation. A copy of the final, signed dissertation must also be deposited with the department office.

