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OFFICE OF THE PRESIDENT

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November 14, 2024

Dr. Sanjay Rai
Secretary
Maryland Higher Education Commission
6 N. Liberty Street
Baltimore, MD 21201

Dear Secretary Rai:

I am writing to request approval for a new Ph.D. program in Biostatistics. The proposal for the new program is attached. I am also submitting this proposal to the University System of Maryland for approval.

The proposal was endorsed by the appropriate faculty and administrative committees. I also endorse this proposal and am pleased to submit it for your review and approval.

Sincerely,

Darryll J. Pines
President
Glenn L. Martin Professor of Aerospace Engineering

DJP/mdc

cc: Candace Caraco, Associate Vice Chancellor
Jennifer King Rice, Senior Vice President and Provost
Boris Lushniak, Dean, School of Public Health

Office Use Only: PP#

Cover Sheet for In-State Institutions
New Program or Substantial Modification to Existing Program

Institution Submitting Proposal	University of Maryland, College Park

Each action below requires a separate proposal and cover sheet.

- (●) New Academic Program
- ( ) New Area of Concentration
- ( ) New Degree Level Approval
- ( ) New Stand-Alone Certificate
- ( ) Off Campus Program
- ( ) Substantial Change to a Degree Program
- ( ) Substantial Change to an Area of Concentration
- ( ) Substantial Change to a Certificate Program
- ( ) Cooperative Degree Program
- ( ) Offer Program at Regional Higher Education Center

Payment Submitted: (●) Yes ( ) No

Payment Type: (●) R*STARS # JJ513070 ( ) Check # JJ513070

Payment Amount: 850

Date Submitted: 12/19/202

Department Proposing Program	Epidemiology and Biostatistics	
Degree Level and Degree Type	Doctoral; Ph.D.	
Title of Proposed Program	Biostatistics	
Total Number of Credits	48	
Suggested Codes	HEGIS: 041901	CIP: 26.1102
Program Modality	(●) On-campus ( ) Distance Education (fully online) ( ) Both	
Program Resources	(●) Using Existing Resources ( ) Requiring New Resources	
Projected Implementation Date (must be 60 days from proposal submisison as per COMAR 13B.02.03.03)	(●) Fall ( ) Spring ( ) Summer	Year: 2025
Provide Link to Most Recent Academic Catalog	URL: https://academiccatalog.umd.edu/	
Preferred Contact for this Proposal	Name: Michael Colson	
	Title: Senior Coordinator for Academic Programs	
	Phone: (301) 405-5626	
	Email: mcolson@umd.edu	
President/Chief Executive	Type Name: Darryll J. Pines	
	Signature: Darryll J. Pines	Date: 11/14/2024
	Date of Approval/Endorsement by Governing Board:	

Revised 1/2021

A. Centrality to the University's Mission and Planning Priorities

Description. The University of Maryland, College Park (UMD) proposes a Doctor of Philosophy (PhD) in Biostatistics. Biostatistics, one of the core disciplines in public health, teaches students analytical methods for collecting, analyzing, and interpreting scientific data collected in public health and medical research. This new doctoral program will address critical needs in public health, biomedical research, and policy analysis through advanced statistical training. This program will be offered by the Department of Epidemiology and Biostatistics in the School of Public Health and will prepare students for leadership roles as biostatisticians, researchers, and educators. The program will emphasize research excellence, innovation in statistical methodologies, and interdisciplinary collaboration, equipping graduates to address complex health challenges locally and globally.

Relation to Strategic Goals. The PhD in Biostatistics strongly aligns with UMD's mission, which seeks to achieve "excellence in teaching, research, and public service within a supportive, respectful and inclusive environment" and to address "the most pressing global challenges" through scholarship and research. The biostatistics program aims to produce experts capable of innovative research that will enhance public health and scientific discovery, advancing UMD's mission to foster impactful research and cultivate a workforce equipped to support Maryland's diverse communities. Biostatistics is also a foundational area of public health training. As such, there is a growing need for academics to train the next generation of public health professionals and scholars.

Funding. Graduate level coursework in Biostatistics is already offered at the university. The Department of Epidemiology and Biostatistics offers a Master of Public Health (MPH) concentration in Biostatistics and offers biostatistics courses to graduate students in other programs. The size of the program will be small at approximately 5 students. Consequently, the department currently has the resources to offer the program.

Institutional Commitment. The instructional and administrative infrastructure already exists for this program as the department offers the MPH concentration in Biostatistics and a PhD in Epidemiology. Most top tier Schools of Public Health have a doctoral program in biostatistics, and the lack of a doctoral program in this area negatively impacts the department's ability to attract top-tier faculty, secure large federal training grants, and improve its national ranking. External reviewers invited for the 2023 departmental self-study strongly recommended that the department establish a doctoral program in biostatistics to remain competitive with peer schools of public health. Because of the available capacity of the department and the need to strengthen the department, UMD strongly supports this proposal.

B. Critical and Compelling Regional or Statewide Need as Identified in the State Plan

Need. Nationally, the growing volume of complex health-related data generated by advances in technology has created a demand for highly trained biostatisticians. Biostatisticians often serve

a critical role for other scientists in providing data analyses of medical and public health data. The state of Maryland in particular has a need for highly skilled biostatisticians that is increasing due to its status as a national hub for health research, with agencies like NIH, FDA, and CDC branches based locally.

State Plan. The proposed program aligns broadly with the 2022 *Maryland State Plan for Postsecondary Education*, specifically Priority 5, "Maintain the commitment to high-quality postsecondary education in Maryland," in particular, the Action Item to "Identify innovative fields of study." The program will foster a culture of innovation by integrating emerging methodologies in statistical analysis and applying them to real-world public health issues. Students will gain skills in innovative fields such as machine learning, big data analytics, and computational biology, which are increasingly essential in biostatistics.

C. Quantifiable and Reliable Evidence and Documentation of Market Supply and Demand in the Region and State

Biostatisticians are among the fastest growing jobs according to the US Bureau of Labor Statistics. During the next decade, an average of 10,600 biostatistician openings are projected annually. These rapid rates of job growth, which are significantly faster than average for all occupations, are due to retiring of a large proportion of current biostatisticians as well as changes in the public health work force after COVID-19 pandemic. These national trends[1] highlight the urgency needed to train biostatisticians to work at state and local governmental public health agencies. The current workforce shrinkage "has the potential to jeopardize the safety, security, and economic prosperity of the US" (p.346).[2]

D. Reasonableness of Program Duplication

Johns Hopkins University (JHU) is the only institution in the state offering a doctoral program in Biostatistics. Due to the unique nature of PhD programs, each program often differs significantly, largely influenced by the specific research expertise and interests of its faculty. Much of the doctoral work is conducted in close collaboration with a faculty mentor, allowing students to engage deeply in their chosen research area. As such, the proposed PhD in Biostatistics will differ from JHU's significantly larger biostatistics program by focusing on topics such as electronic health records, national surveys, social media, imaging genetic, multi-omics and microbiome research in addition to the classical Biostatistics research in survival and longitudinal data. Our program will maintain close relationships with nearby federal institutions (NIH, FDA, USDA, CDC's National Center for Health Statistics) as well as UMD's newly established Institute for Health Computing. We anticipate enrolling five students in this

[1] Robins M, Leider JP, Schaffer K, Gambatese M, Allen E, Hare Bork R. PH WINS 2021 methodology report. J Public Health Manag Pract. 2023;29(Suppl 1):S35–44.
[2] Leider JP, Castrucci BC, Robins M, Hare Bork R, Fraser MR, Savoia E, Piltch-Loeb R, Koh HK. The Exodus Of State And Local Public Health Employees: Separations Started Before And Continued Throughout COVID-19. Health Aff (Millwood). 2023 Mar;42(3):338-348.

program at steady state, and therefore do not think this will have adverse impact on the Hopkins program given the need for experts in biostatistics.

E. Relevance to High-demand Programs at Historically Black Institutions (HBIs)

As indicated above, only Johns Hopkins has a doctoral program in Biostatistics. Consequently, we do not believe that this will have an impact on a Historically Black Institution.

F. Relevance to the identity of Historically Black Institutions (HBIs)

We do not anticipate any negative impacts on the special identities of the HBIs in the state of Maryland. As mentioned above, there are no similar programs at Historically Black Institutions. UMD's School of Public Health has an establish department in Epidemiology and Biostatistics and Master of Public Health concentration in Biostatistics. Consequently, we do not believe this program will negatively impact the identity of a Historically Black Institution.

G. Adequacy of Curriculum Design, Program Modality, and Related Learning Outcomes

Curricular Development. The proposed program aims to fill a critical gap identified through an external review of the Epidemiology and Biostatistics department, which noted the need for advanced training in this core public health discipline. The curriculum emphasizes applied statistics in public health and medicine, including courses in data science and health data analytics, and offers interdisciplinary electives, ensuring graduates are well-prepared to tackle complex public health challenges.

Faculty Oversight. The PhD in Biostatistics program will be led by the Department of Epidemiology and Biostatistics within the School of Public Health. Appendix A includes a list of faculty that will be teaching in the program.

Educational Objectives and Learning Outcomes. The primary educational objective of the program is to train the next generation of scholars in biostatistics and health data science with enhanced public health data analysis skills necessary for future careers in academia, industry, government and other health related professional organizations. The learning outcomes for the program are as follows:

1. Understand theoretical foundations of biostatistical methods.
2. Critically review scientific literature and evaluate appropriateness of the statistical methods and applications.
3. Conduct advanced statistical inferences that are appropriate to specific study designs and data structures.
4. Develop novel statistical methodology applicable to public health and biomedical research.
5. Demonstrate skills in public health data management.

6. Effectively communicate results of statistical analyses to lay and professional audiences.
7. Develop methodological manuscripts for publication in peer-reviewed statistical or biostatistical journals.
8. Prepare written reports of statistical analyses for journal publication, grant applications, and review by regulatory agencies.

Institutional assessment and documentation of learning outcomes. Please see Appendix B for information about assessing the program's learning outcomes.

Course requirements. Some students will be entering the program already having earned a relevant master's degree, such as an MPH with biostatistics concentration or an MS in Biostatistics. Some students, however, will enter the program not having that advanced training. Consequently, the program offers two pathways depending on the student's prior qualifications:

- For students with a relevant master's degree (such as an MS or MPH in Biostatistics), the program requires 48 total credits, including 12 dissertation credits.
- For students without a relevant master's degree, the program requires 60 total credits, including 12 dissertation credits.

Below are the curricular requirements for both pathways:

For those entering with a relevant master's degree:

Core Courses (24 credits)		
Course Number	Course Title	Credits
EPIB652	Categorical Data Analysis	3
EPIB653	Applied Survival Data Analysis	3
EPIB655	Longitudinal Data Analysis	3
EPIB680	Linear Model	3
EPIB610	Foundations of Epidemiology	3
SPHL600	Foundations of Public Health	3
STAT700	Mathematical Statistics I	3
STAT701	Mathematical Statistics II	3
Elective Courses (12 credits from the choices below)		
EPIB611	Intermediate Epidemiology	3
EPIB612	Epidemiologic Study Design	3
EPIB633	Health Survey Design and Analysis	3
EPIB635	Applied Multilevel Modeling in Health Research	3
EPIB654	Clinical Trials: Design and Analysis	3
EPIB656	Applied Bayesian Data Analysis	3
EPIB657	Spatial Statistics for Public Health Data	3

EPIB660	Analysis of National Health Survey Data	3
EPIB661	Applied Multivariate Data Analysis	3
EPIB664	Missing Data Analysis	3
EPIB667	Applied Machine Learning with Python	3
EPIB681	Causal Inference	3
EPIB682	Statistical Learning for Health Data Analysis	3
EPIB683	High-throughput Data Analysis	3
EPIB684	Electronic Health Record Data Analysis	3
EPIB695	Introduction to R for Health Data Analysis	3
Dissertation Credits (12 credits)		
EPIB899	Doctoral Dissertation Research	

For those entering without a relevant master's degree:

Core Courses (33 credits)		
Course Number	Course Title	Credits
EPIB650	Biostatistics I	3
EPIB651	Applied Regression Analysis	3
EPIB652	Categorical Data Analysis	3
EPIB653	Applied Survival Data Analysis	3
EPIB655	Longitudinal Data Analysis	3
EPIB680	Linear Model	3
EPIB697	Public Health Data Management	3
EPIB610	Foundations of Epidemiology	3
SPHL600	Foundations of Public Health	3
STAT700	Mathematical Statistics I	3
STAT701	Mathematical Statistics II	3
Elective Courses (15 credits from the choices below)		
EPIB611	Intermediate Epidemiology	3
EPIB612	Epidemiologic Study Design	3
EPIB633	Health Survey Design and Analysis	3
EPIB635	Applied Multilevel Modeling in Health Research	3
EPIB654	Clinical Trials: Design and Analysis	3
EPIB656	Applied Bayesian Data Analysis	3
EPIB657	Spatial Statistics for Public Health Data	3
EPIB660	Analysis of National Health Survey Data	3
EPIB661	Applied Multivariate Data Analysis	3
EPIB664	Missing Data Analysis	3
EPIB667	Applied Machine Learning with Python	3
EPIB681	Causal Inference	3
EPIB682	Statistical Learning for Health Data Analysis	3
EPIB683	High-throughput Data Analysis	3

EPIB684	Electronic Health Record Data Analysis	3
EPIB695	Introduction to R for Health Data Analysis	3
Dissertation Credits (12 credits)		
EPIB899	Doctoral Dissertation Research	

A list of courses and descriptions is included in Appendix C

General Education. Not applicable for our graduate programs.

Accreditation or Certification Requirements. No accreditation or licensure is required for this program.

Other Institutions or Organizations. The offering unit is not planning to contract with another institution or non-collegiate organization for this program.

Student Support. The department already has the administrative infrastructure to provide student support as it already supports a doctoral program in epidemiology. Doctoral students within the department are officially assigned faculty advisors by the Director of Graduate Studies, based on matching research interest, and faculty's willingness to admit, mentor, and support a student for the duration of their doctoral studies. As such, advisors play a critical role in advising and supporting students in supplementing the curriculum through mentored research experiences.

Marketing and Admissions Information. Students will see admission criteria, financial aid resources, and costs on both the School of Public Health website and find additional information on the Graduate School website.

H. Adequacy of Articulation

Not applicable for this graduate program.

I. Adequacy of Faculty Resources

Program faculty. Appendix A contains a list of faculty members who will teach in the program. The Department of Epidemiology and Biostatistics has experienced faculty with extensive expertise in statistical methodology, public health, and epidemiology. These faculty members will support both instructional and dissertation advising needs.

Faculty training. Faculty teaching in the program will use the university's learning management system along with its extensive electronic resources. They will have access to instructional development opportunities available across the College Park campus, including those offered as part of the Teaching and Learning Transformation Center, many of which are delivered in a

virtual environment. Instructors will work with the learning design specialists on campus to incorporate best practices when teaching in the online environment.

J. Adequacy of Library Resources

The University of Maryland Libraries assessment concluded that the Libraries are able to meet, with current resources, the curricular and research needs of the program.

K. Adequacy of Physical Facilities, Infrastructure, and Instructional Resources

All physical facilities, infrastructure, and instructional equipment are already in place. The program will benefit from UMD's existing advanced research labs, data analysis centers, and public health facilities. These resources will enable students to gain hands-on experience with data analysis, computation, and research projects within the state-of-the-art facilities of the School of Public Health.

L. Adequacy of Financial Resources

Tables 1 and 2 contain the details of resources and expenditures.

Table 1 Resources:
The program will be supported through the reallocation of resources. The coursework, instruction, facilities and administrative support are already in place in the department as much of the coursework is already offered for existing programs and there is capacity to include the additional PhD students.

1. Line 1 shows the reallocated resources, essentially the existing capacity afforded by the department's current activities.
2. Graduate students will be paying tuition by the credit. Tuition revenue for this program is projected based on modest student enrollments and assumes a steady increase in the per-credit rate projected over five years.
3. No external sources of funding are assumed.
4. No other sources of funding are assumed.

Table 2 Expenditures:

1. Faculty salaries are based on cost per course. We assume an annual increase of 3% in salaries with a corresponding 33% benefits rate.
2. Administrative responsibilities (.1 FTE) will be provided by current departmental administrative staff.
3. Graduate assistant support for 2 FTE includes stipends, tuition remission and benefits with annual increase projected over five years.
4. Other expenditures include annual library support and operational expenses.

M. Adequacy of Program Evaluation

Formal program review is carried out according to the University of Maryland's policy for Periodic Review of Academic Units, which includes a review of the academic programs offered by, and the research and administration of, the academic unit (http://www.president.umd.edu/policies/2014-i-600a.html). Program Review is also monitored following the guidelines of the campus-wide cycle of Learning Outcomes Assessment (https://irpa.umd.edu/Assessment/loa_overview.html). Faculty within the department are reviewed according to the University's Policy on Periodic Evaluation of Faculty Performance (http://www.president.umd.edu/policies/2014-ii-120a.html). Since 2005, the University has used an online course feedback survey instrument for students that standardizes course feedback across campus. The course survey has standard, university-wide questions and allows for supplemental, specialized questions from the academic unit offering the course.

N. Consistency with Minority Student Achievement goals

Because Schools of Public Health traditionally focus upon the application of research, many first generation and/or diverse students gravitate toward this field, in which there exists a strong expectation that their careers will broadly impact population health both locally and abroad. This is evidenced by School of Public Health's rich tradition of retaining and graduating a diverse undergraduate student body. Currently, 27% of SPH students are Black and 17% are Hispanic, both significantly exceeding the University averages and directly contributing to the diversity goals defined within the University of Maryland and School of Public Health strategic plans.

The PhD in Biostatistics will prioritize inclusive recruitment and support for minority students, in line with Maryland's goals of equity and access in higher education.

O. Relationship to Low Productivity Programs Identified by the Commission

N/A

P. Adequacy of Distance Education Programs

While primarily on-campus, the program will offer select online courses, providing flexibility for students balancing professional commitments. The online components will adhere to quality standards, ensuring an engaging and rigorous learning experience for all participants.

Table 1: Resource Table

Resources Categories	Year 1	Year 2	Year 3	Year 4	Year 5
1.Reallocated Funds	104756	106906	109119	109415	109721
2. Tuition/Fee Revenue (c+g below)	55100	72871	75057	77309	79628
a. #FT Students	3	4	4	4	4
b. Annual Tuition/Fee Rate	15649	16119	16602	17100	17613
c. Annual FT Revenue (a x b)	46948	64475	66409	68401	70453
d. # PT Students	1	1	1	1	1
e. Credit Hour Rate	510	525	541	557	573
f. Annual Credit Hours	16	16	16	16	16
g. Total Part Time Revenue (d x e x f)	8152	8397	8648	8908	9175
3. Grants, Contracts, & Other External Sources	0	0	0	0	0
4. Other Sources	0	0	0	0	0
TOTAL (Add 1 - 4)	159856	179777	184177	186725	189349

Table 2: Expenditure Table

Expenditure Categories	Year 1	Year 2	Year 3	Year 4	Year 5
1. Faculty (b+c below)	39900	54796	56440	58133	59877
a. #FTE	0.3	0.4	0.4	0.4	0.4
b. Total Salary	30000	41200	42436	43709	45020
c. Total Benefits	9900	13596	14004	14424	14857
2. Admin. Staff (b+c below)	9310	9589	9877	10173	10478
a. #FTE	0.1	0.1	0.1	0.1	0.1
b. Total Salary	7000	7210	7426	7649	7879
c. Total Benefits	2310	2379	2451	2524	2600
3. Total Support Staff (b+c below)	0	0	0	0	0
a. #FTE	0	0	0	0	0
b. Total Salary	0	0	0	0	0
c. Total Benefits	0	0	0	0	0
4. Graduate Assistants (b+c)	95446	97316	99242	99242	99242
a. #FTE	2.0	2.0	2.0	2.0	2.0
b. Stipend	46862	48268	49716	49716	49716
c. Tuition Remission	33120	33120	33120	33120	33120
d. Benefits	15464	15928	16406	16406	16406
5. Equipment	0	0	0	0	0
6. Library	5000	5000	5000	5000	5000
7. New or Renovated Space	0	0	0	0	0
8. Other Expenses: Operational Expenses	5000	5000	5000	5000	5000
TOTAL (Add 1 - 8)	154656	171702	175559	177549	179598

Appendix A: Faculty Information- PhD in Biostatistics

The following faculty members are projected to teach in the program. All faculty are full-time unless otherwise indicated.

Name	Highest Degree Earned, Program, and Institution	University of Maryland, College Park Title (indicate if part-time)	Courses
Xin He	PhD, Statistics, University of Missouri	Associate Professor and Associate Chair	EPIB650, EPIB651, EPIB653, EPIB655
Mei-Ling Ting Lee	PhD, Mathematics/Statistics, University of Pittsburgh	Professor	EPIB651, EPIB653, EPIB654, EPIB788
Yan Li	PhD, Survey Methodology, University of Maryland	Professor	EPIB650, EPIB660
Menglu Liang	PhD, Biostatistics, Pennsylvania State University	Assistant Clinical Professor	EPIB650, EPIB651, EPIB697
Huang Lin	PhD, Biostatistics, University of Pittsburgh	Assistant Professor	EPIB650
Tianzhou Ma	PhD, Biostatistics, University of Pittsburgh	Assistant Professor	EPIB652, EPIB661, EPIB664
Jamie L. Trevitt	PhD, Public Health, Johns Hopkins University	Assistant Clinical Professor and Director of Graduate Studies	
Cher Dallal	PhD, Epidemiology, University of Pittsburgh	Associate Professor	EPIB611
Typhanye Vielka Dyer	PhD, Public Health, University of California Los Angeles	Associate Professor	EPIB788
Hongjie Liu	PhD, Epidemiology, University of California Los Angeles	Professor	EPIB612, EPIB740, EPIB788
Quynh Nguyen	PhD, Epidemiology, University of North Carolina	Associate Professor	EPIB633
Thu Nguyen	ScD, Social Epidemiology, Harvard University	Associate Professor	EPIB637, EPIB622
Amir Sapkota	PhD, Environmental Health Sciences,	Professor and Chair	EPIB788

	Johns Hopkins University		
Edmond Shenassa	ScD, Epidemiology and Maternal and Child Health, Harvard University	Professor	EPIB610, EPIB612
Shuo Chen	PhD, Biostatistics, Emory University	Professor (UMB Affiliated)	
Chixiang Chen	PhD, Biostatistics, Pennsylvania State University	Assistant Professor (UMB Affiliated)	
Yulei He	PhD, Biostatistics, University of Michigan	Adjunct faculty (NCHS/CDC Branch Chief)	EPIB56, EPIB664

Appendix B: Plan for Assessing Learning Outcomes: PhD in Biostatistics

Annual Progress Review Meeting

Annually and prior to May 1st, each student will be required to meet with their advisor and, if desired, the Biostatistics faculty, to report on their progress over the past year and to receive guidance for the upcoming academic year. Students must provide:

1. A completed Student Degree Progress Report, detailing their mastery of learning outcomes.
2. An unofficial transcript, submitted to faculty members at least five working days before the annual progress meeting.

During the meeting, the student presents a brief oral summary of the written assessment. Faculty and student will discuss strengths and weaknesses and collaboratively develop a plan to address any identified weaknesses. At the conclusion, faculty will evaluate the student's accomplishments to determine if they are making satisfactory progress towards the degree. If progress is unsatisfactory, the advisor will issue specific improvement guidelines, asking the student to prepare a timeline to return to satisfactory progress. Consecutive years of unsatisfactory progress may lead to termination. The Director of Graduate Studies must review the Progress to Degree Report, with copies provided to the student and kept on file by the department.

Program Milestones

Program of Study (Milestone 1)

The Program of Study is a formal plan that integrates courses, research, and experiences essential to scholarship. Approval of the Program of Study constitutes Milestone 1 in the Ph.D. program, listing the courses and research experiences required for the Ph.D. degree. Coursework and research plans are approved in a single committee meeting.

Comprehensive Exam (Milestone 2)

Completion of the Comprehensive Exam is a significant milestone, assessing the student's readiness for creative, independent research in biostatistics. Rather than retesting course content, the exam evaluates the ability to integrate learning outcomes and research skills. Students may take the Comprehensive Exam after completing all core courses and at least 70% of electives in their Program of Study, with advisor approval. Students entering with a Master's in Biostatistics may request to take the exam earlier, pending advisor approval. Success in the Comprehensive Exam qualifies the student to begin dissertation work.

Dissertation Proposal Defense/Advance to Candidacy (Milestone 3)

Following the Comprehensive Exam, the student prepares and defends their dissertation proposal. The dissertation must represent original research that extends knowledge in the field and align with the Program of Study. Upon faculty approval of the proposal, the student will formally defend it before their committee, advancing to candidacy upon success.

Dissertation Defense (Milestone 4)

Ph.D. candidates collaborate closely with their advisor to finalize their dissertation. The dissertation defense, an open meeting, primarily involves the oral examination of the dissertation by the committee, who may question the candidate on any aspect of their degree.

The oral defense meeting must be scheduled at least 10 working days in advance of the meeting with examining committee members. Again, 10 working days prior to the meeting, the student must give each member of the examining committee and the Director of Graduate Studies a finished copy of the thesis manuscript to review.

There are three possible outcomes at the oral defense: the thesis can be accepted as is, can be rejected, or can be accepted on the condition that certain changes are made within a specified time frame. Students must obtain final approval of their Thesis to complete the degree. When final approval is granted, the Thesis Examining Committee will sign and submit the "Report of Examining Committee" form to the Graduate School. After passing the oral defense, the student must submit an electronic copy of his/her thesis to the Graduate School (submit online at www.gradschool.umd.edu/etd/) and one hard copy to the EPIB Director of Graduate Studies.

Appendix C: Course Descriptions

Core Courses
(* Notes courses waived if student enters with relevant master's degree.)

EPIB610 Foundations of Epidemiology (3 Credits)
Introduction to the discipline of epidemiology and its applications to health issues and practices. Basic epidemiologic concepts and methods will be covered.

***EPIB650 Biostatistics I (3 Credits)**
Basic statistical concepts and procedures for Public Health. Focuses on applications, hands-on-experience, and interpretations of statistical findings.

***EPIB651 Applied Regression Analysis (3 Credits)**
An introduction to important statistical methods used in public health research, including nonparametric hypothesis testing, ANOVA, simple and multiple linear regression, logistic regression, and categorical data analysis.

EPIB652 Categorical Data Analysis (3 Credits)
Methods for analysis of categorical data as applied to public health research, including contingency tables, logistic regression, multicategory logic models, loglinear models, and models for matched-pairs.

EPIB653 Applied Survival Data Analysis (3 Credits)
Overview of statistical methods for analyzing censored survival data, including the Kaplan-Meier estimator, the log-rank test, Cox PH model.

EPIB655 Longitudinal Data Analysis (3 Credits)
Statistical models for drawing scientific inferences from longitudinal data, longitudinal study design, repeated measures and random effects to account for experimental designs that involve correlated responses, handling of missing data.

EPIB680 Linear Model (3 Credits)
This course covers the theory of linear models, including multivariate normal distribution, least squares estimation, Gauss-Markov theorem, generalized least squares, distribution theory, and model selection. More advanced topics in this course include generalized linear models, linear mixed effects models, and generalized linear mixed effects models.

***EPIB697 Public Health Data Management (3 Credits)**
This course is designed to provide students with the expertise needed to effectively manage research data using SAS as the statistical programming language.

SPHL600 Foundations of Public Health (3 Credits)
An overview of the goals, functions, and methods of public health. After an introduction to the

core concepts and tools used in public health research and practice, applications of these methodologies are considered in the context of current controversies/problems in public health. Students work together to develop strategies for prevention and control that taken into consideration different points of view, outside research, and impacts on individuals and communities.

STAT700 Mathematical Statistics I (3 Credits)
Sampling distributions including noncentral chi-squared, t, F. Exponential families, completeness. Sufficiency, factorization, likelihood ratio. Decision theory, Bayesian methods, minimax principle. Point estimation. Lehmann-Scheffe and Cramer-Rao theorems. Set estimation.

STAT701 Mathematical Statistics II (3 Credits)
Testing hypotheses: parametric methods. Neyman-Pearson lemma. Uniformly most powerful tests. Unbiased tests. Locally optimal tests. Large sample theory, asymptotically best procedures. Nonparametric methods, Wilcoxon, Fisher-Yates, median tests. Linear models, analysis of variance, regression and correlation. Sequential analysis.

Elective Courses

EPIB611 Intermediate Epidemiology
Analysis of epidemiologic methods as applied to epidemiologic research, analysis of bias, confounding, effect modification issues, overview of design, implementation, and analysis of epidemiologic studies.

EPIB612 Epidemiologic Study Design
Application of epidemiologic study designs, analytic methods used for analysis of cohort, case-control, cross-sectional, and clinical trials research.

EPIB633 Health Survey Design and Analysis
An overview of types of survey research designs, questionnaire design, measurement issues, and techniques for recruiting and interacting with participants. Students will discuss and implement a variety of health survey analysis techniques, including how to utilize SAS statistical software to estimate descriptive statistics and implement regression models, while accounting for complex survey designs.

EPIB635 Applied Multilevel Modeling in Health Research
Multilevel modeling is a popular analytic technique in health research that collects data from participants at hierarchic levels, e.g., residents nested in neighborhoods, and patients in hospitals. The course covers topics in multilevel modeling including two- and three-level multilevel linear modeling, logistic regression model, modeling with ordered and nominal outcomes, as well as strategies for model building. This course focuses on the application of multilevel modeling, rather than mathematics.

EPIB654 Clinical Trials: Design and Analysis
This course provides an introduction to the clinical trials design and data analysis. Topics covered include: history/background and process for clinical trial, key concepts for good statistics practice (GSP)/good clinical practice (GCP), regulatory requirement for pharmaceutical/clinical development, basic considerations for clinical trials, designs for clinical trials, classification of clinical trials, power analysis for sample size calculation for different designs, statistical analysis for efficacy evaluation, statistical analysis for safety assessment, implementation of a clinical protocol, statistical analysis plan, data safety monitoring, adaptive design methods in clinical trials (general concepts, group sequential design, dose finding design, and phase I/II or phase II/III design) and controversial issues in clinical trials.

EPIB656 Applied Bayesian Data Analysis
The theory and practical application of Bayesian statistical methods in the field of public health and related areas. A variety of models will be discussed including linear regression, multilevel model, generalized linear model, generalized linear mixed model.

EPIB657 Spatial Statistics for Public Health Data
Overview three main areas of spatial statistics: point patterns, geostatistical data, and lattice (areal) data. Application of spatial statistical models including CSR, k-function, krigging, semivariogram, CAR, SAR, GWR, spatial GLM, and multilevel model to public health and environmental data analysis.

EPIB660 Analysis of National Health Survey Data
Provides background on how features such as stratification, clustering, and unequal sample selection probabilities can invalidate the assumptions underlying traditional statistical techniques, those implicitly assuming a simple random sampling with replacement design. Application using the SURVEY family of SAS/STAT procedures (Version 9.4 or later).

EPIB661 Applied Multivariate Data Analysis
Multivariate analysis targets data with simultaneous measurements on many variables and studies the relationship between these variables. This course introduces important multivariate analysis methods used in public health research. Topics include multivariate regression analysis, multivariate analysis of variance (MANOVA), principal component analysis (PCA), factor analysis, discriminant analysis (classification), clustering analysis, canonical correlation analysis (CCA) and correspondence analysis (CA).

EPIB664 Missing Data Analysis
Missing data is a common problem in almost all scientific fields. Students will learn the different patterns and mechanisms of missing data, common procedures to handle missingness including weighting procedure, imputation-based procedure and model-based procedure. Useful and popular imputation methods and tools will be introduced. Numerous real data examples will be included to help students understand and solve the real world problem with missing data for different study designs.

EPIB667 Applied Machine Learning with Python
This graduate-level course in machine learning focuses on modern techniques for analyzing complex and massive public health data sets. Emphasis is placed on applications, computational methods, and the theoretical foundations of machine learning. Topics covered include unsupervised learning, supervised learning, and deep neural networks, among others.

EPIB681 Causal Inference
This course provides a rigorous statistical overview of causal inference at the graduate level. Students will learn to define causal effects, understand the assumptions necessary for data and model analysis, and implement popular statistical methods such as matching, instrumental variables, and inverse probability of treatment weighting. There will also be opportunities to apply these methods to example data in R.

EPIB682 Statistical Learning for Health Data Analysis
This course will introduce students to important statistical learning methods used in health data analysis. Topics covered will include regularization, dimension reduction, classification, clustering and neural network based methods. For each topic, emphasis will be placed on its application, the computational algorithm and the theory behind. Students will learn how to perform analyses using statistical learning methods and understand the results. Real healthcare data examples and programming codes will be provided for their applications.

EPIB683 High-throughput Data Analysis
High-throughput data refer to large-scale datasets generated using advanced technologies that allow the simultaneous measurement of thousands to millions of features, which are common in public health and biomedical research nowadays. Examples of high-throughput data include genetic, transcriptomic, microbiome and imaging data. These data are usually featured by their high-dimensionality and complexity. This course introduces important statistical and machine learning methods used to analyze high-throughput data. The first half of the course focuses on the methods, topics covered include dimension reduction, variable selection, classification, clustering, Bayesian hierarchical modeling, graphical modeling, meta-analysis and data integration methods. The second half of the course focuses on the application of these methods in real high-throughput data examples.

EPIB684 Electronic Health Record Data Analysis
This course will teach students how to use health data (e.g., electronic health records [EHR], discharge and service records, administrative claims) for epidemiologic and health services research. Students will learn about how each type of health data is generated, strengths and limitations of various health data sources, and coding nomenclature (e.g., ICD-10 CM diagnosis and procedure codes). Students will be given access to deidentified health data and asked to perform statistical analysis to answer research questions. Students will also learn about current hot topics in health data, including common data models, risk prediction and AI, and data linkage.

EPIB695 Introduction to R for Health Data Analysis
A hands-on introduction to the statistical package R for health data management and analysis. The first part of the course focuses on basic and essential data manipulation and visualization using R. The second part emphasizes the use of R in statistical analyses, including summarization, correlation, chi-squared test, t-tests, ANOVA, simple and multiple regression.

Dissertation Course

EPIB899 Doctoral Dissertation Research
Research for doctoral dissertation in epidemiology or biostatistics under the guidance of a faculty advisor.