



UNIVERSITY OF  
MARYLAND

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 Master of Science 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,

A handwritten signature in black ink that reads "Darryll J. Pines".

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



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

Institution Submitting Proposal	University of Maryland, College Park
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*Each action below requires a separate proposal and cover sheet.*

- |   |   |
|---|---|
| <input checked="" type="radio"/> New Academic Program | <input type="radio"/> Substantial Change to a Degree Program            |
| <input type="radio"/> New Area of Concentration       | <input type="radio"/> Substantial Change to an Area of Concentration    |
| <input type="radio"/> New Degree Level Approval       | <input type="radio"/> Substantial Change to a Certificate Program       |
| <input type="radio"/> New Stand-Alone Certificate     | <input type="radio"/> Cooperative Degree Program                        |
| <input type="radio"/> Off Campus Program              | <input type="radio"/> Offer Program at Regional Higher Education Center |

Payment <input checked="" type="radio"/> Yes	Payment <input checked="" type="radio"/> R*STARS # JJ513070	Payment	Date
Submitted: <input type="radio"/> No	Type: <input type="radio"/> Check # JJ513070	Amount: 850	Submitted: 12/19/2024

Department Proposing Program	Epidemiology and Biostatistics		
Degree Level and Degree Type	Master's; Master of Science		
Title of Proposed Program	Biostatistics		
Total Number of Credits	43		
Suggested Codes	HEGIS: 041902	CIP: 26.1102	
Program Modality	<input checked="" type="radio"/> On-campus <input type="radio"/> Distance Education (fully online) <input type="radio"/> Both		
Program Resources	<input checked="" type="radio"/> Using Existing Resources <input type="radio"/> Requiring New Resources		
Projected Implementation Date <small>(must be 60 days from proposal submission as per COMAR 13B.02.03.03)</small>	<input checked="" type="radio"/> Fall <input type="radio"/> Spring <input type="radio"/> Summer    Year: 2025		
Provide Link to Most Recent Academic Catalog	URL: <a href="https://academiccatalog.umd.edu/">https://academiccatalog.umd.edu/</a>		

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:	Date: 11/14/2024

	Date of Approval/Endorsement by Governing Board:
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## **A. Centrality to the University's Mission and Planning Priorities**

*Description.* The University of Maryland, College Park (UMD) proposes a Master of Science (MS) 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 master's 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 (EPIB) in the School of Public Health and will prepare students for leadership roles as biostatisticians, researchers, and educators. The department already offers a Master of Public Health (MPH) in Biostatistics; however, the proposed MS will focus on advanced biostatistical methodologies and public health data science for specialized careers and doctoral preparation, while the existing MPH in Biostatistics will continue to emphasize broader public health applications with a foundation in biostatistical training. The proposed MS program addresses the growing demand for biostatisticians resulting from the massive increase of health data and the need for experts who can analyze this data to inform public health decisions, and will also provide students who are unable to finish its counterpart Biostatistics Ph.D. program (proposed separately but concurrently with this proposal) with an opportunity to earn a graduate degree in biostatistics.

*Relation to Strategic Goals.* The MS 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.

*Funding.* Graduate level coursework in Biostatistics is already offered at the university. As mentioned above, the Department of Epidemiology and Biostatistics offers an MPH concentration in Biostatistics and offers biostatistics courses to graduate students in other programs. The size of the program will be small at approximately five to eight 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. As mentioned above, this proposal will accompany a proposal for a doctoral program in Biostatistics. 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. This was reflected in the final report from the external reviewers that was part of the 2023 departmental self-study. If the PhD program is approved, it will be important for the doctoral students who are not able to finish their PhD to have an opportunity to still

earn a master's degree if they have completed the required number of credits. Because of the availability capacity of the department to offer the program, and the need to have a master's program available for the PhD students, 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 the COVID-19 pandemic. These national trends<sup>1</sup> 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).<sup>2</sup>

## **D. Reasonableness of Program Duplication**

Johns Hopkins University is the only institution in the state offering an MS program in Biostatistics. As mentioned above, there is an increasing need for biostatisticians and the proposed program can help alleviate this workforce shortage. The proposed biostatistics programs will maintain close relationships with nearby federal institutions (NIH, FDA, USDA,

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<sup>1</sup> 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.

<sup>2</sup> 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.

CDC's National Center for Health Statistics) as well as UMD's newly established Institute for Health Computing. Senior investigators from these organizations will be invited to share their real-world experience with the students as a guest lecturer. In return, the guest lecturer will have an opportunity to recruit highly talented students to work with them as a part of the student's internship requirement or their MS thesis project. We anticipate enrolling five to eight students in this program at steady state, and therefore do not think this modest enrollment size will have an adverse impact on the Hopkins program.

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

As indicated above, only Johns Hopkins has a master's 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 established 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 MS 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 who 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, and to prepare students for future enrollment in top ranked Biostatistics PhD programs. The learning outcomes for the program are as follows:

1. Understand the 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. Gain methodology research experience or collaborative experience in applied biostatistics.
5. Use statistical analytical software to perform advanced statistical procedures and demonstrate skills in public health data management.
6. Effectively communicate results of statistical analyses to lay and professional audiences.
7. 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.* The 43-credit curriculum includes 25 credits of core coursework, 12 credits of electives, and a 6-credit thesis.

<b>Core Courses (25 credits)</b>		
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
EPIB667	Applied Machine Learning with Python	3
EPIB697	Public Health Data Management	3
EPIB610	Foundations of Epidemiology	3
SPHL601	Core Concepts in Public Health	1
<b>Elective Courses (12 credits from the choices below)</b>		
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
EPIB680	Linear Model	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
<b>Dissertation Credits (6 credits)</b>		
EPIB799	Master's Thesis 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 and an MPH with a concentration in Biostatistics. [we could use another sentence here about student support for master's students.]

*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 MS 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. 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](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 fields 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 School of Public Health 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 MS in Biostatistics will prioritize inclusive recruitment and support for minority students, in line with Maryland's goals of equity and access in higher education. Additionally, UMD will leverage its existing undergraduate Public Health Science (PHSC) program, which has one of the most diverse student populations on campus, to encourage current undergraduates from diverse backgrounds to consider the MS in Biostatistics program as a pathway to advanced careers in public health data science.

#### **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
<b>TOTAL (Add 1 - 4)</b>	<b>159856</b>	<b>179777</b>	<b>184177</b>	<b>186725</b>	<b>189349</b>

**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
<b>TOTAL (Add 1 - 8)</b>	<b>154656</b>	<b>171702</b>	<b>175559</b>	<b>177549</b>	<b>179598</b>

## Appendix A: Faculty Information- MS 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, Johns Hopkins University	Professor and Chair	EPIB788

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: MS in Biostatistics**

### **Assessment 1: Satisfactory Completion of Coursework**

Students must meet minimum requirements for “satisfactory progress” each year in the master’s program to be allowed to continue. Students must maintain a 3.0 GPA throughout their program (See Graduate School policy on Academic Standing). All graduate students must register for at least 1 credit hour each semester until graduation. Students should register for the number of credits that will, in the judgment of the graduate program faculty, accurately reflect their involvement in graduate study (Graduate School Requirements). Students must receive at least a “B-” in individual MPH program cognate courses for satisfactory progress. If a student receives a “C+” or lower in a Biostatistics MS program course, the student must repeat the course and receive a satisfactory grade (at least a B-). If the student does not receive a satisfactory grade the second time, they will not be allowed to continue in the program.

All MS in Biostatistics students are required to complete a thesis and enroll in EPIB799 for 6 credit hours. All required coursework must be completed before enrolling in EPIB799. Electives may be taken concurrently with completion of the Thesis. If the thesis is not completed during the registered time period, students must be registered for at least 1-credit of the thesis (EPIB799) each semester until the work is completed and defended.

### **Assessment 2: Thesis Proposal**

The student must select a thesis topic in consultation with his/her faculty advisor and prepare a written proposal that details what is to be accomplished and how it will be done. Students should begin to develop their thesis proposal the semester before they plan on defending their final thesis.

A Thesis Examining Committee of three Graduate Faculty members (at least two committee members must be EPIB Biostatistics faculty) must approve the thesis proposal. One of these three must be the student's faculty advisor, who chairs the committee. When the proposal is ready for review, the student will schedule a meeting with the Thesis Examining Committee. The student must submit a copy of their proposal to the examining committee at least 10 working days in advance of the meeting. He/she must also post an abstract of the study and information about the meeting time, place and date 10 working days before the meeting on the departmental listserv. At the proposal meeting, the document may be approved as is, approved with certain changes, or rejected. In the latter two cases, the student will revise the proposal and submit the proposal to the chair of the committee. If needed, a second formal in-person meeting may be required. NOTE: Students are limited to two formal proposal meetings.

Once the proposal is approved, committee members will provide written approval in the form of signatures on the SPH Proposal Approval Form. The thesis advisor forwards this form to the EPIB Director of Graduate Studies, who will sign the form and place it in the student's file. If the research thesis involves human subjects, university human subjects approval must be obtained

only after the proposal has been approved by the Thesis Examining Committee and before data collection can begin.

After the project proposal has been approved (and Human Subjects approval obtained if required), the student may begin work on the project and enroll in EPIB799. It is expected the project will be conducted according to what was approved by the Thesis Examining Committee.

Before making any substantive changes to that proposal, approval from the examining committee is required. The student must consult with their faculty advisor to determine which changes are substantive and require committee approval.

### **Assessment 3: Oral Thesis Defense**

The final step in completing a Master's thesis is to successfully pass an oral defense conducted by the Thesis Examining Committee, ideally the same committee that approved the thesis proposal. This committee must first be approved by the Graduate School, using the form NOMINATION OF THESIS OR DISSERTATION COMMITTEE. Once they have approved the Thesis Examining Committee, the Graduate School will issue and send to the Department the "Report of Examining Committee" form. 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/](http://www.gradschool.umd.edu/etd/)) and one hard copy to the EPIB Director of Graduate Studies.

## **Appendix C: Course Descriptions**

### **Core Courses**

#### **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, multcategory 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.

#### **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.

#### **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.

#### **SPHL601 Core Concepts in Public Health (1 Credit)**

Introduces students to the history, functions, systems, policies, and models of public health practice in the United States and globally. The course offers seminars, interactive activities, and

assessments aimed at establishing a baseline understanding of public health necessary for higher level and integrative learning in subsequent public health courses.

## **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.

### **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.

### **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.

### **Thesis Course**

#### **EPIB799 Master's Thesis Research**

Research for MS thesis under the guidance of faculty advisor.