Biostatistics

Biostatistics

Biostatistics is the science of applying statistical theory and principles to research in public health, medicine, biology, pharmaceuticals, environmental science, and other related fields.

DEGREES OFFERED

• Master of Public Health
• Master of Science

CERTIFICATE

• Applied Biostatistics

MPH IN BIOSTATISTICS

The MPH degree with a major in Biostatistics is meant for individuals with a general interest in public health, who lack formal training in biostatistics and would like to gain skills needed to understand and apply standard statistical techniques. The purpose of the degree program is to:

• Introduce key principles of probability and statistical inference,
• Teach standard techniques of database management and analysis, and
• Provide guidance regarding critical appraisal of research from a statistical perspective

The program builds on the existing Applied Biostatistics Certificate, allowing for added coursework for those individuals interested in obtaining a more intensive examination of common biostatistical techniques as well as a comprehensive training in the core disciplines of public health.

MS IN BIOSTATISTICS

The Master of Science (MS) Program in Biostatistics is meant for college graduates with interest and background in mathematics and statistics who wish to learn both the methodology and the application of biostatistics in the health sciences. The goals of this program are similar to the current MPH in Biostatistics Program in learning objectives; however, MS students will receive a more extensive methodological foundation as well as be expected to take additional statistical courses instead of the “core” public health courses required for any MPH.

A typical student who graduates with an MS in Biostatistics from WVU would be qualified to work as a biostatistician or research coordinator in research organizations such as a pharmaceutical company, contract research organization (CRO), a university, or a health department. MS graduates also will be prepared to pursue doctoral education in biostatistics or similar disciplines.

BIOSTATISTICS CERTIFICATE

The Applied Biostatistics Certificate is designed for those individuals who lack formal training in biostatistics and would like to gain skills needed to understand and apply standard statistical techniques. It is an online program that is available to practitioners and/or students at WVU and elsewhere.

The primary objectives of the program are thus to:

• Describe basic concepts of probability and statistical inference
• Demonstrate standard techniques of database management and analysis
• Compare and contrast study designs common to health research
• Recognize the primary sources of bias observed in health research
• Interpret appropriate inferences from data based on strengths and limitations of major epidemiologic study designs as well as the results of descriptive and inferential statistical analyses

Individuals who would be interested in such a Certificate include clinical and translational researchers at varying levels of their career (faculty, fellows, residents, basic scientists) as well as public health practitioners, in the state of West Virginia or beyond. Interested individuals in the program should have a desire to be more self-sufficient with their research, specifically being able to know basic study design principles, analyze their data, and interpret their results.

The entire curriculum will be available both online and in-person (live), thus being accessible to individuals from a variety of backgrounds, locations, and experiences. The program will take advantage of existing course technology where courses are taught in a synchronous fashion in which the instructor lectures in-class, and the lecture (along with associated PowerPoint slides or other files, such as SAS programs) is broadcast online. While the lecture is available live during the lecture itself, the video or audio of the lecture is archived and available on the course for access at any time. All course notes, homeworks, programs, etc. are available online, and the instructor is available in a number of formats (online chat, email, phone) to accommodate distance-learning students.
Applied Biostatistics Certificate Program students will typically take one class per semester. Completion of the program will typically take two years. Certificate Program students will pay tuition at the standard School of Public Health per-credit rate. Please visit the School of Public Health financial information link (http://publichealth.hsc.wvu.edu) for more information on current rates.

FACULTY

CHAIR
• Snehalata Huzurbazar - Ph.D. (Colorado State University)

PROFESSOR
• George A. Kelley - DA (Middle Tennessee State University)

ASSOCIATE PROFESSOR
• Sijin Wen - Ph.D. (The University of Texas Health Sciences Center at Houston)

ASSISTANT PROFESSOR
• Christa L. Lilly - Ph.D. (Vanderbilt University)

RESEARCH INSTRUCTOR
• Kristi Kelley - M.Ed. (University of North Carolina at Charlotte)

MPH in Biostatistics

ADMISSIONS GUIDELINES
• A baccalaureate degree from an accredited college or university with a preferred overall GPA of 3.0.
• Basic competencies in mathematics.
• GRE scores of 150 (verbal), 150 (quantitative), 3.5 (analytical writing), or a terminal degree.
• TOEFL scores (minimum 550 paper-based) (minimum 213 computer-based).

TO APPLY FOR THE MPH IN BIOSTATISTICS
If you are ready to apply to West Virginia University School of Public Health, the admissions team is here to assist you. Our School of Public Health is CEPH (http://www.ceph.org) accredited, and we participate in SOPHAS (http://www.sophas.org) (Schools of Public Health Application Service). We are also one of the schools participating in SOPHAS (http://www.sophas.org) (Schools of Public Health Application Service). Our MPH Admissions process is a two-step process. All MPH applications must be submitted through the national SOPHAS service and applicants must also submit a WVU Graduate application.

In addition to the general application, applicants must submit to SOPHAS a statement of purpose and objectives, official GRE test scores, three letters of reference, a current resume/curriculum vitae, and all university transcripts. SOPHAS requires original transcripts from ALL U.S. institutions attended! (Even Study Abroad)

There is a $120 SOPHAS application fee. Applicants must indicate their first choice of MPH major, and may also indicate a second choice. A maximum of two choices is allowed.

• E-submit your application as soon as the applicant entered information is complete. Do NOT wait for SOPHAS to receive transcripts, recommendations or test scores
• Plan Ahead! Allow up to 4 weeks for SOPHAS to verify grades, process and mail your application to your designated institutions after your documents have been received.
• SOPHAS grants fee waivers based upon financial need for Peace Corps Volunteers, McNair Scholars, Gates Millennium Scholars Program, AmeriCorps, U.S. and International applicants

Applications that are complete will then be reviewed by the department. Students will receive a communication from the WVU School of Public Health regarding their recommendation for acceptance and instructions to complete the WVU Graduate application and pay the $60.00 WVU application fee.

Important: When sending GRE scores for consideration for admission at WVU use the GRE WVU School of Public Health College code: 0157. This is the code that MUST be used, otherwise your GRE score will not be reported to SOPHAS and your application will be incomplete and therefore will not be reviewed for an admissions decision. [There are different codes for other programs at West Virginia University.]

All other degrees and certificate programs will use the WVU application system (https://app.applyyourself.com/AYApplicantLogin/fl_ApplicantConnectLogin.asp?id=wvugrad).
MS in Biostatistics

ADMISSIONS GUIDELINES

- Baccalaureate degree from an accredited college or university (preferred GPA: 3.0 overall; 3.4 for quantitative courses)
- Course experience including:
  - Multivariable calculus (equivalent to WVU MATH 251)
  - Matrix or elementary linear algebra (equivalent to WVU MATH 343)
  - Knowledge of a programming language
- GRE scores: 155 quantitative, 150 verbal, and 3.5 for analytical writing
- A completed MS application, including a Statement of Purpose
- Three letters of recommendation

TO APPLY FOR THE MS IN BIOSTATISTICS

Complete the WVU graduate application and submit with the processing fee ($60.00): http://graduateadmissions.wvu.edu/.

Applicants must submit a statement of purpose, official GRE test scores, three letters of reference, a current resume/curriculum vitae, and all university transcripts. The deadline for applications to be considered for the fall (no spring/summer admissions are permitted) is July 1 (priority deadline: April 1).

Applications that are complete will be sent to the department for review. Students will receive an e-mail through from the WVU School of Public Health regarding their recommendation for acceptance.

Applied Biostatistics Certificate

ADMISSIONS GUIDELINES

- Baccalaureate degree from an accredited college or university with a preferred overall GPA of 3.0 (official transcripts required)
- GRE scores or a terminal degree (MD, Ph.D., etc.)
- Essay describing previous education and experience and career objectives
- Resume or curriculum vitae
- At least two letters of recommendation
- Computer skills are a program requirement. It is the responsibility of the students to become skilled in computer applications and to participate in the Health Sciences Center Mandatory Laptop Program.
- The admissions process will include a 15-20 minute phone interview between the Biostatistics Certificate Admissions Committee and the applicant.

Students currently enrolled at WVU should fill out the admissions form for current students to apply for the Applied Biostatistics Certificate. Please contact Dr. Christa Lilly (cice@hsc.wvu.edu) with questions or the completed form.

STUDENTS INTERESTED IN APPLYING FOR THE APPLIED BIOSTATISTICS CERTIFICATE MUST:

- Complete the WVU graduate application and indicate Applied Biostatistics Certificate and submit with the processing fee.
- https://app.applyyourself.com/AYApplicantLogin/ApplicantConnectLogin.asp?id=wvugrad
- Submit official school transcripts and official GRE scores to:

WVU HSC Admissions
1 Medical Center Drive
1170 HSC North
Morgantown, WV 26506

- International students must submit to:

Office of Graduate Admissions and Recruitment
PO Box 6510
Morgantown, WV 26506-6510

Master of Public Health

MPH Major in Biostatistics Description

The MPH degree with a major in Biostatistics is meant for individuals with a general interest in public health, who lack formal training in biostatistics and would like to gain skills needed to understand and apply standard statistical techniques. The purpose of the degree program is to:
• Introduce key principles of probability and statistical inference,
• Teach standard techniques of database management and analysis, and
• Provide guidance regarding critical appraisal of research from a statistical perspective

The program builds on the existing Applied Biostatistics Certificate, allowing for added coursework for those individuals interested in obtaining a more intensive examination of common biostatistical techniques as well as a comprehensive training in the core disciplines of public health.

Biostatistics Major Competencies

In addition to the standard MPH Foundational Competencies required of all MPH students, our major in Biostatistics also prepares students to meet six competencies specific to the major. These include:

1. Manage data structures efficiently using standard statistical software.
2. Evaluate basic multivariable statistical techniques commonly used in clinical and public health settings.
3. Explain the motivations, underlying theory, and assumptions of advanced methodological tools for biostatisticians.
4. Conduct and evaluate systematic reviews with meta-analysis.
5. Develop written presentations based on statistical analyses for both substantive investigators and members of the community.
6. Develop oral presentations based on statistical analyses for both substantive investigators and members of the community.

MAJOR REQUIREMENTS

A final GPA of 3.0 or higher is required for the successful completion of the program.

Students must earn a minimum grade of "C-" in all PUBH and BIOS coursework.

### MPH Foundational Courses

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>PUBH 610</td>
<td>Contemporary Foundations of Public Health Practice</td>
<td>2</td>
</tr>
<tr>
<td>PUBH 611</td>
<td>Epidemiology for Public Health Practice</td>
<td>2</td>
</tr>
<tr>
<td>PUBH 612</td>
<td>Research Translation and Evaluation in Public Health Practice</td>
<td>4</td>
</tr>
<tr>
<td>PUBH 620</td>
<td>Building and Sustaining Public Health Capacity</td>
<td>2</td>
</tr>
<tr>
<td>PUBH 621</td>
<td>Public Health Prevention and Intervention</td>
<td>3</td>
</tr>
<tr>
<td>PUBH 630</td>
<td>MPH Field Practicum</td>
<td>3</td>
</tr>
<tr>
<td>PUBH 640</td>
<td>Leadership and Collaboration in Public Health</td>
<td>3</td>
</tr>
<tr>
<td>PUBH 641</td>
<td>Systems Thinking in Public Health Practice</td>
<td>2</td>
</tr>
<tr>
<td>PUBH 696</td>
<td>Graduate Seminar</td>
<td>1</td>
</tr>
</tbody>
</table>

### Biostatistics Major Courses

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOS 603</td>
<td>Applied Biostatistics 2</td>
<td>3</td>
</tr>
<tr>
<td>BIOS 604</td>
<td>Applied Biostatistics 3</td>
<td>3</td>
</tr>
<tr>
<td>BIOS 611</td>
<td>Data Management and Reporting</td>
<td>3</td>
</tr>
<tr>
<td>BIOS 623</td>
<td>Biostatistics Careers and Skills</td>
<td>2</td>
</tr>
<tr>
<td>BIOS 629</td>
<td>Application of Biostatistics to Public Health Data</td>
<td>2</td>
</tr>
<tr>
<td>BIOS 663</td>
<td>Introduction to Meta-Analysis</td>
<td>3</td>
</tr>
</tbody>
</table>

### Electives

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOS 603</td>
<td>Applied Biostatistics 2</td>
<td>3</td>
</tr>
<tr>
<td>BIOS 604</td>
<td>Applied Biostatistics 3</td>
<td>3</td>
</tr>
<tr>
<td>BIOS 611</td>
<td>Data Management and Reporting</td>
<td>3</td>
</tr>
<tr>
<td>BIOS 623</td>
<td>Biostatistics Careers and Skills</td>
<td>2</td>
</tr>
<tr>
<td>BIOS 629</td>
<td>Application of Biostatistics to Public Health Data</td>
<td>2</td>
</tr>
<tr>
<td>BIOS 663</td>
<td>Introduction to Meta-Analysis</td>
<td>3</td>
</tr>
</tbody>
</table>

As Approved by MPH Program Advisor

**Total Hours**: 44

---

* 1. All students in the WVU SPH MPH program are required to maintain a portfolio that demonstrates their ability to meet the competencies associated with the MPH Foundational Courses, the Department Major Courses, and to apply a selection of those competencies in an approved practice-based setting(s). This portfolio must be submitted for review at the end of each academic year, as well as reviewed and approved prior to the successful completion of the program.

2. The MPH degree will be awarded based on successful completion of all academic requirements and demonstrated achievement of competencies via the student portfolio system and class-based evaluations of competency attainment.

**SUGGESTED PLAN OF STUDY**

<table>
<thead>
<tr>
<th>First Year</th>
<th>Hours Spring</th>
<th>Hours Summer</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fall</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PUBH 610</td>
<td>2</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>PUBH 611</td>
<td>2</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>PUBH 612</td>
<td>4</td>
<td>3</td>
<td></td>
</tr>
</tbody>
</table>

---

* 1. All students in the WVU SPH MPH program are required to maintain a portfolio that demonstrates their ability to meet the competencies associated with the MPH Foundational Courses, the Department Major Courses, and to apply a selection of those competencies in an approved practice-based setting(s). This portfolio must be submitted for review at the end of each academic year, as well as reviewed and approved prior to the successful completion of the program.

2. The MPH degree will be awarded based on successful completion of all academic requirements and demonstrated achievement of competencies via the student portfolio system and class-based evaluations of competency attainment.
BIOS 610  Biostatistical Theory and Methods 1 4
BIOS 611  Data Management and Reporting 3
BIOS 612  Biostatistical Theory and Methods 2 3
BIOS 620  Applied Linear Models HS 3
BIOS 621  Categorical Data Analysis HS 3
BIOS 623  Biostatistics Careers and Skills 2
PUBH 659  Public Health Foundations 3

Electives
BIOS 622  Analysis of Time-to-Event Data
BIOS 662  Statistics in Clinical Trials
BIOS 663  Introduction to Meta-Analysis
STAT 513  Design of Experiments
EPID 601  Public Health Epidemiology
EPID 611  Concepts and Methods of Epidemiology
EPID 612  Applied Epidemiology for Public Health
STAT 521  Statistical Analysis System Programming
STAT 522  Advanced Statistical Analysis System Programming
STAT 523  Statistical Computing
STAT 531  Sampling Theory and Methods
STAT 540  Introduction to Exploratory Data Analysis
STAT 541  Applied Multivariate Analysis
STAT 543  Bioinformatics Data Analysis

Total credit hours: 44

Note: With approval from the MPH Program Advisor and the Director of Practice-Based Learning, PUBH 630: MPH Field Practicum can be taken anytime during Year 2.

Master of Science in Biostatistics

MS-Biostatistics students will gain the following general competencies that will be assessed continuously through the assessment processes already in place in the School of Public Health (SPH):

1. Assess foundational concepts of probability and statistical inference.
2. Analyze clinical and public health data using descriptive biostatistical methods.
3. Distinguish appropriate basic inferential statistical analyses and summarize their results.
4. Manage standard statistical software to efficiently manage data structures.
5. Summarize central concepts of statistical theory and inference.
6. Develop appropriate plans to analyze standard continuous data in order to make valid inferences.
7. Develop appropriate plans to analyze standard categorical data in order to make valid inferences.
8. Communicate effectively, in writing and verbally, with substantive investigators and members of the community when assisting in the design of research studies as well as the results of statistical analyses.
9. Explain each of the five core disciplines in public health and illustrate the ways each of the core disciplines have contributed to the historical evolution of public health

MAJOR REQUIREMENTS

MS Required Courses
BIOS 610  Biostatistical Theory and Methods 1 4
BIOS 611  Data Management and Reporting 3
BIOS 612  Biostatistical Theory and Methods 2 3
BIOS 620  Applied Linear Models HS 3
BIOS 621  Categorical Data Analysis HS 3
BIOS 623  Biostatistics Careers and Skills 2
PUBH 659  Public Health Foundations 3

Electives
BIOS 622  Analysis of Time-to-Event Data
BIOS 662  Statistics in Clinical Trials
BIOS 663  Introduction to Meta-Analysis
STAT 513  Design of Experiments
EPID 601  Public Health Epidemiology
EPID 611  Concepts and Methods of Epidemiology
EPID 612  Applied Epidemiology for Public Health
STAT 521  Statistical Analysis System Programming
STAT 522  Advanced Statistical Analysis System Programming
STAT 523  Statistical Computing
STAT 531  Sampling Theory and Methods
STAT 540  Introduction to Exploratory Data Analysis
STAT 541  Applied Multivariate Analysis
STAT 543  Bioinformatics Data Analysis
STAT 551  Nonparametric Statistics

Or other approved courses

<table>
<thead>
<tr>
<th>Choice of Thesis or Non-Thesis Option</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Thesis Option</strong></td>
<td></td>
</tr>
<tr>
<td>BIOS 628  Biostatistics Practicum</td>
<td></td>
</tr>
<tr>
<td>BIOS 697  Research</td>
<td></td>
</tr>
<tr>
<td><strong>Non-Thesis Option</strong></td>
<td></td>
</tr>
<tr>
<td>BIOS 628  Biostatistics Practicum</td>
<td></td>
</tr>
<tr>
<td>Elective</td>
<td></td>
</tr>
</tbody>
</table>

| Total Hours                           | 36 |

**SUGGESTED PLAN OF STUDY (THESIS OPTION)**

**First Year**

<table>
<thead>
<tr>
<th>Fall</th>
<th>Hours</th>
<th>Spring</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOS 610</td>
<td>4 BIOS 620</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>BIOS 611</td>
<td>3 BIOS 621</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>BIOS 623</td>
<td>2 BIOS 612</td>
<td>3</td>
<td></td>
</tr>
</tbody>
</table>

9 9

<table>
<thead>
<tr>
<th>Second Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fall</td>
</tr>
<tr>
<td>BIOS 628</td>
</tr>
<tr>
<td>Elective</td>
</tr>
<tr>
<td>Elective</td>
</tr>
</tbody>
</table>

9 9

Total credit hours: 36

**SUGGESTED PLAN OF STUDY (NON-THESIS OPTION)**

**First Year**

<table>
<thead>
<tr>
<th>Fall</th>
<th>Hours</th>
<th>Spring</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOS 610</td>
<td>4 BIOS 612</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>BIOS 611</td>
<td>3 BIOS 620</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>BIOS 623</td>
<td>2 BIOS 621</td>
<td>3</td>
<td></td>
</tr>
</tbody>
</table>

9 9

<table>
<thead>
<tr>
<th>Second Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fall</td>
</tr>
<tr>
<td>BIOS 628</td>
</tr>
<tr>
<td>Elective</td>
</tr>
<tr>
<td>Elective</td>
</tr>
</tbody>
</table>

9 9

Total credit hours: 36

The MS degree will be awarded based on successful completion of all academic requirements.

**Doctor of Philosophy**

**Biostatistics Major Competencies**

- Assimilate the foundations of public health, including the physical, biological, and social behavioral/factors which affect the health of the community.
- Synthesize and illustrate principles of study design, estimation, statistical inference, and standard data analysis methods to students and researchers across various health disciplines
- Integrate the foundations of statistical theory and inference for estimation and testing of hypotheses in public health
- Discern gaps in current statistical methods that limit further public health research and propose solutions based on rigorous theoretical justification
- Synthesize new developments in the biostatistical literature to address relevant and challenging public health questions
• Evaluate research reports and proposals for research funding on the basis of their scientific integrity, validity, and the strength of the quantitative analysis
• Prepare reports of quantitative analyses for journal publication, presentations at scientific meetings, and grant application.

MAJOR REQUIREMENTS

Common Core Courses for the SPH Doctoral Program

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>EPID 710</td>
<td>Advanced Principles of Epidemiology</td>
<td>3</td>
</tr>
<tr>
<td>EPID 711</td>
<td>Methodological Issues in Design &amp; Analysis of Cohort Studies</td>
<td>3</td>
</tr>
<tr>
<td>PUBH course</td>
<td>Foundations of Public Health</td>
<td>3</td>
</tr>
</tbody>
</table>

Research

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOS 797</td>
<td>Research</td>
<td>1</td>
</tr>
<tr>
<td>C&amp;I 789</td>
<td>Teaching in Higher Education</td>
<td>3</td>
</tr>
<tr>
<td>PUBH 790</td>
<td>Teaching Practicum</td>
<td>3</td>
</tr>
<tr>
<td>BMS 700</td>
<td>Scientific Integrity</td>
<td>1</td>
</tr>
<tr>
<td>BMS 720</td>
<td>Scientific Writing</td>
<td>2</td>
</tr>
</tbody>
</table>

BIOS Required Courses

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOS 623</td>
<td>Biostatistics Careers and Skills  *</td>
<td>1</td>
</tr>
<tr>
<td>BIOS 700</td>
<td>Foundations of Modern Statistical Inference</td>
<td>3</td>
</tr>
<tr>
<td>BIOS 701</td>
<td>Modern Statistical Inference</td>
<td>3</td>
</tr>
</tbody>
</table>

Select one of the following:

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOS 720</td>
<td>Theory and Application of Linear Models</td>
<td>4</td>
</tr>
<tr>
<td>STAT 645</td>
<td>Linear Models</td>
<td>1</td>
</tr>
<tr>
<td>&amp; BIOS 745</td>
<td>and Advanced Application of Linear Models</td>
<td>1</td>
</tr>
<tr>
<td>BIOS 721</td>
<td>Advanced Categorical Data Analysis for Health Sciences</td>
<td>4</td>
</tr>
<tr>
<td>BIOS 740</td>
<td>Advanced Longitudinal Data Analysis</td>
<td>3</td>
</tr>
<tr>
<td>BIOS 788</td>
<td>Biostatistical Grant Writing</td>
<td>2</td>
</tr>
<tr>
<td>BIOS 796</td>
<td>Graduate Seminar</td>
<td>1</td>
</tr>
<tr>
<td>BIOS 796</td>
<td>Graduate Seminar</td>
<td>1</td>
</tr>
</tbody>
</table>

Electives Courses

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOS 622</td>
<td>Analysis of Time-to-Event Data</td>
<td>1</td>
</tr>
<tr>
<td>BIOS 764</td>
<td>Bayesian Biostatistics</td>
<td>1</td>
</tr>
<tr>
<td>BIOS 765</td>
<td>Advanced Structural Equation Models</td>
<td>1</td>
</tr>
<tr>
<td>STAT 547</td>
<td>Survival Analysis</td>
<td>1</td>
</tr>
<tr>
<td>STAT 745</td>
<td>Data Mining</td>
<td>1</td>
</tr>
<tr>
<td>STAT 761</td>
<td>Theoretical Statistics 1 **</td>
<td>1</td>
</tr>
<tr>
<td>STAT 762</td>
<td>Theoretical Statistics 2 **</td>
<td>1</td>
</tr>
<tr>
<td>STAT 763</td>
<td>Stochastic Processes</td>
<td>1</td>
</tr>
<tr>
<td>STAT 765</td>
<td>Statistical Methods-Bioinformatics</td>
<td>1</td>
</tr>
</tbody>
</table>

Total Hours: 115

* Students with MS in Statistics or Biostatistics may be exempt from these courses
** Strongly recommended for students interested in an academic career.

SUGGESTED PLAN OF STUDY

First Year

<table>
<thead>
<tr>
<th>Course</th>
<th>Hours Spring</th>
<th>Hours Summer</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOS 700</td>
<td>3 BIOS 701</td>
<td>3 C&amp;I 789</td>
<td>3</td>
</tr>
<tr>
<td>EPID 710</td>
<td>3 BIOS 721</td>
<td>4 BIOS 720</td>
<td>2</td>
</tr>
<tr>
<td>STAT 645</td>
<td>3 BIOS 623</td>
<td>2 BIOS 797</td>
<td>1</td>
</tr>
<tr>
<td>BIOS 745</td>
<td>1 BIOS 788</td>
<td>2 BIOS 788</td>
<td>2</td>
</tr>
<tr>
<td>BMS 700</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

Total: 11 + 11 + 6 = 28
CERTIFICATE CODE - CG32

The Applied Biostatistics Certificate is designed for those individuals who lack formal training in biostatistics and would like to gain skills needed to understand and apply standard statistical techniques. It is an in-person and/or online program that is available to practitioners and/or students at WVU and elsewhere.

The primary objectives of the program are to:

- Describe basic concepts of probability and statistical inference
- Demonstrate standard techniques of database management and analysis
- Compare and contrast study designs common to health research
- Recognize the primary sources of bias observed in health research
- Interpret appropriate inferences from data based on strengths and limitations of major epidemiologic study designs as well as the results of descriptive and inferential statistical analyses

Individuals who would be interested in such a Certificate include clinical and translational researchers at varying levels of their career (faculty, fellows, residents, basic scientists) as well as public health practitioners, in the state of West Virginia or beyond. Interested individuals in the program should have a desire to be more self-sufficient with their research, specifically being able to know basic study design principles, analyze their data, and interpret their results.

The entire curriculum will be available both online and in-person (live), thus being accessible to individuals from a variety of backgrounds, locations, and experiences. The program will take advantage of existing course technology where courses are taught in a synchronous fashion in which the instructor lectures in-class, and the lecture (along with associated PowerPoint slides or other files, such as SAS programs) is broadcast online. While the lecture is available live during the lecture itself, the video or audio of the lecture is archived and available on the course for access at any time. All course notes, homework, programs, etc. are available online, and the instructor is available in a number of formats (online chat, email, phone) to accommodate distance-learning students.

Applied Biostatistics Certificate Program students will typically take one class per semester. Completion of the program will typically take two years.
Major Learning Outcomes

BIOSTATISTICS

MPH BIOSTATISTICS MAJOR COMPETENCIES:

- Manage data structures efficiently using standard statistical software.
- Evaluate basic multivariable statistical techniques commonly used in clinical and public health settings.
- Explain the motivations, underlying theory, and assumptions of advanced methodological tools for biostatisticians.
- Conduct and evaluate systematic reviews with meta-analysis.
- Develop written presentations based on statistical analyses for both substantive investigators and members of the community.
- Develop oral presentations based on statistical analyses for both substantive investigators and members of the community.

MS IN BIOSTATISTICS MAJOR COMPETENCIES:

- Assess foundational concepts of probability and statistical inference.
- Analyze clinical and public health data using descriptive biostatistical methods.
- Distinguish appropriate basic inferential statistical analyses and summarize their results.
- Manage standard statistical software to efficiently manage data structures.
- Summarize central concepts of statistical theory and inference.
- Develop appropriate plans to analyze standard continuous data in order to make valid inferences.
- Develop appropriate plans to analyze standard categorical data in order to make valid inferences.
- Communicate effectively, in writing and verbally, with substantive investigators and members of the community when assisting in the design of research studies as well as the results of statistical analyses.
- Weigh a public health problem in terms of magnitude, person, time, and place.
- Explain each of the five core disciplines in public health and illustrate the ways each of the core disciplines have contributed to the historical evolution of public health

COURSES

BIOS 601. Applied Biostatistics 1. 3 Hours.
CoReq: BIOS 602. Introduces parametric and nonparametric statistical methodology, including descriptive measures, elementary probability, estimation, hypothesis testing, confidence intervals, common nonparametric methods, and base contingency table analysis. Empirically demonstrates underlying theory.

BIOS 602. Applied Biostatistics Lab. 1 Hour.
PR or CONC: BIOS 601. This course, taken concurrently with BIOS 601, introduces students to the use of statistical software (SAS, R) to perform basic analyses.

BIOS 603. Applied Biostatistics 2. 3 Hours.
PR: BIOS 601 and BIOS 602. Addresses estimation and hypothesis testing within the context of the generalized linear model. Examines multiple linear regression, logistic regression, survival analysis, and select advanced techniques. Emphasis on applied data analysis of health care studies.

BIOS 604. Applied Biostatistics 3. 3 Hours.
PR: BIOS 602 and BIOS 603. Focus on advanced methodological tools important in public health contexts. Topics include structural equation models and hierarchical linear models (mixed models, random-effect models), categorical methods, survival analysis and clinical trials.

BIOS 605. Applied Biostatistics Capstone. 2 Hours.
PR: BIOS 601 and BIOS 602 and BIOS 603 and BIOS 604 and consent. Students will work on a dedicated data analysis stemming from their own research or the work of others, culminating in a final research paper.

BIOS 610. Biostatistical Theory and Methods 1. 4 Hours.
PR: BIOS major or permission of instructor. Students will learn the general theory underlying statistical methods. Frequentist, likelihood and Bayesian methods will be introduced for modeling and analyzing data on one and two variables. Probability distributions and basic statistical theory will be included as needed. The R programming language will be used to analyze data in addition to learning basics of statistical methods.

BIOS 611. Data Management and Reporting. 3 Hours.
Introduction to statistical software for data management and analysis. Focus is on SAS and R for data management and analysis.
BIOS 612. Biostatistical Theory and Methods. 2. 3 Hours.
PR: BIOS 610. Build on concepts from BIOS 610, with an introduction to more advanced modeling and data analysis for more than two variables, and with complicated dependence structures. Probability distributions and statistical theory are introduced and developed as needed, and methods such as mixed models, time series, spatial data analysis and multivariate data analysis will be presented along with analyses of data.

BIOS 620. Applied Linear Models HS. 3 Hours.
PR: BIOS 610 or BIOS 612. This course will teach the theory and practice of regression analysis. This includes but not limited to estimation, testing, confidence procedures, the geometry of least squares, regression diagnostics and plots, modeling, model selection, polynomial regression, and collinearity.

BIOS 621. Categorical Data Analysis HS. 3 Hours.
PR: BIOS 610 and BIOS 611. Introduction to the analysis of categorized data with a Health Sciences-Epidemiologic focus: rates, ratios, and proportions; relative risk and odds ratio; Mantel-Haenszel methods; logistic regression, Poisson regression, and other models for categorical data.

BIOS 622. Analysis of Time-to-Event Data. 3 Hours.
PR: BIOS 610 and BIOS 611. Introduction to modern methods for the analysis of time-to-event data (e.g. survival, cessation, and recidivism). Theory and application are emphasized; covering survival functions, hazard rates, inference, regression, model construction, stratification, time-dependent covariates, and clinical trials.

BIOS 623. Biostatistics Careers and Skills. 2 Hours.
Focus on career options and skills needed to attain them. Lectures, seminars, collaborative research group meetings, consulting sessions, and discussions will cover topics including consulting, working in collaborative research teams, preparing for an advanced biostatistics degree, and career options. Skills emphasized are time management, computational skills, written and oral communication.

BIOS 628. Biostatistics Practicum. 3 Hours.
PR: Consent. Students will work in a collaborative setting for a minimum of 180 hours, applying sophisticated biostatistical principles and skills learned in classes to address research questions that arise in that setting.

BIOS 629. Application of Biostatistics to Public Health Data. 2 Hours.
Students will develop research question(s) pertaining to an available public health related data set, determine the public health relevance of that question, plan analyses and implement that plan, and determine public health impact of analysis results. Students will gain practical experience integrating biostatistics concepts within a public health issue.

BIOS 660. Applied Bioinformatics 1. 3 Hours.
PR: BIOS 610 and BIOS 611. Foundational methodological tools for analyzing molecular and population genetics are discussed in detail including methods for modeling genetic inheritance, linkage analysis, genetic association studies, family designs, SNPs analysis, gene interactions, and genome wide association studies.

BIOS 661. Applied Bioinformatics 2. 3 Hours.
PR: BIOS 612 and BIOS 660. The course will cover the fundamental methods that have been successfully applied in bioinformatics, such as supervised learning, unsupervised learning and multiple testing. Students will learn relevant programming languages and software.

BIOS 662. Statistics in Clinical Trials. 3 Hours.
PR: BIOS 610 and BIOS 611. Introduces concepts relevant to the design and analysis of clinical trials. Topics covered include protocol development, quality control, ethical considerations, adherence, randomization, power analysis, and interim analysis.

BIOS 663. Introduction to Meta-Analysis. 3 Hours.
An introduction to the quantitative analysis (meta-analysis) of data from systematic reviews, including (1) effect size and precision, (2) fixed versus random-effects models, (3) heterogeneity, (4) complex data structures, and (5) bias.

BIOS 691A-Z. Advanced Topics. 1-6 Hours.
PR: Consent. Investigation in advanced topics that are not covered in regularly scheduled courses.

BIOS 693A-Z. Special Topics. 1-6 Hours.
A study of contemporary topics selected from recent developments in the field.

BIOS 695. Independent Study. 1-6 Hours.
Faculty-supervised study of topics not available through regular course offerings.

BIOS 696. Graduate Seminar. 1 Hour.
PR: Consent. Each graduate student will present at least one seminar to the assembled faculty and graduate student body of his or her program.

BIOS 697. Research. 1-15 Hours.
PR: Consent. Research ACTivities leading to thesis, problem report, research paper or equivalent scholarly project, or dissertation. (Grading will be S/U.).

BIOS 698. Thesis. 1-6 Hours.
PR: Consent. This is an optional course for programs that believe that this level of control and supervision is needed during the writing of student's reports, theses, or dissertations.

BIOS 700. Foundations of Modern Statistical Inference. 3 Hours.
PR: Consent. The foundations and application of advanced statistical theory used in the field of biostatistics will be presented, including likelihood theory with related estimation, asymptotic and inferential theory, and theoretical and computational procedures for missing data.
BIOS 701. Modern Statistical Inference. 3 Hours.
PR: BIOS 700 or Consent. Advanced statistical theory for biostatistics will be presented, including estimation theory, semi-parametric theory, asymptotic and inferential theory, and algorithmically based estimators and inference.

BIOS 720. Theory and Application of Linear Models. 4 Hours.
PR: BIOS 700 or Consent. This is a theoretical course in linear models for continuous responses and their applications. Topics include matrix theory, the multivariate normal distribution, multivariate quadratic forms, estimability, reparameterization, linear restrictions, estimation theory, weighted least squares, multivariate tests of linear hypotheses, multiple comparisons, confidence regions, and missing data.

BIOS 721. Advanced Categorical Data Analysis for Health Sciences. 4 Hours.
PR: BIOS 700 or Consent. This course offers an advanced examination of statistical theory and application of methods for models with categorical response data; concepts include likelihood theory and application, general linear models theory and application, estimating equations and contingency table methods.

BIOS 740. Advanced Longitudinal Data Analysis. 3 Hours.
PR: BIOS 720 or consent. This course gives an advanced understanding and approach to the analysis of longitudinal data; concepts include linear mixed effects models, generalized linear models for correlated data (including generalized estimating equations), computational issues and methods for fitting models, and dropout or other missing data. Knowledge of an appropriate software package and basic matrix algebra is assumed.

BIOS 745. Advanced Application of Linear Models. 1 Hour.
PR or CONC: STAT 645 or Consent. This course offers an understanding of advanced linear models as utilized in practice. Application of linear models across a range of research areas will be emphasized, covering computational techniques, practical issues that arise in utilizing linear models, and interpretation of results.

BIOS 764. Bayesian Biostatistics. 3 Hours.
PR: BIOS 700 or consent. This course examines fundamental aspects of the Bayesian paradigm and will focus on Bayesian inferential methods with emphasis on biostatistics applications. Topics covered include: principles of Bayesian statistics; single-parameter and multi-parameter models; Bayesian linear and generalized linear models; Monte Carlo approaches to model fitting; Prior elicitation, with illustrations of a variety of computational methods.

BIOS 765. Advanced Structural Equation Models. 3 Hours.
PR: (BIOS 610 and BIOS 611) or Consent. This course will focus on advanced structural equation modeling techniques important in public health contexts. Topics include basic psychometrics, path analysis and advanced structural equation modeling techniques, using relevant software packages.

BIOS 788. Biostatistical Grant Writing. 2 Hours.
This course gives an advanced conceptual and applied understanding of writing external grants in Biostatistics. Topics include writing grants as a principal investigator and assisting others in grant-writing as a co-investigator, with a focus on NIH grants.

BIOS 790. Teaching Practicum. 1-3 Hours.
PR: Consent. Supervised practice in college teaching of BIOS. Note: This course is intended to insure that graduate assistants are adequately prepared and supervised when they are given college teaching responsibility. It also provides a mechanism for students not on assistantships to gain teaching experience.

BIOS 796. Graduate Seminar. 1 Hour.
PR: Consent. Each graduate student will present at least one seminar to the assembled faculty and graduate student body of his or her program.

BIOS 797. Research. 1-15 Hours.
PR: Consent. Research activities leading to thesis, problem report, research paper or equivalent scholarly project, or a dissertation. (Grading will be S/U.).

BIOS 798. Thesis or Dissertation. 1-6 Hours.
PR: Consent. This is an optional course for programs that believe that this level of control and supervision is needed during the writing of students’ reports, theses, or dissertations.