Overview
This course is intended to provide in-depth, exposure to the theory and methods of epidemiologic research. Topics to be covered include causal inference, measures of disease frequency and association, study design, bias and confounding, validity, and epidemiologic analysis. The course is designed for students entering the PhD program in Epidemiology. However, students from other graduate groups are welcome, as long as they meet the pre-requisites; such students are welcome during any year of study.

Learning outcomes
After completing this course, students will be able to:
- Describe the science of epidemiology
- Demonstrate ability to develop a variety of observational and analytic study designs
- Discuss in detail the quantitative foundations of epidemiologic theory and methods
- Describe current approaches to epidemiologic research
- Identify sources of bias and ways to address them
- Critically assess epidemiologic literature
- Formulate study designs to address specific problems in population health

Class format
This is primarily a lecture course with in-class laboratory.

Participating faculty
Course director and facilitator: John H. Holmes, PhD  jholmes@mail.med.upenn.edu
Teaching assistant: Elle Saine, MA  msaine@pennmedicine.upenn.edu

Course units
This is a 1.0cu course.

Contact hours
The course will consist of one three-hour classroom session each week. In addition, a discussion board will be established on Canvas for out-of-class communication.

Course structure
The course is designed around four modules, each focusing on a major area of epidemiologic research principles. Each module (except for the last) consists of a series of sessions which are dedicated to a specific topic or method:
- Basic concepts
- Study design and conduct
- Epidemiologic data analysis
- A special topic to be selected based on student’s interests
- Final project presentation, specific to each student’s interest area
Class structure
Each class will generally follow the same schedule.

- Hour 1: Lecture with participation
- Hour 2: In-class laboratory of methods pertaining to the week’s lecture
- Hour 3: Discussion of key literature pertaining to the week’s lecture

Take-home problem sets associated with each module will be assigned approximately every two weeks and reviewed in the class following the due date.

Course materials
The required materials for the course include a textbook (Rothman, Lash, and Greenland: Modern Epidemiology, Third Edition), and selected readings from the epidemiologic literature.

Pre-requisites
Students are expected to have quantitative proficiency. It is expected that all students will have some knowledge and/or experience in working in biomedical research.

Evaluation of student performance
The grade for the course will be based on the following:

- An annotated reading journal prepared from the articles presented in class (20%). The journal will include a table of contents, followed by each article paired with a brief (one 1-2 page) “reaction paper,” that will demonstrate the student’s understanding of the article’s content and its place in the epidemiologic literature. The journal will consist of reaction papers that you will write that provides your reaction to the paper we will be discussing in class each Friday. We will be reviewing your reaction papers in class at that time as well. The reaction paper is not an abstract; rather, it should represent the student’s own synthesis of the issues that the article addresses or attempts to address. The format of the reaction paper is as follows; please follow this format, using the section headings provided here:
  - Citation. Bibliographic citation of the paper you are reacting to
  - Summary. Provide a brief summary of the paper, in your own words. (4-5 sentences)
  - Critical review. Identify the key positive and negative points raised in the paper. (1-3 paragraphs)
  - Opinion. Provide your opinion of the value of the work to data scientists. (1 paragraph)
  - Personal reflection. Discuss the value of the work to you, answering the questions such as whether the paper was worth reading, whether or not you could see using the work described in the paper in the future, and if you would recommend the paper to others. (1 paragraph)
- Problem sets (60%)
  - Rates and standardization
  - Interaction
  - Design of observational studies
  - Design of analytic studies
  - Causation
  - Analysis of bias
- Final project presentation (20%)
  - Each student will deliver a 15-minute presentation including:
    - Description of the problem domain
    - Background/prior work
    - Formulation of a research question
    - Specific aims for a project to address the research question
Outline of methods to address the research question

- Study design
- Target population
- Data source(s)
- Sampling methods (if needed)
- Analysis plan

- 5 minutes will be allowed for questions
- Students will submit a written report on their project, using the above outline as structure
- Group projects are allowed and encouraged, but the work must reflect the effort of all students in the group. Extra time will be allotted for the presentation, proportional to the number of students in a group.
## Class Schedule

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<th>Module</th>
<th>Date</th>
<th>Lecture, Lab, and Guided Literature Review</th>
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<td>Basic Concepts</td>
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<td>Introduction to course</td>
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<td>A brief history of epidemiology</td>
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<td></td>
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<td>Causation and causal inference (Ch. 1-2)</td>
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<td>9/14</td>
<td>Measures of occurrence (Ch. 3)</td>
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<td>9/21</td>
<td>Measures of effect and association (Ch. 4)</td>
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<td>9/28</td>
<td>Causal diagrams and analysis of bias (Ch. 12)</td>
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<td>Study Design and Concepts</td>
<td>10/5</td>
<td>Descriptive studies (Ch. 6)</td>
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<td>10/12</td>
<td>Cohort studies (Ch. 7)</td>
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<td>10/19</td>
<td>Case-Control studies (Ch. 8)</td>
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<td>10/26</td>
<td>Validity and precision (Ch. 9-10)</td>
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<td>Design strategies (Ch. 11)</td>
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<tr>
<td>Epidemiologic Data Analysis</td>
<td>11/2</td>
<td>Categorical analysis (Ch. 14)</td>
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<td>11/9</td>
<td>Stratified analysis (Ch. 15-16)</td>
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<td>Review session</td>
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<td>11/23</td>
<td>Introduction to Bayesian methods (Ch. 18)</td>
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<td>11/30</td>
<td>No class (Thanksgiving break)</td>
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<td>Special topic</td>
<td>12/7</td>
<td>Social epidemiology (Ch. 26)</td>
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<td>Final Presentations</td>
<td>12/14</td>
<td>In-class presentation of final project</td>
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