**DEPARTMENT:** **Environmental Health**

**COURSE NUMBER: EH590R** **SECTION NUMBER:**

**CREDIT HOURS: 2** **SEMESTER: Fall 2020**

**COURSE TITLE: Application of 'Omics Technologies in Public Health Research**

**CLASS HOURS AND LOCATION: Mondays 10:00-11:50am**

**INSTRUCTOR NAME: Todd Everson, PhD**

**INSTRUCTOR CONTACT INFORMATION**

EMAIL: Todd.M.Everson@Emory.edu

PHONE:404-727-8136

SCHOOL ADDRESS OR MAILBOX LOCATION: CNR 2025

**OFFICE HOURS Mondays 1:00-3:00pm**

**Teaching Assistant(s):**

## COURSE DESCRIPTION

Introductory course to provide an overview of the systems biology, genomics, epigenomics, metabolomics, microbiome studies, and the potential policy and translational implications of this line of research. The course will include overviews of the underlying biological principles driving these analyses, laboratory methods involved, analytic approaches, epidemiologic considerations, recent developments (biological aging), and the strengths/limitations of these approaches. Upon completion of this course, students should be better equipped to read and interpret the scientific literature utilizing these methods and begin to consider how these approaches could be included in their own research.

## MPH/MSPH FOUNDATIONAL COMPETENCIES:

EH Department Competencies

- Apply the principles of epidemiology to assess health effects of environmental exposures.
- Apply the principles of exposure science to characterize environmental exposures

**CONCENTRATION COMPETENCIES:**

- Apply epidemiological methods to the breadth of settings and situations in public health practice.

**COURSE LEARNING OBJECTIVES:**

- Recognize the utility of large-scale molecular data approaches applied to public health research
- Understand the biological basis of the molecular features being interrogated
- Explain the experimental basis of these techniques and recognize the strengths and limitations of these approaches
- Be able to read, critically evaluate, and interpret scientific papers utilizing –omics technologies
- Consider how these technologies could inform new research in various aspects of public health
- Reflect on how results of these studies could be utilized to drive policy or inform prevention or intervention approaches

**EVALUATION**

Class Participation (40%): Students are expected to ask questions of presenters and participate when questions are asked to the class. Contributing to in-class discussions is such an important part of this class, so attendance is part of your grade and absences must be approved in advance by the instructor; each unexcused absence beyond one will lower your grade by 5% on the grading scale.

Article Critiques (30%): Groups of students (2-3) will be tasked with presenting an overview of a selected research article, describing the strengths/limitations of the authors' approach, the main findings, and the students' own interpretations about the strength of evidence presented in the article, followed by a class discussion.

Final Project (30%): Students will prepare a final project (3-4pg paper with minimum 5 refs) that relates to the students' public health fields and interests (ie. health disparities, maternal and child health, translational research, exposure assessment, etc.). Students can either chose to:

1. Write a commentary about how 'omics can be incorporated into their selected public health field, or
2. Write a descriptive paper about publicly available -omics resources in their selected field, and how those resources could be leveraged to answer a novel research question.

**Grading Scale:** *Pass/Fail is optional with instructor approval.*

| A | A- | B+ | B | B- | C | F |
|---|---|---|---|---|---|---|
| 90-100% | 85-89% | 80-84% | 75-79% | 70-74% | 55-69% | <55% |

## COURSE STRUCTURE

EH 590R, "*Applications of 'Omics Technologies in Public Health Research*", will provide students with an overview of the systems biology, genomics, epigenomics, metabolomics, microbiome studies, and the potential policy and translational implications of this line of research. Dr. Everson will serve as the primary course instructor throughout the semester. At the start of the third week, groups of students will sign-up for the article presentation/critique topics, the presentations/critiques themselves will occur throughout the semester. Guest speakers will be invited to present on topics for their respective fields, and lead discussion on the promises and challenges within those fields. Students will get approval for their final project structure and topic by the tenth week of class, and final projects will be due on the last day of class.

## COURSE POLICIES

Attendance is mandatory and absences must be approved in advance by the instructor; each unexcused absence beyond one will lower your grade by 5% on the grading scale. The only assignment that will be handed in is the final project, which is due on the last day of class. Late submissions will not be accepted.

As the instructor of this course I endeavor to provide an inclusive learning environment. However, if you experience barriers to learning in this course, do not hesitate to discuss them with me and the Office for Equity and Inclusion, 404-727-9877.

## RSPH POLICIES

### Accessibility and Accommodations

Accessibility Services works with students who have disabilities to provide reasonable accommodations. In order to receive consideration for reasonable accommodations, you must contact the Office of Accessibility Services (OAS). It is the responsibility of the student to register with OAS. Please note that accommodations are not retroactive and that disability accommodations are not provided until an accommodation letter has been processed.

Students who registered with OAS and have a letter outlining their academic accommodations are strongly encouraged to coordinate a meeting time with me to discuss a protocol to implement the accommodations as needed throughout the semester. This meeting should occur as early in the semester as possible.

Contact Accessibility Services for more information at (404) 727-9877 or accessibility@emory.edu. Additional information is available at the OAS website at http://equityandinclusion.emory.edu/access/students/index.html

**Honor Code**

**You are bound by Emory University's Student Honor and Conduct Code.** RSPH requires that all material submitted by a student fulfilling his or her academic course of study must be the original work of the student. Violations of academic honor include any action by a student indicating dishonesty or a lack of integrity in academic ethics. *Academic dishonesty refers to cheating, plagiarizing, assisting other students without authorization, lying, tampering, or stealing in performing any academic work, and will not be tolerated under any circumstances.*

The RSPH Honor Code states: "Plagiarism is the act of presenting as one's own work the expression, words, or ideas of another person whether published or unpublished (including the work of another student). A writer's work should be regarded as his/her own property."
(http://www.sph.emory.edu/cms/current_students/enrollment_services/honor_code.html)

**COURSE CALENDAR (Tentative)**

| Date | Topic | Activities |
|---|---|---|
| Aug. 31 | Intro to 'Omics & Systems Biology | Lecture, Discussion |
| Sep. 7 | Labor Day | No Class – Think about presentation topics and dats |
| Sep. 14 | Principles of Molecular Epidemiology | **Sign up for Presentation Topic/Date** |
| Sep. 21 | Principles of Molecular Epidemiology | Lecture, *Possible Group Presentation*, Discussion |
| Sep. 28 | Genomics & Transcriptomics | Lecture, Discussion |
| Oct. 5 | Genomics & Transcriptomics | Lecture, *Possible Group Presentation*, Discussion |
| Oct. 12 | Fall Break | No Class |
| Oct. 19 | Epigenomics | Lecture, Discussion |
| Oct. 26 | Epigenomics | Lecture, *Possible Group Presentation*, Discussion |
| Nov. 2 | Biological Aging | Lecture, Discussion, **Get approval for final project topic** |
| Nov. 9 | Biological Aging | Lecture, *Possible Group Presentation*, Discussion |
| Nov. 16 | Metabolomics | Lecture, *Possible Group Presentation*, Discussion |
| Nov. 23 | Microbiome | Lecture, *Possible Group Presentation*, Discussion |
| Nov. 30 | Translation & Policy | Lecture, *Possible Group Presentation*, Discussion |
| Dec. 7 | Translation & Policy, Wrap-up | **Final Projects Due** |

**COURSE OUTLINE (Tentative)**

Introducing 'omics and systems biology – 2 weeks

History and evolution of omics
Where does omics fit in Environmental Health and Epidemiology?
Basic concepts of systems biology
Basic cell biology

Class Materials:

- PowerPoint Lecture, Discussion
- Readings: Vineis (2018) From John Snow to omics: the long journey of environmental epidemiology, *European Journal of Epidemiology*

Principles of Molecular Epidemiology – 2 weeks

Intro to epidemiologic principles
Temporality, mechanisms, and biomarkers
Random error, False Negatives and False Positives
Measurement error and information bias

Class Materials:

- PowerPoint Lecture, Article Presentations/Critiques, Discussion
- Readings:
    1. Maturana (2016) Toward the integration of Omics data in epidemiological studies: still a "long and winding road", *Genetic Epidemiology*
    2. Richmond (2016) Challenges and novel approaches for investigating molecular mediation, *Human Molecular Genetics*

Genomics & Transcriptomics Module – 2.5 weeks

Introduction to Genetics and Central Dogma
Genetic Variability in Population Studies and GWAS
Transcriptome (include discussion of cellular heterogeneity)
Systems biology Analysis of Transcriptome data
Mitochondrial dynamics

Class Materials:

- PowerPoint Lecture, Article Presentations/Critiques, Discussion
- Readings:
    1. Bush (2016) Genome-Wide Association Studies, *PLOS Computational Biology*
    2. Horikoshi (2016) Genome-wide associations for birth weight and correlations with adult disease, *Nature*
    3. Gupta (2016) Transcriptome analysis reveals dysregulation of innate immune response genes and neuronal activity-dependent genes in autism, *Nature Communications*

Epigenomics Module – 2.5 weeks

Introduction to Epigenetics
DNA modifications from single genes to genomes
Chromatin modifications and applications

Noncoding RNA
Distinctions between GWAS and EWAS approaches/considerations

Class Materials:

- PowerPoint Lecture, Article Presentations/Critiques, Discussion
- Readings:
    1. Ladd-Acosta (2016) The role of epigenetics in genetic and environmental epidemiology, Epigenomics
    2. Joubert (2016) DNA Methylation in Newborns and Maternal Smoking in Pregnancy: Genome-wide Consortium Meta-analysis, *American Journal of Human Genetics*
    3. Tobi (2018) DNA methylation as a mediator of the association between prenatal adversity and risk factors for metabolic disease in adulthood, *Science Advances*

Biological Aging – 2 weeks

Telomere length
Epigenetic clocks
Mechanisms underlying ageing processes
Genetic and environmental influences
As predictors of morbidity and mortality

Class Materials:

- PowerPoint Lecture, Article Presentations/Critiques, Discussion
- Readings:
    1. Hastings (2017) Translating Measures of Biological Aging to Test Effectiveness of Geroprotective Interventions: What Can We Learn from Research on Telomeres?, *Frontiers in Genetics*
    2. Horvath (2018) DNA methylation-based biomarkers and the epigenetic clock theory of ageing, *Nature Reviews Genetics*
    3. Zhang (2020) The ageing epigenome and its rejuvenation, *Nature Reviews Molecular Cell Biology*

Metabolomics Module – 1 week

Introduction to cellular metabolism
Systems biology analysis of metabolomics data
Distinctions between MWAS vs. GWAS and EWAS

Class Materials:

- PowerPoint Lecture, Article Presentations/Critiques, Discussion
- Readings:
    1. Fearnley (2016) Metabolomics in epidemiology: from metabolite concentrations to integrative reaction networks, International Journal of Epidemiology
    2. Mu (2019) Metabolomics Profiling before, during, and after the Beijing Olympics: A Panel Study of Within-Individual Differences during Periods of High and Low Air Pollution, Environmental Health Perspectives

Microbiome – 1 week

From microbiology to microbiome
The Human Microbiome Project
Incorporation of microbiome studies in population research

Class Materials:

- PowerPoint Lecture, Article Presentations/Critiques, Discussion
- Readings:
    1. Griffith (2019) Invited Commentary: Improving the Accessibility of Human Microbiome Project Data Through Integration With R/Bioconductor, *American Journal of Epidemiology*
    2. Klase (2018) The microbiome and antibiotic resistance in integrated fishfarm water: Implications of environmental public health, *Science of the Total Environment*

Translational and Policy Implications of 'omics research – 2 weeks

Communicating this research to the public
Incorporation of 'omics and risk assessment
Using 'omics in preventive or treatment efforts

Class Materials:

- Final Projects Due, PowerPoint Lecture, Discussion
- Readings:
    1. Vrijheid (2014) The exposome: a new paradigm to study the impact of environment on health, *Thorax*
    2. Holtzman (2018) Editing the epigenome: reshaping the genomic landscape, *Annual Review of Genomics and Human Genetics*