

# EPID/MICROBIOL 582

## Molecular Epidemiology

### COURSE SYLLABUS — Winter 2022

## // COURSE OVERVIEW

### Course Information

**Instructor:** Evan Snitkin, PhD

**Course Assistants:** Ali Pirani and Hasan Abu-Amara

**Session:** Jan 5, 2022 – April 18, 2022

**Weekly class meeting:** Mondays and Wednesdays, 8:30-10:00am, 1112 SPH2

**Office hours:** M/W 10:30am-noon

**Contact:** [esnitkin@umich.edu](mailto:esnitkin@umich.edu)

### Format

The course is scheduled to be in person, but I will also be using Zoom to record each session and allow for virtual guest speakers. Please check your version of zoom, and make sure you are using version 5.3.0 or higher and are viewing using an app (either on a computer or mobile phone). This enables use of newer zoom features, such as allowing participants to choose a breakout room of their choice.

### Course Description

Molecular Epidemiology (but really Genomic Epidemiology) --- Provide an overview of cutting-edge approaches for microbial genomic analysis, with a focus on their application in the emerging field of genomic epidemiology. Lectures will be reinforced with discussions and extensive hands-on training. Students will gain experience on the command-line and in performing downstream analysis and visualization in R.

### Course Goals/Foundational Competencies (FC)

- To gain hands on experience in the analysis of microbial genomic data
- To gain experience in interpreting microbial genomic data to inform public health action

### Learning Objectives

Specifically, you will be able to:

1. Navigate the Unix command line and submit jobs to a compute cluster
2. Run a suite of modern tools for bacterial genomic analysis

3. Execute bacterial genomic workflows starting with data download/quality control and leading all the way through processed results that are suitable for interpretation
4. Analyze bacterial genomic data sets to summarize their strain distribution, antibiotic resistance potential and identify putative cases of recent transmission
5. Describe challenges associated with studying transmission using bacterial genomic data

### Pre-requisites

We will not assume prior coursework, but will expect a basic understanding of microbiology, molecular biology and infectious disease outbreaks.

## // COURSE REQUIREMENTS

Most class sessions will comprise 20-30 minutes background lecture on the day's topic, followed by ~60-70 minutes of guided computational lab work. Students are required to attend both lecture and lab components. In addition, it will be expected that required readings/materials are reviewed in advance of class. Detailed instructions for pre-class readings and assignments will be available on the Canvas website.

### Course Materials

All course materials will be available on or linked from the Canvas site.

## // COURSE COMMUNICATION

To ensure that your questions are answered as promptly as possible, please follow the communications guidelines below:

### Academic Support

- **Zoom/classroom** is best used for live sessions with the instructor and peers.
- **Slack:** Slack channels will be created to discuss different topics, homework and/or assignments.
- **Email:** Topics that do not fit within the context of a Slack discussion and/or are private in nature can be communicated via email

## // ASSIGNMENTS & GRADING

### Individual Assignments (50%)

There will be four individual assignments. These assignments will be designed to provide you with additional experience with data analysis tools that are introduced during lectures, as well as opportunities to practice tool exploration and data interpretation.

### Group journal article presentation (10%)

The class will break into groups, with each group presenting a journal article to the class that describes the application of bacterial genomics to study transmission of antibiotic resistant organisms. The presentation will be expected to encompass background, methods, and interpretations.

### Final project (30%)

For the final project we will break into teams, with each team's objective being perform a genomic epidemiologic investigation. Teams will present their findings, as well as relevant background material, to the class.

### Participation (10%)

Participation is a key component of this course. Participation will include actively participating in lecture and small group discussions, as well as during outside discussions (e.g. on Slack and Canvas). Participation will be marked complete/not complete.

## // COURSE POLICIES

### What you can expect from me

#### > Commitment to your learning and your success

I believe all students are unique and will thrive in a learning environment that is challenging yet supportive of critical thinking and active learning. My goal as an instructor is to encourage mastery, competency and transformational learning relevant to success in the field of public health. Please talk to me if there is anything you want to discuss or about which you are unclear. I want to be supportive of your learning and growth.

#### > Inclusive & supportive learning community

I believe that learning happens best when we all learn together as a community. This means creating a space characterized by generous listening, adventurous civility, humility, patience, and hospitality. I will strive to create a safe classroom environment that promotes scholarly dialogue and informed debates that are respectful of diverse perspectives. Classroom discussions, activities, and assignments dealing with sensitive issues involving social determinants of health will demonstrate these values and beliefs.

### > **Openness to feedback**

I appreciate straightforward feedback from you regarding how well the class is meeting your needs. Let me know if material is not clear or when its relevance to the student learning outcomes for the course is not apparent. Please also let me know if there's an aspect of the class you find particularly interesting, helpful, or enjoyable!

### > **Responsiveness**

I will monitor email daily and respond to all messages within ~24 hours Monday-Friday (~48 hours over weekends or holiday periods).

### > **Clear guidelines and prompt feedback on assignments**

I'll provide clear instructions for all assignments and grading criteria. I'll provide detailed feedback on your submissions and update grades promptly CANVAS.

## **What I expect from you**

### > **Attend class**

You are expected to attend all scheduled meetings. We will plan to meet in person, but there will also be a Zoom option if needed. If you must miss a meeting due to illness, a family emergency, a religious holiday, or some other valid reason, please let me know **prior** to the class in question. Unexcused absences will impact your overall participation grade.

### > **Participate**

I encourage you to ask questions in class and in discussion forums to help create a vibrant learning environment. I'll expect all of us to be respectful of each other's contributions, whether we agree with them or not.

### > **Be proactive**

If you find that you have any trouble keeping up with assignments or other aspects of the course, make sure you let me know as early as possible. Make sure that you are proactive in informing me when difficulties arise during the course so that I can help you find a solution.

### > **Complete assignments**

All assignments for this course will be submitted electronically through CANVAS unless otherwise instructed. I encourage you to make your best effort to submit all assignments on time, but I understand that sometimes circumstances arise that are beyond our control. If you need an extension, please contact me. Assignments submitted late without prior approval will not be eligible for full credit.

### > **Seek help if you need it**

We believe it is important to support the physical and emotional well-being of our students. If you are experiencing physical or mental health issues, we encourage you to use available resources such as those listed below. If you have a health issue that is affecting your performance or participation in the course, and/or if you need help connecting with these resources, please contact me or the SPH Office for Student Engagement and Practice via [phs.support@umich.edu](mailto:phs.support@umich.edu).

- [Well-being for U-M Students](#): Embrace the concept of well-being as a multidimensional lifelong journey. Search university-wide resources (note the “virtual” location filter) and take breaks with stress-relieving videos.
- [MiTalk](#): Review information on a variety of mental health topics, including recorded workshops, online lectures, and skill-building tools.
- [Stressbusters App](#): View, share, store, and use campus event announcements, news alerts, student and department videos, one-touch dial emergency buttons, health tips, surveys and other features, directly on iOS and Android mobile devices.
- [SPH Emergency Fund Request](#): Request support if you encounter an emergency situation or another unusual, unforeseen expense while enrolled in your degree program.
- [Sexual Assault Prevention and Awareness Center \(SAPAC\) Chat](#): Your chat advocate can help answer questions about your concerns related to sexual assault, sexual harassment, stalking, or intimate partner violence and connect you to resources. SAPAC services include - but are not limited to - information and advocacy regarding housing, academics, Title IX, and medical options, and criminal legal processes.

## Student Well-Being

Students may experience stressors that can impact both their academic experience and their personal well-being. These may include academic pressure and challenges associated with relationships, mental health, alcohol or other drugs, identities, finances, etc.

If you are experiencing concerns, seeking help is a courageous thing to do for yourself and those who care about you. If the source of your stressors is academic, please contact me so that we can find solutions together. For personal concerns, U-M offers many resources, some of which are listed at [Resources for Student Well-being](#) on the Well-being for U-M Students website. You can also search for additional resources on that website.

### > Inform me of any accommodations needed

If you need special accommodations due to a disability, illness, or injury, please inform me as soon as possible. In particular, if you are registered with the university's [Services for Students with Disabilities](#) and would like to activate any accommodations, please provide me with your VISA letter as early as possible. Please note that some accommodations take longer to implement than others (e.g. scheduling live captioning during Zoom sessions).

Some religious holidays may occur on regularly scheduled class days. Because available class sessions are limited in number, we will have to hold class on all such days. If you must miss a meeting due to a religious holiday, please get permission from me prior to the class in question.

### > **Commit to integrity**

As a student in this course and at this university you are expected to maintain a high degree of professionalism, commitment to active learning and participation in this class, and also integrity in your behavior in and out of the classroom. Preparation of papers assigned on an individual basis must represent your own individual effort. When used, resource materials should be cited in conventional reference format.

To promote academic integrity and improve student outcomes this course will use a plagiarism detection service. Cheating and other forms of academic misconduct will not be tolerated and will be dealt with firmly. Student academic misconduct refers to behavior that includes plagiarism, cheating on exams or assignments, fabrication of data, falsification of records or official documents, intentional misuse of equipment or materials (including library materials), or aiding and abetting the perpetration of such acts.

Please visit <https://sph.umich.edu/ns/student-resources/index.html> for the full Policy on Student Academic Conduct Standards and Procedures.

### > **Support Diversity, Equity, and Inclusion**

The University of Michigan School of Public Health seeks to create and disseminate knowledge, with the aim of preventing disease and promoting the health of populations worldwide. We recognize the histories of social discrimination globally and seek to promote and extend opportunities for members of all groups that historically have been marginalized. We commit to developing the institutional mechanisms and norms necessary to promote the values of diversity, equity, and inclusion, both inside and outside our classrooms. To this end, SPH upholds the expectations that all courses will (1) be **inclusive**, (2) promote **brave discussions**, (3) follow **multicultural ground rules**, and (4) abide by **U-M policies and procedures**.

- **Inclusive courses** are those in which teachers and learners co-create and co-sustain environments that support and encourage all members to participate equitably.
- **Brave** (rather than safe) discussions promote diversity and social justice learning by acknowledging the dynamics of oppression and privilege both inside and outside the classroom.
- **Multicultural ground rules** acknowledge diverse experiences in the classroom and offer strategies for holding one another appropriately accountable.
- **U-M policies and procedures** can be found at <https://diversity.umich.edu> with additional resources and instructions for reporting discrimination at <https://sph.umich.edu/diversity-equity-inclusion/resources.html>.

## // COURSE SCHEDULE

| Section                                                                |        | Lecture                                          | Lab                                               | Assignments                               |
|------------------------------------------------------------------------|--------|--------------------------------------------------|---------------------------------------------------|-------------------------------------------|
| Working with sequence data at the command line                         | 5-Jan  | 1- Overview of genomic epidemiology              | Intro to bash                                     |                                           |
|                                                                        | 10-Jan | 2- Great Lakes environment                       | Intro to cluster computing                        |                                           |
|                                                                        | 12-Jan | 3- Sequence data formats                         | Working with sequence files in Unix               | Working on the command line               |
|                                                                        | 17-Jan |                                                  |                                                   |                                           |
| Generating sequence data and summarizing strain diversity and function | 19-Jan | 4 - Illumina sequencing and data QC              | Trimming and filtering sequence data              |                                           |
|                                                                        | 24-Jan | 5 - Genome assembly                              | Genome assembly and evaluation                    |                                           |
|                                                                        | 26-Jan | 6 - Genome annotation                            | Genome annotation and functional classification   |                                           |
|                                                                        | 31-Jan | 7 - Resitome analysis                            | Antibiotic resistance gene and variant annotation |                                           |
|                                                                        | 2-Feb  | 8 - Data download and genome comparison          | In silico MLST and rapid pairwise distance        | Data download, QC and genome annotation   |
| Basic phylogenetic analysis                                            | 7-Feb  | 9 - Reference based variant calling              | Antibiotic resistance mutations                   |                                           |
|                                                                        | 9-Feb  | 10 - Using genomic data to study transmission    |                                                   |                                           |
|                                                                        | 14-Feb | 11 - Intro to Rstudio                            | Intro to R                                        |                                           |
|                                                                        | 16-Feb | 12 - Basic phylogenetic analysis                 | Visualizing and interpreting phylogenies          |                                           |
|                                                                        | 21-Feb | 13 - Genome wide association studies             | Identifying resistance causing variants           |                                           |
| Spring break                                                           | 23-Feb | 14 - Recombination detection                     | Acinetobacter outbreak                            | Mutations and trees                       |
|                                                                        | 28-Feb |                                                  |                                                   |                                           |
| Tracking transmission from sequencing data                             | 2-Mar  |                                                  |                                                   |                                           |
|                                                                        | 7-Mar  | Journal article resentation work time            |                                                   |                                           |
|                                                                        | 9-Mar  | 15 - Guest lecture on AMR in public health       |                                                   |                                           |
|                                                                        | 14-Mar | 16 - Hospital outbreak investigation             | Class journal article presentations               |                                           |
|                                                                        | 16-Mar | 17 - Transmission in endemic settings            | Class journal article presentations               |                                           |
|                                                                        | 21-Mar | 18 - Regional outbreaks                          | ST258 KPC outbreak in Chicago                     | Genomic epidemiology of regional outbreak |
|                                                                        | 23-Mar | 19 - Regional endemic spread                     | ST258 spread in LA County with regentrans         |                                           |
| Genomic epidemiology of SARS-CoV-2                                     | 28-Mar | 20 - Guest lecture on environmental surveillance |                                                   |                                           |
|                                                                        | 30-Mar | 21 - Guest lecture on genomics in state labs     |                                                   |                                           |
|                                                                        | 4-Apr  | Project work time                                |                                                   |                                           |
|                                                                        | 6-Apr  | 22 - SARS-CoV-2 genomics                         | SARS-CoV-2 genome filtering and QC                |                                           |
|                                                                        | 11-Apr | Project work time                                |                                                   |                                           |
| Final                                                                  | 13-Apr | 23 - Dated phylogenetic analysis                 | Early introduction and spread across the U.S.     |                                           |
|                                                                        | 18-Apr | Project presentations                            |                                                   |                                           |