Evolution of Infectious Disease

Course Number: MCB 435
Credit Hours: 3

Instructor: Dr. Rachel Whitaker
The best way to reach me is to *talk to me in person*. Please meet me before or after class, at office hours or make an appointment. Email is not an efficient way to reach me. Please do not depend on it.

office: CLSL C222 (Tuesday, Thursday)
IGB 3101 (Monday, Wednesday, Friday)

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Teaching Assistants: Samantha DeWerff dewerff2@illinois.edu

Meeting Place and Time:

Class:	Tuesdays and Thursdays 11:00-12:20 PM 17 Psychology Building
Whitaker office hours:	Wednesday 12:30-2:00 PM 3410 IGB (or contact clscott@illinois.edu for appointment)
DeWerff office hours:	Monday 9:00 – 10:00 (or by appointment)

Course website: Moodle MCB435

Course Summary: Understanding the evolution and ecology of infectious disease is of great importance to human and animal health. We will illustrate critical applications of basic ecological and evolutionary principles with examples from the recent primary literature. We will focus on what genomics and sequence analysis can tell us about the ecology of healthy and protective human microbiome, spread and emergence of disease, the evolutionary basis for antibiotic resistance, effective vaccine design, and emerging infectious disease.

Learning Objectives: A successful student in MCB435 will learn to:

- Critically read the primary scientific literature and evaluate results.
- Frame sophisticated biological questions and formulate testable hypotheses.
- Build a logical evidence-based argument and communicate your knowledge to others.
- Describe how a whole system works from the molecular to the organism or ecosystem level.
- Analyze signatures of evolutionary and ecological processes in genomic data.
- Predict how human actions influence dynamic microbial communities in the
    - The stability and diversity of the human microbiome.
    - The spread, emergence or eradication of infectious disease.

Readings: Microbiome diversity and genome resolved evolution of infectious disease are new and rapidly progressing fields – no single textbook provides the background you will need. Articles to support lecture material and provide additional detailed, in-depth, information may be provided on the website. Students are not responsible for these reading materials on examinations unless otherwise noted. These readings are meant to augment the classroom materials.

In addition, we will read and discuss five articles from the primary literature. **Students are responsible for the material covered in these articles on quizzes.** For more information see Reading the Primary Literature.

Evaluations:

Quizzes (3 best of 4)	300
Microbiome Workshop	200
Avida Workshop	200
Semester Project	300
Total	1000

Late policy: Any assignments handed in after the posted deadline will be marked down 10 points each day to half the total points.

Quizzes – 300 pts (top 3 x 100 pts each)
Quizzes will cover lectures and materials on assigned papers and workshops. Quizzes are cumulative but focus on topics since the last quiz. Quizzes will include the paper discussed on the day of the quiz (it must be read ahead of time). Quizzes will follow paper discussions and last for approximately 30 minutes. Of the four possible 100 pt quizzes students are permitted to drop 1 with their lowest score for a total of 300 points.

Workshops -- 200 pts each
Two in-class workshops will allow students to practice experimental design and data analysis. More complete rubrics can be found on the class website.

1. The Microbiome workshop will involve a class microbiome study throughout the semester. We will be designing an experiment and writing a proposal to support it. We will then be implementing, analyzing data, and writing a laboratory report on the class data from the project.
2. The Avida workshop will be an individual *in silico* experiment. Students again will propose and run an experiment of their own design on in silico evolution (with controls and replicates), analyze data, and write a report on their individual data.

Semester Project -- 300 points
Many of the topics in our class are of great interest to the general public. After taking MCB435 you will have a responsibility to take what you learned and teach others about these important topics that impact everyone everyday. As a semester project the class will split into 4 topics centered around pertinent questions. The end goal is to write a blog post or short video and present the research your group has done in the topic area to the general audience. Most of the project results in independent student outcomes until the final group synthesis.

Extra credit: Evolution of Infectious Disease in the news – Extra credit up to 40 pts (20 pts each article)
Everyday there are reports in the popular press about the evolution of infectious disease or the microbiome. For extra credit monitor this news and highlight one article from the population press that relates to topics we have discussed. Possible sources include: any major newspaper or news organization, (New York Times, Chicago Tribune, Washington Post, National Public Radio), news/science blogs for example HuffingtonPost, Science Daily, Science News, MicrobeWorld. News articles must be current being posted by you with a date and report in class within two weeks of when they are posted. To earn credit you must submit your report in the format described and present your article at the beginning of the following class. Please see Extra Credit for more information on the format

Date	Topic	Assignments and evaluations		
		Quizzes (drop 1)	Semester Project	Workshops
January 15	The Molecular Revolution/Overview			
January 17	Scales of Diversity			
January 22	Human Microbiome Communities			
January 24	Changes in the Microbiome/Microbiome Experimental Design			
January 29	Choosing and reading primary literature		Topic Reviews Read	Proposal for microbiome experiment (50 pts)
January 31	Group paper selection			Microbiome Experiment begins
February 5	*Paper 1* *Vangay, Pajau, et al. "US Immigration Westernizes the Human Gut Microbiome." Cell 175, no. 4 (November 1, 2018): 962-972.e10.*	*Quiz 1 (100 pts)*		
February 7	Microbial Populations and Genomes		List of papers due	
February 12	Evolutionary Processes: Mutation			
February 14	Evolutionary Processes: Selection		Focus paper justification (25 pts)	Microbiome Experiment ends
February 19	*Paper 2* *Couce, Alejandro et al. "Mutator Genomes Decay, despite Sustained Fitness Gains, in a Long-Term Experiment with Bacteria." Proceedings of the National Academy of Sciences 114, no. 43 (October 24, 2017): E9026–35.*	*Quiz 2 (100 pts)*		
February 21	Evolutionary Processes: Gene flow			
February 26	Evolution Workshop		Paper Summary (50 pts)	
February 28	Evolution Workshop			
March 5	Transmission			
March 7	Discuss paper summaries			Avida Experimental Design Due (50 pts)
March 12	Signatures of Molecular Evolution			
March 14	Paper 3 Klemm, Elizabeth J., et al. "Emergence of an Extensively Drug-Resistant Salmonella Enterica Serovar Typhi Clone Harboring a Promiscuous Plasmid Encoding Resistance to Fluoroquinolones and Third-Generation Cephalosporins." MBio 9, no. 1 (March 7, 2018): e00105-18.	*Quiz 3 (100 pts)*	Paper Critique (50 pts)	
Spring break				
March 26	Co-evolution and choosing a host			
March 28	Paper 4			Avida Experiment Report Due (150 pts)

	Kafetzopoulou, L. E., S "Metagenomic Sequencing at the Epicenter of the Nigeria 2018 Lassa Fever Outbreak." Science 363, no. 6422 (January 4, 2019): 74–77.			
April 2	One Health		Topic synthesis (50 pts)	
April 4	*Paper 5* *Pehrsson, Erica C., et al. "Interconnected Microbiomes and Resistomes in Low-Income Human Habitats." Nature 533, no. 7602 (May 2016): 212–16. https://doi.org/10.1038/nature17672.*	*Quiz 4 (100 pts)*		
April 9	Group Project			
April 11	Group Project		Translated synthesis (50 pts)	
April 16	Microbiome Workshop			
April 18	Microbiome Workshop			
April 23	Group Project			
April 25	Project Presentation		Draft Projects due	
April 30	Group Project Revision			Microbiome Paper Due (150 pts)
May 8	8-11 Final		Project Presentations (75 pts)	
Total Score		**300**	**300**	**400**