

# Evolutionary and Genomic Medicine

ECEV 33365 · WF 1:30-2:50 p.m. · Winter 2018

## Instructors

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## Course description

Evolution is regularly investigated in free-living organisms, but some of its most fascinating and important examples occur in the interface between free-living and non-free-living states. In this course, we will use evolutionary and ecological principles to study the dynamics of viruses, unicellular organisms, and cells in multi-cellular organisms relevant to human medicine. The emphasis will be on the evolution of pathogens, the evolution of cells of the immune system in response to pathogen invasion, the basis of autoimmune disorders, and the population genetics of cancerous cells in light of recent cancer genomic studies. This will be a mixed lecture and seminar-style course with substantial reading, presentation, and discussion by students.

## Course objectives

The primary objective of this course is to teach you at a conceptual level how to analyze the evolutionary dynamics of medically relevant, competing cell (or cell-like) populations: pathogens, lymphocytes, and tumors. A secondary objective is to introduce you to major recent advances in these areas and to highlight the questions that remain unanswered.

## Prerequisites

Students should have a solid background in evolution and some exposure to population genetics. Many concepts will be reviewed in class, but we expect students to have facility with basic concepts and the motivation to get up to speed on them quickly. Students should also have basic skills in R or python (or be prepared to develop them through mostly self-instruction). If you have concerns, please contact one of the instructors in the first week.

## Format

Each class will begin with a discussion of the reading assigned for that day. People may be asked to provide incisive summaries of each article or to lead the discussion. Plan to contribute substantively to the discussion every class. Discussions will be followed by short, interactive lectures introducing the next topic and reading. We will occasionally use these lectures to work through problems. Near the end of the course, one class will be dedicated to student presentations of term papers.

## Readings

Because this is a discussion class, it is important to read the assigned papers deeply and critically. For example, it will often be useful to read the supplements of articles and to look up

heavily referenced related papers or topics on your own. If you find a paper especially difficult, please come to office hours or work through it with other members of the class. Your thoughts on the reading should be well developed by the time you show up to class. You are welcome to suggest readings if you find any that may be relevant.

### **Problem sets**

There is one exercise (to select next year's influenza vaccine strains) that integrates knowledge from the first half of the course.

### **Exam**

If enrollment is high or demand strong, we will offer an optional exam in lieu of a final paper.

### **Paper**

This course provides heavy exposure to recent, high-quality scientific papers, and we'll be discussing active areas of research. We encourage you to take advantage of your interest and growing expertise in the course topics to write a term paper on a relevant subject of your choice. The paper should be 5-7 pp. long (single-spaced), excluding references, figures, and tables. You have two options when writing this paper, which will be partially dictated by your topic:

- (1) Identify an interesting question and analyze the extent to which it has been answered scientifically (a review/perspective paper). We emphasize the perspective aspect of a review paper. In other words, we are not seeking a summary of what has been said but an analysis of a particular subject.
- (2) Identify an interesting question, describe its importance and the extent to which it has been answered scientifically, and propose experiments that would help answer the question (a grant proposal). You may include preliminary data.

Note that both types of papers require comprehensive knowledge of the relevant literature. Thus, it's important to start reading early to develop a sense of whether there is enough material for a review paper or if a proposal is more appropriate. One or more tentative questions (topics) with brief descriptions are due *at the latest* by February 15. Your final question, a list of at least a dozen references (that you have read), and an outline of your paper will be due February 22. The presentation will be an opportunity for you to obtain feedback from other students and the instructors before submitting the final paper. We will provide detailed guidelines for the papers later in the term.

### **Office hours**

Office hours are by appointment. You are also welcome to email questions.

### **Evaluation**

Half of your grade (50%) will be based on the quality of your contributions to the discussions. The problem set will be 10% of your grade. Forty percent is based on the final paper and presentation *or* exam.

### **Academic/Scientific integrity**

There is no tolerance for breaches of academic integrity. You are responsible for understanding the definitions of plagiarism, cheating, etc., and for following proper citation practices. You may not reuse material from another assignment or project for this class without prior approval. Please talk with the instructors if you are unsure.

## Accommodations

If you require any accommodations for this course, as soon as possible please provide your instructor with a copy of your Accommodation Determination Letter (provided to you by the Student Disability Services office) so that you may discuss with him/her how your accommodations may be implemented in this course. The University of Chicago is committed to ensuring the full participation of all students in its programs. If you have a documented disability (or think you may have a disability) and, as a result, need a reasonable accommodation to participate in class, complete course requirements, or benefit from the University's programs or services, you are encouraged to contact Student Disability Services as soon as possible. To receive reasonable accommodation, you must be appropriately registered with Student Disability Services. Please contact the office at 773-702- 6000/TTY 773-795-1186 or disabilities@uchicago.edu, or visit the website at disabilities.uchicago.edu. Student Disability Services is located at 5501 S. Ellis Avenue.

## Tentative Syllabus

<b>Date</b>	<b>No.</b>	<b>Topic</b>
Jan. 3 (W)	1	Evolutionary themes and pathogen dynamics
Jan. 5 (F)	2	Phylogenetics
Jan. 10 (W)	3	Antigenic evolution
Jan. 12 (F)	4	Vaccine-induced evolution
Jan. 17 (W)	5	Antimicrobial resistance: theory
Jan. 19 (F)	6	Antimicrobial resistance: constraints
Jan. 24 (W)	7	Predicting evolution
Jan. 26 (F)	8	Antibodies and evolved evolvability
Jan. 31 (W)	9	Antibodies and competition
Feb. 2 (F)	10	Immunity as an investment
Feb. 7 (W)	11	Concept of cancer as cellular and evolutionary phenomena
Feb. 14 (W)	12	Cancer genomics ( <i>paper questions due</i> )
Feb. 16 (F)	13	The coalescence of cells and genetic diversity within tumors
Feb. 21 (W)	14	Evolution of "free-living" single cells ( <i>outline due</i> )
Feb. 23 (F)	15	Transition from normal to cancerous state, cancer stem cells
Feb. 28 (W)	16	Canalization and transcriptome stability in relation to miRNA regulation
Mar. 2 (F)	17	Immunotherapy
Mar. 7 (W)	18	Presentations
Mar. 12 (M)	-	<i>Papers due by 9 a.m.</i>