

Evolution of Infectious Disease

Spring Semester

TTh 10:55-12:15

ENR 123

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Office Hours: Tuesdays 12:45-2pm, Foran 316 or by appointment

Course Description:

Evolution underlies every aspect of biology, but many people have an impression that evolution is restricted to the study of fossils revealing how large organisms are related to one another. Evolution continues to occur, and we can study both microevolution and macroevolution of microbes within human lifetimes. We will survey how pathogenic microorganisms have evolved, with an emphasis on understanding how the same evolutionary principles that we infer from large eukaryotic species can be concretely observed in viruses, bacteria and eukaryotic parasites. This course will highlight the rapidity with which microbes respond to changing ecology, including human interventions, and the mechanisms of creating and maintaining population variation that underlies this adaptability. Through studying the evolution of specific pathogens in depth, the role of both natural selection and genetic drift will be illustrated. The practical applications of experimental evolution and evolutionary theory in designing vaccines, drugs and other interventions against infectious disease will also be covered. While some microbial biology and immunology will be taught as a necessary component of understanding microbial evolution, this will not be a course in pathogenic microbiology, and will focus on the evolution of viruses, bacteria and a few eukaryotic pathogens.

In addition to the lectures, students are expected to learn some course concepts directly from the primary scientific literature and from a wide range of media that communicate science to the public: a bestselling book on emerging diseases, the New York Times, science bloggers, podcasts and YouTube clips produced by scientists. Students will demonstrate their own ability to contribute to the discussion of evolutionary principles and research by producing two blog posts, which will be available on the course sakai site, but not available to the general public/search engines.

Learning Goals:

- Through the course readings, lectures and assignments you will understand and apply basic principles and concepts in the biological sciences (evolution and microbiology).
- In course assignments, you will use current technologies to access information, to conduct research, and to communicate findings. Through blogging about current microbial evolution research, you will use an emerging mode of scientific communication to communicate complex ideas effectively, in standard written English, to a general audience.
- You will demonstrate that you can evaluate and critically assess sources and use the conventions of attribution and citation correctly when research blogging.

Prerequisite: 01:447:380 Genetics or equivalent or professor's permission

Assessment and Grading:

Midterm 1: 30%

Midterm 2: 30%

Blog post 1: 10% + 4% Peer feedback on two blog posts (2% each)

Blog post 2: on aspect(s) of the **evolution** of infectious disease of your choice

26% in four assigned parts:

Topic/references: 2%

Outline: 3%

Draft: 6%

Final post: 15%

Both writing assignments will involve critically reading the primary literature, assessing the veracity of arguments and claims and using (and citing) these sources properly. Blog posts will be shared within the class – and the first will be peer-reviewed -- but only on the course website so as to not make them accessible on the wider internet. You can view a sample blog post showing the features of the sakai blogging editor on the class sakai site

<https://sakai.rutgers.edu/portal/site/855a2905-cfed-4965-bb12-9c4e8dad167c>

Late Assignments: Late submissions of the topic/references, outline or rough draft will be accepted and graded up to a week after the due date but will not be returned with detailed comments. This will place students who submit their assignments late at a disadvantage relative to their classmates, who will receive feedback on their writing, comprehension and presentation. After one week, late submissions will not be accepted. **Both final blog post assignments will not be accepted after their due dates: 2/19, and 5/4 respectively.** Both blog posts must be saved on the sakai site by 11:59PM on the respective due dates.

Extra Credit Quizzes: Every once in a while the class will begin with a very short, optional, extra credit quiz on general concepts and interesting details from the recently assigned readings. Each quiz will be worth up to three extra points on the student's lowest midterm score. There will be 6 quizzes throughout the semester, providing a chance to improve one midterm's score by up to 18 points.

Missed Midterms: If a student must miss a midterm the student must email or speak to the professor **prior to the exam.** Such students may be asked to verify their reason for absence. Absences not communicated to the professor prior to the exam will result in a grade of 0% for that midterm. For students with properly communicated absences, makeup exams will be oral and conducted during office hours or by arrangement as soon as possible to the missed exam.

Scholarly Conduct: As with all courses at Rutgers, cheating and plagiarism are strictly forbidden (see <http://academicintegrity.rutgers.edu/>). Violations of Rutgers' policy will result in a grade of 0% for that assignment. **Not only text, but all images used in assignments must be properly attributed and be used with the copyright holders' permission.**

This syllabus is not a contract. It is the planned course outline. Items may be added, subtracted, or changed at the discretion of the professor. The on-line version of the syllabus takes precedence over any printed copies.

Course reference material:

Book (selected chapters):

TCP Laurie Garrett. 1995. The Coming Plague. Penguin Books: New York.
Available at the bookstore and many places online.

Journal articles:

J. D. Graci and C. E. Cameron 2004 Challenges for the development of ribonucleoside analogues as inducers of error catastrophe. *Antiviral Chemistry and Chemotherapy* 15:1-13.
<http://www.intmedpress.com/serveFile.cfm?sUID=ff30ac00-fbd6-4b60-b2a5-f34390c87374>

P. E. Turner and L. Chao 1999 Prisoner's dilemma in an RNA virus.
Nature 398:441-443.
<http://www.yale.edu/turner/pdf/p006.pdf>

(Another paper for the blog post announced a week prior to the posted due date)

Podcasts:

TWIV This Week in Virology (Vincent Racaniello, Columbia) <http://www.twiv.tv/>

and many others, see URLs

Blogs:

STC Small Things Considered (ASM, Elio Schaechter and others)
<http://schaechter.asmblog.org/schaechter/>

and many others, see URLs

Videos on phage therapy:

Nature of Things (EliavaPhageNY) 8:03 and 9:26
<http://www.youtube.com/watch?v=d-v8uSG2ewk>
<http://www.youtube.com/watch?v=QBdepPvPYMQ>

CBS news coverage of Listeria phage spray for deli meats
<http://www.cbsnews.com/video/watch/?id=2072447n>

LECTURE TOPICS

Assignments for each lecture should be read/watched/listened to prior to that lecture

- 1/20 Course overview, importance of disease, evolution and science communication
- 1/22 Q1 Basic virology, viral diversity, origins of viruses
STC: <http://schaechter.asmblog.org/schaechter/2010/04/paleovirology.html>
STC: <http://schaechter.asmblog.org/schaechter/2012/07/the-rise-of-genomic-superspreaders.html>
Optional, recommended for those without much background in virology:
TWIV 60: Making Viral RNA -- optional, conversational introduction to RNA virology
<http://rybicki.wordpress.com/2012/02/06/a-short-history-of-the-discovery-of-viruses-part-1/>
- 1/27 Mutation, phylogenetics and molecular epidemiology
<http://www.nature.com/scitable/topicpage/reading-a-phylogenetic-tree-the-meaning-of-41956>
http://scienceblogs.com/evolvingthoughts/2007/01/clade_1.php
- 1/29 Mutation, quasispecies, and related antiviral therapy
Graci and Cameron 2004
- 2/3 Reassortment, recombination and natural selection.
- 2/5 Q2 Consequences of coinfection
Turner and Chao 1999
<http://www.virology.ws/2011/01/13/multiplicity-of-infection/>
<http://phenomena.nationalgeographic.com/2013/01/14/influenza-our-incompetent-enemy/>
- 2/10 Transmission and the evolution of virulence
<http://www.virology.ws/2012/01/18/how-lethal-is-ebolavirus/>
http://epidemic.bio.ed.ac.uk/ebolavirus_fatal_rate
<http://www.washingtonpost.com/wp-srv/special/health/how-ebola-spreads/>
- 2/12 Emergence
Paper for blog post available on sakai
TCP 15: All in Good Haste (p.528-549)
<http://www.nytimes.com/2012/07/31/science/flu-that-leapt-from-birds-to-seals-is-studied-for-human-threat.html>
Radiolab Patient Zero (updated 11/13/14) (70m) <http://www.radiolab.org/story/patient-zero-updated/>
- 2/17 Q3 Case study: HIV
TCP: 11 Hatari: Vinidogodogo (p281-389)
- 2/19 Case study: Swine Flu
Blog post due
TCP: 6 The American Bicentennial (p153-191)
TWIV 30: A/Mexico/4108/2009 H1N1 (67m)
- 2/24 Case study: emerging ssDNA viruses
Peer reviews of blog post due
- 2/26 Bacterial diversity, origins of bacteria
<http://scienceblogs.com/aetiology/2006/05/17/archaea-as-human-pathogens-1/>
- 3/3 **Midterm 1** (viral evolution)

- 3/5 Bacterial evolution: mutation, mutators and periodic selection
STC: <http://schaechter.asmblog.org/schaechter/2011/11/a-pestis-from-the-past.html>
blogs.discovermagazine.com/loom/2012/09/19/the-birth-of-the-new-the-rewiring-of-the-old/
- 3/10 Bacterial evolution: horizontal gene transfer and antibiotic resistance
Topics and 3-5 primary references for final blog post due, returned next class
TCP: The Revenge of the Germs13 (p411-456)
<http://www.scientificamerican.com/podcast/episode/more-with-maryn-mckenna-on-antibiot-12-02-02/>
- 3/12 Q4 Diseases of diseases/Phage therapy
YouTube selections
CBS news clip <http://www.cbsnews.com/video/watch/?id=2072447n>
<http://blogs.discovermagazine.com/notrocketscience/2011/05/31/fighting-evolution-with-evolution-using-viruses-to-target-drug-resistant-bacteria/>
- 3/24 Vaccine development, effects of vaccination
<http://blogs.plos.org/biologue/2012/07/31/could-vaccines-breed-super-virulent-malaria/>
- 3/26 Case Study: foodborne pathogens
STC: <http://schaechter.asmblog.org/schaechter/2010/02/five-questions-about-lysogeny.html>
Outlines of final blog post due, returned next class
- 3/31 Case Study: *Vibrio cholera*
- 4/2 Q5 Case Study: *Staphylococcus aureus*
TCP: 12 Feminine Hygiene (p390-410)
<http://www.youtube.com/watch?v=q2ZnocqmC28> (Christina Burch)
- 4/7 Sexually transmitted microbes
TCP: 10 Distant Thunder (p260-280)
<http://www.wired.com/2013/01/almost-untreatable-gonorrhea/>
- 4/9 Scientific writing/final blog post-related discussions
- 4/14 **Midterm II** (bacterial evolution)
- 4/16 Q6 Disease evolution and conservation biology
<http://blogs.discovermagazine.com/notrocketscience/2012/08/16/zebra-herpes-virus-kills-zoo-polar-bears/>
- 4/21 Eukaryotes as pathogens, Malaria
Rough drafts of final blog post due, returned in one week
- 4/23 Human-pathogen coevolution
- 4/28 Frontiers: multipathogen diseases, transmissible cancers
<http://www.nytimes.com/2011/01/25/science/25cancer.html>
- 4/30 Ethics and the evolution of infectious diseases
- 5/4 *Final blog post due on sakai by 11:59pm*