Evolution of Infectious Disease

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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.

Course 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 the 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 communicate effectively in modes appropriate to this area of inquiry (evolution) and that you can evaluate and critically assess sources and use the conventions of attribution and citation correctly.

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. 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):
Available at the bookstore and many places online.

Journal articles:
http://www.intmedpress.com/serveFile.cfm?sUID=ff30ac00-fbd6-4b60-b2a5-f34390c87374

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

Course overview, importance of disease, evolution and science communication

Q1

Basic virology, viral diversity, origins of viruses

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/

Mutation, phylogenetics and molecular epidemiology

http://www.nature.com/scitable/topicpage/reading-a-phylogenetic-tree-the-meaning-of-41956

Mutation, quasispecies, and related antiviral therapy

Graci and Cameron 2004

Reassortment, recombination and natural selection.

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/

Transmission and the evolution of virulence

http://www.virology.ws/2012/01/18/how-lethal-is-ebolavirus/
http://epidemic.bio.ed.ac.uk/ebolavirus_fatality_rate

Emergence

Paper for blog post available on sakai

TCP 15: All in Good Haste (p.528-549)
Radiolab Patient Zero (updated 11/13/14) (70m) http://www.radiolab.org/story/patient-zero-updated/

Q3

Case study: HIV

TCP: 11 Hatari: Vinidogodogo (p281-389)

Case study: Swine Flu

Blog post due

TCP: 6 The American Bicentennial (p153-191)
TWIV 30: A/Mexico/4108/2009 H1N1 (67m)

Case study: emerging ssDNA viruses

Peer reviews of blog post due

Bacterial diversity, origins of bacteria
http://scienceblogs.com/aetiology/2006/05/17/archea-as-human-pathogens-1/

Midterm 1 (viral evolution)
Bacterial evolution: mutation, mutators and periodic selection
blogs.discovermagazine.com/loom/2012/09/19/the-birth-of-the-new-the-rewiring-of-the-old/

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/

Q4 Diseases of diseases/Phage therapy
YouTube selections
CBS news clip http://www.cbsnews.com/video/watch/?id=2072447n

Vaccine development, effects of vaccination
http://blogs.plos.org/biologue/2012/07/31/could-vaccines-breed-super-virulent-malaria/

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

Case Study: Vibrio cholera

Q5 Case Study: Staphylococcus aureus
TCP: 12 Feminine Hygiene (p390-410)
http://www.youtube.com/watch?v=q2ZnocqmC28 (Christina Burch)

Sexually transmitted microbes
TCP: 10 Distant Thunder (p260-280)
http://www.wired.com/2013/01/almost-untreatable-gonorrhea/

Scientific writing/final blog post-related discussions

Midterm II (bacterial evolution)

Q6 Disease evolution and conservation biology

Eukaryotes as pathogens, Malaria
Rough drafts of final blog post due, returned in one week

Human-pathogen coevolution

Frontiers: multipathogen diseases, transmissible cancers

Ethics and the evolution of infectious diseases

Final blog post due on sakai by 11:59pm