NJIT BIOLOGY

Course Syllabus

FALL 2014

BIOLOGY 368-H01: ECOLOGY & EVOLUTION OF DISEASE HONORS

NJIT: BIOL 368 (call number 90239) ■ **RU: 28:120:368**

INSTRUCTOR:	Dr. Gareth J. Russell	**PHONE:**	973-353-1429
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OFFICE HOURS:	T, R: 11:30am - 1:00pm	**COURSE SCHEDULE:**	T, R: 10 - 11:25am, FMH 307 @ NJIT

INTRODUCTION: **Ecology and Evolution of Disease** addresses those aspects of ecology and evolutionary biology most relevant to understanding the origin, dynamics and treatment of disease (both infectious and hereditary/genetic). The class will be a mixture of lecture and discussion of case studies, including topics of current interest. Material covered will include biology, mathematical models, and some aspects of human behavior.

This course is open to all with the necessary biology background, and is particularly recommended for **pre-med students**, including those in the Accelerated Programs. It serves as an introduction to the science behind public health.

PREREQUISITES: Foundations of Ecology and Evolution is **required**. (General Biology or Concepts in Biology is not sufficient). It will also be assumed that you know the basics of cell biology and genetics, so Foundations of Cell and Molecular Biology (or equivalent) is strongly recommended, as is a basic ability in mathematics so that model formulations can be followed. Calculus I is strongly recommended.

CREDITS: 3 ■ **SCHEDULE:** Class meets Tuesday and Thursday, 10:00 to 11:25, in FMH 307 on the NJIT campus. Attendance is expected. (No-one will do well in this course without attending class.)

TEXTBOOKS: All three textbooks are required. They will be in the NJIT bookstore.

- *Plague Time* by Paul Ewald. ISBN 0385721846. (Note that there are two editions of this book, with different subtitles. The only other difference is in the Foreword — the one subtitled "The New Germ Theory of Disease" has an updated forward that mentions a few case studies that occurred after the original version. If you have the other version, don't worry.)
- *Why We Get Sick* by Randolph M. Nesse and George C. Williams. ISBN 0679746749.
- *Infectious Disease Ecology* by Ostfeld, Keesing and Eviner. ISBN 069112485X.

LINKS: Links to external media are now on their own page.

GRADING & EXAMS: There will be two exams, a mid-term and a final, and a substantial number of writing assignments, both in-class and take-home (this is a **writing-intensive** course for Rutgers students). The grading will be as follows:

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GRADING & EXAMS, CONT.:

Component	Percentage
Logistics (getting on Moodle)	1%
Participation in class	24%
Writing Assignments	30%
Mid-term Exam	20%
Final Exam	25%
Total	**100%**

Please note that in-class participation is very important! It means doing the readings, coming to class prepared with notes, questions, and ideas, and engaging in discussion. If you sit in the corner and don't say anything until asked, or if it transpires that you haven't done the reading, then you will *not* do well in this class. You will get three scores out of 8, after 5 weeks, 10 weeks, and at the end of the semester. The sum of these will be your participation score. **Individual scores greater than 8 are possible if your participation is exceptional**, but your final score cannot be greater than 24.

COURSE OUTLINE:

- This syllabus is a general outline. Exact timings may change if we go slower or faster than anticipated on some topics. Check back with this page for updates.
- Textbook readings are identified as "Ewald", "NW" (Nesse and Williams) or "OKE" (Ostfeld, Keesing and Eviner). Other readings are PDF files — click on the name to download them.

Week 1: Introduction.
Content: Class introduction and logistics. Assessment of student knowledge. Introduction to evolutionary medicine (Dawkins video). Introduction to ecological medicine (Machupo virus and acute hemorrhagic feve case study). **Reading:** NW Ch1 and 2; OKE Ch19. **Writing:** How to take notes. Concept mapping. **Homework assignment:** Notes/Concept map of Machupo Virus discovery (OKE Ch19).
Week 2: Genetic diseases and the need for math.
Content: Hardy Weinberg equilibrium. Selection. Persistence of recessive traits. Case studies: Sickle-cell anemia and malaria. Tay-Sachs disease. **Reading:** Allison 1954; Koeslag et al. 1984. **Writing:** Converting real-world problems to math (and back again). **Homework assignment:** Descriptive notes on Tay-Sachs equations.
Week 3: Simple disease models.
Content: SIS, SIR models. **Reading:** Extract from Keeling and Rohani 2008. **Writing:** Describe qualitatively the 'lessons' from a mathematical model. **Homework assignment:** Download, install and test the CDF Player from wolfram.com. Explore the following modules: SIREpidemicWithNoDemography.cdf and SIREpidemicWithDemography.cdf.

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COURSE OUTLINE, CONT.:

Week 4: More complex disease models.

Content: Multi-pathogen systems, multi-population systems, mulit-species systems, vectors and hosts. Case study: measles and whooping cough. Vaccination strategies. Biodiversity and the dilution effect. Case study: Lyme disease.
Reading: OKE Ch3; Keesing et al. 2006. Also you can download the spatially explicit airborne and contact-based epidemic simulations: AirborneEpidemic.cdf; ContactEpidemic.cdf.
Writing: None
Homework assignment: Read and make notes on **Ewald Ch1** in preparation for next week.

Week 5: Virulence and resistance.

Content: Virulence as a strategy of the pathogen. Why being virulent is the default state. Selection factors that enhance virulence. Selection factors that reduce virulence. Case study: Cholera. (Antibiotic) resistance, not necessarily connected to virulence. Circumstances in which it *may* be connected. Case study: Hospitals and MRSA. STDs in general.
Reading: Ewald Ch 1; Ewald Ch 2; Ewald et al. 1998; Pybus and Rambaut 2009 (discussion about within- and between-host evolutionary rates — focus on the box devoted to HIV).
Writing: Make notes on HIV readings for next week.
Information literacy: How find follow-up research via citations.
Homework assignment: Search for more recent papers (and other writings) on HIV origins. Citation list due at beginning of **Wednesday** class next week. Be prepared to tell us about one of your articles.

Week 6: HIV/AIDS I.

Content: History of HIV epidemic. Phylogenetic reconstruction of HIV and SIV. Origins of HIV. Wednesday class: student-led discussion of latest research.
Reading: Article from CNN; Worobey et al. 2008 (paper that the CNN article mentions, about origin of HIV-1 strain — it's short, so try to read what you can); Wertheim and Worobey 2009 (about overall phylgeny of HIV and SIV strains); GapMinder HIV Chart and Animation.
Writing: Make notes on HIV readings for next week.
Homework assignment: Search for more recent papers on virulence and/or drivers of HIV (in Africa and/or elsewhere).

Week 7: HIV/AIDS II.

Content: Summary of last week. Evidence about dynamics of virulence. Social and economic drivers of HIV. Wednesday class: student-led discussion of latest research.
Reading: Ariën et al 2005 (just the introduction and conclusions). Quiñones-Mateu 2005 (this is a commentary on Ariën et al); Herbeck et al 2008 (the latest on the evoution of virulence). Optional readings: Lipsitch and Nowak 1995 (a quite simple model of an HIV-like disease).
Media: (These are on the media page.) Rosling talk from ted.com. Oster talk from ted.com. See also the GapMinder HIV Chart and Animation.
Writing: See homework assignment.
Homework assignment: Paper: "The Ecological and Evolutionary Perspective on HIV." Due in **two** weeks.

Week 8: Zoonoses and EIDs.

Content: Global trends in EIDs. Zoonotic diseases as invasive species; the ecological parallels (and differences).
Reading: OKE Ch16.
Media: Video on emerging infectious disease: "Bird Flu: How Safe Are We?" (shown in class). Wolfe talk from ted.com (on the media page).
Writing: None
Homework assignment: Continue working on HIV paper.

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COURSE OUTLINE, CONT.:

Week 9: Zoonoses and EIDs (continued).

Content: Zoonotic EIDs: predicability at different stages, and implications for control.
Reading: OKE Ch20; Daszak et al. 2000, Jones et al. 2008.
Media: Daszak talk (on the media page).
Writing: None
Homework assignment: Continue working on HIV paper. See citation list example below:
Daszak, P., A.A. Cunningham and A. D. Hyatt (2000) Emerging Infectious Diseases of Wildlife — Threats to Biodiversity and Human Health. Science 287: 443–449.

Week 10: Germ Theory I.

Content: Introduction. History of (slow) discovery of infectious agents of disease. Recent examples: Cervial cancer (HPV), Kaposi's sarcoma (HHV8), liver cancer (Hepatitis B and C), peptic ulcer (*Helicobacter pylori*), Lyme disease.
Reading: Ewald Ch 3, 7. Baseman & Koutsky 2005**;** Woodman et al. 2007**. Optional:** Duelli et al. 2007**.**
Media: None.
Writing: Note-taking.
Homework assignment: For next week: look up latest on infectious causation of human breast cancer.

Week 11: Germ Theory II, Cancer I.

Content: Possible examples: Breast cancer, mental diseases.
Reading: Ewald Ch 10, NW Ch 14. Merlo et al 2006.
Media: None.
Writing: Note-taking.
Homework assignment:

Week 12: Cancer II.

Content: Content.
Reading: NW Ch 12. Attolini and Michor 2009 (overview of an evolutionary approach to cancer), Abbot and Michor 2006 (quantitative study of emergence of chemotherapy drug resistance), Foo and Michor 2009 (study of chemotherapy dosing schedules — mathematically complex, so just try to get the gist of it); Parato et al. 2005 (use of viruses to target cancer).
Media: None.
Writing: Note-taking.
Homework assignment:

Week 13 (Tuesday class only): Obesity, Allergies, Antibiotic Resistance and the Hygiene Hypothesis.

Content: Content.
Reading: NW Ch 10, 11. Ewald Ch 4, 5, 6. Neu 1992 (older but still good review of antibiotic resistance) Davies and Davies 2010 (excellent, up-to-date review), Sommer et al. 2009 (article about antibiotic resistance in 'normal' human microflora). Enright et al. 2002 (evolutionary history of MSRA) Kennedy et al. 2008 (optional: clonal expansion of cMRSA — quite technical, read just introduction and conclusions). Levy 2001 (article about 'anti-microbial' products); NYT article on emerging resistance among gram-negative bacteria.
Media: TED talk by Jessica Green — "Are We Filtering the Wrong Microbes?" — on media page.
Writing: Note-taking.
Homework assignment: For next week: look up 'futurist' articles on the latest medical and other advances (in Wired and similar places), especially those with positive spin, look into the reality behind them, and write up a few notes to bring to class about whether they seem promising to you (or not).

COURSE OUTLINE, CONT.:

Week 14: Recent advances: What is the prognosis?
Content: Content. **Reading:** NW Ch 8, 15. Ewald Ch 14. **Media:** None. **Writing:** None **Homework assignment:** Study for final exam!
Week 15 (Tuesday only): Review: What have we learned?
Content: Course syllabus. **Reading:** All. **Media:** All. **Writing:** None **Homework assignment:** Study for final exam!
FINAL EXAM WEEK: DECEMBER 15-19, 2014

EPILOGUE: If you feel like it, watch the TED Video featuring Susan Blackmore talking about memes, and ask yourself whether what we have learned in this course might apply to cultural transmission. Are there pathological ideas?

EXAMPLE EXAM QUESTION

The final exam will offer a choice of medium- and long-answer questions. Medium questions will be worth 5 points each, and take approximately 1/2 to 1 page of the exam booklet to answer. Long questions will be worth 10 points each, and will take more like 2 pages. You must answer questions worth **a total of 30 points**, including at least one long question.

Here is an example of how a medium question might be worded.

- Name and briefly describe the three main approaches that bacteria use to resist antibiotics (and other toxins in their environment). Give specific examples of a) one of the approaches, and b) how we have tried to overcome it.

Here is an example of how a long question might be worded.

- What does Ewald mean by "Germ Theory"? Give some accepted examples that support the theory, and some examples that are controversial, and/or which simply haven't been looked at properly yet. What do you think: is Ewald probably right or wrong? Why do you think that?