

## Syllabus – Biol 568 Fall 2010 – Disease ecology and evolution

### Welcome:

The ecology and evolution of infectious diseases (aka host-parasite or host-pathogen interactions) has roots that go back a century. However, it did not begin to emerge as a discipline until the past 30 years, and has exploded in the current millennium. The class will cover topics such as mathematical theory on host-pathogen interactions; empirical studies of human, wildlife, insect, and plant host populations; emerging infectious diseases; effects on host behavior; host-parasite coevolution; multi-host and multi-pathogen systems; and anthropogenic effects on disease. The greatest depth of understanding has been achieved at the level of population interactions, specifically interactions of a single host population with a single pathogen population. The broader goal of the class is to provide a comprehensive and up-to-date understanding of the causes and consequences of infectious disease at levels from individual organisms to the globe.

### Instructor:

Dr. Charles Mitchell

Office hours: Thursday 3:00-4:00PM, and by appointment.

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### Grade:

Transmission exam: 25%

Evolution exam: 25%

Ecology exam: 25%

Final paper: 15%

Final oral presentation: 10%

**Midterm and final exams.** The exams will generally be short-answer essay in format, and will focus on eliciting higher-level thought: analysis, synthesis, and evaluation. With the exception of questions dealing with the mathematical theories covered in the class, there will be little emphasis on direct recall and simple comprehension.

**Class participation.** Your active participation in this class will be crucial not only for your own learning, but for that of your classmates. If everyone participates actively, there will be a synergistic benefit for all. Most lectures will include some time for discussion as well. Please come to class prepared with your questions and ideas.

**Final Exam: paper & oral presentation.** Instead of a question-based final exam, the final exam will consist of a paper and oral presentation on a topic of each student's choosing.

- The topic should either add depth to the class by providing a more advanced exploration of a topic covered in the class, or it should add breadth to the class by covering an additional topic not otherwise covered. (See below for a starter list of possible topics.) To make sure you choose a topic suitable for the class, you need to get instructor approval of your topic. You can get approval by email, during office hour, or after most class meetings. Part of getting approval is to show one reference (i.e. published paper) that you intend to cite. The deadline for getting approval is immediately after the last class before Thanksgiving.

- Your paper needs to fit on two double-spaced pages. It needs to cite at least three references that were not class readings. It can also cite one reading from class. It can cite no more than five references total. All references cited should be in peer-reviewed scientific journals; these appear in the Science Citation Index (<http://eresources.lib.unc.edu/eid/list.php?letter=S>). Citations in the text, and the list of references cited, should follow the format in the Ostfeld (2008) paper assigned for lecture 17. Avoid plagiarism (<http://www.unc.edu/depts/wcweb/handouts/plagiarism.html>). Email your paper to me (as an MS Word file) by 8:00AM the day of the final exam. You also must bring a printed copy to the final exam, and all pages must be stapled (if there is more than one printed page).
- Each student will give their presentation during the scheduled final exam period. Each presentation should last 5 minutes, which will be followed by 2 minutes for questions. Email your presentation to me (as a PowerPoint or PDF) by 8:00AM the day of the final exam. You also must bring a backup copy to the final exam, either on your laptop or on a USB flash memory drive.
- You are strongly encouraged to meet with a partner or in small groups to practice and improve your oral presentations. In particular, it is important that your presentation lasts very close to the target of 5 minutes; this takes practice. However, you should not receive any help on your paper; this needs to be entirely your own work, following the UNC Honor Code. To avoid any problems with this, it would be safest to finish your paper before working with others on your presentation.

**A starter list of some possible paper & oral presentation topics (please don't limit yourself to these):**

Climate change and disease.

Virus evolution.

Disease in social networks

The influence of host social systems.

Heterogeneity in host populations (e.g. "super-spreaders").

Case studies of pathogen emergence not covered in class.

Real-time monitoring, modeling, and management of epidemics.

Infectious disease through human history (and its future?)

**Blackboard:** Will be used to share readings and communicate announcements.

**A useful resource (online dictionary of ecological epidemiology):**

<http://www.swintons.net/jonathan/Academic/glossary.html>

**Please note:** Except for the final exam, the class schedule below is subject to change.

**Class schedule**

Tue 24 Aug: Lecture 1 – Introduction to disease ecology and evolution.

Reading: none assigned.

Thu 25 Aug: Lecture 2 – (A) Transmission Biology. (B) Microparasite-host dynamics: the basic framework.

Reading 1: Anderson and May 1991, *Infectious Diseases of Humans*, Ch. 2.

Reading 2: Hastings 1997, *Population Biology*, Ch. 10.

Tue 31 Aug: Lecture 3 – Microparasite-host dynamics: population models and data.

Reading 1: Anderson and May 1991, *Infectious Diseases of Humans*, Ch. 2.

Reading 2: Hastings 1997, *Population Biology*, Ch. 10.

Thu 2 Sept: Lecture 4 – Macroparasite-host dynamics: parasite life-histories and diversity.

Reading: Dobson et al. 1992, Macroparasites: worms and others, chapter in *Natural Enemies* book edited by Crawley, pages 329-343 only.

Tue 7 Sept: Lecture 5 – Macroparasite-host dynamics: population models and data.

Reading: Dobson et al. 1992, Macroparasites: worms and others, chapter in *Natural Enemies* book edited by Crawley, pages 329-343 only.

Thu 9 Sept: Lecture 6 – Transmission theory.

Reading 1: McCallum et al. 2001 *TREE*, How should transmission be modeled?

Tue 14 Sept: Lecture 7 – Vector and sexual transmission.

Reading 1: Michalakis and Renaud 2009, *Nature*, Evolution in vector control.

Reading 2: Anderson and May 1991, *Infectious Diseases of Humans*, social heterogeneity and STDs: Chap 11.1 and 11.2, except the part from equation (11.2) through (11.7) and all of section 11.2.2 are NOT required.

Thu 16 Sept: Lecture 8 – You are (infected by) what you eat (and drink): environmental transmission. Discussion and review (Q&A format).

Reading: Cottingham et al. 2003, *FREE*, Environmental microbe and human pathogen: the biology and ecology of *Vibrio cholerae*.

Tue 21 Sept: **Transmission exam.** (covers all material to date)

Thu 23 Sept: Lecture 9 – Evolution of virulence.

Reading: Ebert and Herre 1996, *Parasitology Today*, The evolution of parasitic diseases.

Tue 28 Sept: Lecture 10 – Host-parasite coevolution. Love in the time of cholera: disease and the evolution of sex. The Red Queen hypothesis.

Reading: Lively 1996, *BioScience*, Host-parasite coevolution and sex (NOTE: The sections on pages 111-113 on "rank order truncation selection" and "the ratchet and the red queen" are NOT required).

Thu 30 Sept: Lecture 11 – Evolution of antibiotic resistance. (Guest lecture by Lisa Bono, UNC Biology)

Reading: Levy 1998, *Scientific American*, The challenge of antibiotic resistance.

Tue 5 Oct: Lecture 12 – Cospeciation.

Reading: Holmes 2010, *Nature*, The gorilla connection.

Thu 7 Oct: Lecture 13 – Parasites and host behavior.

Reading: Moore 1995, *BioScience*, The behavior of parasitized animals: when an ant ... is not an ant.

Tue 12 Oct: UNIVERSITY DAY

Thu 14 Oct: Lecture 14 – Immune dynamics.

Reading 1: Levin and Antia 2001, *Science*, Why we don't get sick.

Optional Reading 2: Wobeser (2006) Disease in Wild Animals – Chapter 6 – Defense, resistance, and repair.

Tue 19 Oct: Lecture 15 – Rapid evolution in host-pathogen systems

Reading 1: Earn et al. 2002, *TREE*, Ecology and evolution of the flu.

Optional Reading 2: Altizer et al. 2003, *TREE*, Rapid evolutionary dynamics and disease threats to biodiversity.

Thu 21 Oct: FALL BREAK.

Tue 26 Oct: Lecture 16 – Synthesis: Pathogen phylodynamics. Discussion and review (Q&A format).

Reading: Grenfell et al. 2004, *Science*, Unifying the epidemiological and evolutionary dynamics of pathogens.

Thu 28 Oct: **Evolution exam.** (covers all material not on the previous exam)

Tue 2 Nov: Lecture 17 – Host population regulation by parasites.

Reading 1: Ostfeld 2008, *Journal of Animal Ecology*, commentary on Readings 2 and 3.

Optional Reading 2: Pedersen and Greives 2008, *Journal of Animal Ecology*, The interaction of parasites and resources cause crashes in a wild mouse population.

Optional Reading 3: Hudson et al. 1998, *Science*, Prevention of population cycles by parasite removal.

Thu 4 Nov: Lecture 18 – Keeping the herd healthy: vaccination, culling, and predation.

Reading 1: Ostfeld and Holt 2004, *FREE*, Are predators good for your health?

Tue 9 Nov: Lecture 19 – Disease and conservation biology.

Reading 1: Cleaveland et al 2007 *ConsBiol*.

Thu 11 Nov: Lecture 20 – Emerging parasites I: global patterns.

Reading 1: Woolhouse and Dye 2001 *PTRSoc*.

Reading 2: Daszak et al. 2000 *Science*.

Tue 16 Nov: Lecture 21 – Emerging parasites II: ephemeral outbreaks.

Reading: Dobson 2005 *Science*.

Thu 18 Nov: Lecture 22 – Parasites in multi-species host communities and foodwebs. (Guest lecture by Dr. James Cronin, UNC Biology.)

Reading: Keesing et al. 2006, *Ecology Letters*, Effects of species diversity on disease risk.

Tue 23 Nov: Lecture 23 – When it rains, it pours: hosts with multiple parasites.

Reading 1: Smith et al. 2007, *Ecology*, Globalization of human infectious disease.

Reading 2: Druilhe et al. 2005, *Trends in Parasitology*, Worms can worsen malaria.

**Last day to get your paper & oral presentation topic approved.**

Thu 25 Nov: THANKSGIVING.

Tue 30 Nov: Lecture 24 – Emerging parasites III: sustained shifts.

Reading 1: Daszak and Cunningham 2003 *J. Parasitology*.

Reading 2: Woolhouse et al. 2005 *TREE*.

Thu 2 Dec: Lecture 25 – Synthesis: Parasites as natural enemies: are they really different? Discussion and review (Q&A format).

Reading: Lafferty and Kuris 2002, *TREE*, Trophic strategies, animal diversity, and body size.

Tue 7 Dec: **Ecology exam.** (covers all material not on the previous exams).

**Thursday 16 December 12:00-3:00PM in the regular classroom: FINAL EXAM (papers & oral presentations due).**