ECOL 8520 - FUNDAMENTALS OF DISEASE BIOLOGY II

John M. Drake & Pej Rohani

Spring 2017

Course Information

Class time: MW 10:10-11:30am, W 1:25-3:20pm

Location: Ecology Computer Lab

Instructors: Dr. John Drake (Office: 133 Ecology, email: jdrake@uga.edu) & Dr. Pejman (Office: 36 Ecology, email: rohani@uga.edu)

Course description. The fundamentals of infectious disease biology focusing on microparasite infections (e.g., viruses, bacteria). Taught in four-week modules, the course covers essential concepts in ecology, evolution, immunology, biochemistry, cell biology, and metabolism as they relate to specific infectious diseases. Each module is self-contained, and students can register to receive credit for one or more modules. For Spring 2017, these modules are: Morbillivirus (January 9-25), Mycoplasma (January 30 - February 15), Arboviruses (February 20 - March 15), and Influenza (March 20 - April 5).

Course objectives. This course provides students interested in infectious diseases with a "cross-scale" foundation via the in-depth analysis of specific case studies focusing on microparasites (e.g., viruses, bacteria). Lectures will focus on essential organizing principles in infectious diseases stemming from research at the molecular, cellular levels through the organismal, population, community, and biosphere levels. Computer labs focus on posing and solving numerical problems related to the dynamics of infectious diseases and also reinforce the content introduced in lectures.

Students are expected to develop a skill and appreciation for thinking about microparasite infections from multiple perspectives and will be challenged to identify and articulate the connections between biological scales. Specifically, they will:

- Learn to consider infectious disease problems from the perspective of different levels of organization.
- Develop the expertise to frame research questions that bridge multiple levels of organization and that have cross-scale implications.
- Acquire an in-depth, cross-scale understanding of at least one distinct infectious disease system and acquire the skills to translate this knowledge to other disease systems.

Assignments and grading policy. This course is graded on the A-F system. A grade will be assigned for each module based on a written assessment, i.e. a short exam (50%), class participation (20%), and performance on lab assignments (20%). Students that enroll for all modules will be assigned an overall grade based on performance leading a class discussion (10%), average of grades for each module (60%), and final class project (30%).

Class project. Students work independently on a disease system of their choice. They are tasked with investigating and writing about a cross-scalar problem. Goal of project is to have students apply the skills they have acquired in at least one case study module (above) by identifying a problem that bridges scales and investigating the problem from different perspectives.

Missed class policy. Unless permission is obtained in advance or appropriate documentation is received (e.g., doctor's note), the instructor reserves the right to assign a grade of F if more than three classes are missed.

Office hours & contact policy. Office hours are by appointment; the primary means for out-of-class contact should be e-mail (jdrake@uga.edu and rohani@uga.edu).

Official University Policy. The course syllabus is a general plan for the course; deviations announced to the class by the instructor may be necessary. All academic work must meet the standards contained in *A Culture of Honesty*. Students are responsible for informing themselves about those standards before performing any academic work.

Schedule of topics

Date	Module	Topic	Readings
Jan 9	Morbillivirus	Transmission dynamics 1	(1), (2)
Jan 11	Morbillivirus	Transmission dynamics 2	(3)
Jan 16	Morbillivirus	Spatial dynamics 1	(4)
Jan 18	Morbillivirus	Spatial dynamics 2	(5)
Jan 23	Morbillivirus	Near-critical dynamics 1	(6)
Jan 25	Morbillivirus	Near-critical dynamics 2; Exam 1	Manuscript, (7)
Jan 30	Mycoplasma	Strain dynamics 1	TBD
Feb 1	Mycoplasma	Strain dynamics 2	TBD
Feb 6	Mycoplasma	Vaccine evolution 1	TBD
Feb 8	Mycoplasma	Vaccine evolution 2	TBD
Feb 13	Mycoplasma	Behavior & immunity 1	TBD
Feb 15	Mycoplasma	Behavior & immunity 2; Exam 2 T	BD
Feb 20	Arbovirus	Chikungunya virus 1	TBD
Feb 20	Arbovirus	Chikungunya virus 2	(8), (9)
Feb 27	Arbovirus	Dengue 1	TBD
Mar 1	Arbovirus	Dengue 2	(10), (11)
Mar 13	Arbovirus	West Nile virus 1	(12)
Mar 15	Arbovirus	West Nile virus 2; Exam 3	(13), (14)
Mar 20	Influenza	Whin-host dynamics 1	TBD
Mar 22	Influenza	Whin-host dynamics 2	(15)
Mar 27	Influenza	Evolution 1	(16)
Mar 29	Influenza	Evolution 2	(17)
Apr 3	Influenza	Multi-host multi-path dynamics 1	(18)
Apr 5	Influenza	Multi-host multi-path dynamics 2; Exam 4	(19)
Apr 10	Projects		
Apr 12	Projects		
Apr 17	Projects		
Apr 19	Projects		
Apr 24	Projects		
Apr 26	Projects		

Readings

1. Lloyd-Smith JO, et al. (2005) Should we expect population thresholds for wildlife disease? *Trends Ecol Evol* 20(9):511–519.

2. Metcalf CJE, Ferrari M, Graham AL, Grenfell BT (2015) Understanding herd immunity. *Trends in Immunology* 36:753–755.

3. Ferrari MJ, Grenfell BT, Strebel PM (2013) Think globally, act locally: The role of local demographics and vaccination coverage in the dynamic response of measles infection to control. *Philos Trans R Soc Lond B Biol Sci* 368(1623):20120141.

4. Metcalf CJE, Hampson K, Tatem AJ, Grenfell BT, Bjørnstad ON (2013) Persistence in epidemic metapopulations: Quantifying the rescue effects for measles, mumps, rubella and whooping cough. *PLoS One* 8(9):e74696.

5. Grais RF, et al. (2006) Estimating transmission intensity for a measles epidemic in niamey, niger: Lessons for intervention. *Trans R Soc Trop Med Hyg* 100(9):867–873.

6. Rhodes-and-Anderson-1996.pdf.

7. Jansen VAA, et al. (2003) Measles outbreaksina population with declining vaccine uptake. *Science* 301.

8. Yakob L, Clements ACA (2013) A mathematical model of chikungunya dynamics and control: The major

epidemic on réunion island.

9. Drake JM, Beier JC (2014) Ecological niche and potential distribution of anopheles arabiensis in africa in 2050. *Malar J* 13:213.

10. WHO-VMI Dengue Vaccine Modeling Group, et al. (2012) Assessing the potential of a candidate dengue vaccine with mathematical modeling. *PLoS Negl Trop Dis* 6(3):e1450.

11. Ferguson NM, et al. (2016) Benefits and risks of the Sanofi-Pasteur dengue vaccine: Modeling optimal deployment. *Science* 353(6303):1033–1036.

12. Dobson A (2004) Population dynamics of pathogens with multiple host species. *Am Nat* 164 Suppl 5:S64–78.

13. Magori K, Bajwa WI, Bowden S, Drake JM (2011) Decelerating spread of west nile virus by percolation in a heterogeneous urban landscape. *PLoS Comput Biol* 7(7):e1002104.

14. LaDeau SL, Kilpatrick AM, Marra PP (2007) West nile virus emergence and large-scale declines of north american bird populations. *Nature* 447(7145):710–713.

15. Handel A, Akin V, Pilyugin SS, Zarnitsyna V, Antia R (2014) How sticky should a virus be? The impact of virus binding and release on transmission fitness using influenza as an example. *J R Soc Interface* 11(92):20131083.

16. Lessler J, et al. (2012) Evidence for antigenic seniority in influenza a (H3N2) antibody responses in southern china. *PLoS Pathog* 8(7):e1002802.

17. Bedford T, et al. (2014) Integrating influenza antigenic dynamics with molecular evolution. *Elife* 3:e01914.

18. Roche B, et al. (2014) Adaptive evolution and environmental durability jointly structure phylodynamic patterns in avian influenza viruses. *PLoS Biol* 12(8):e1001931.

19. Barton HD, Rohani P, Stallknecht DE, Brown J, Drake JM (2014) Subtype diversity and reassortment potential for co-circulating avian influenza viruses at a diversity hot spot. *J Anim Ecol* 83(3):566–575.