ECOL/BIOL 4150L/6150L:
Population Biology of Infectious Diseases
Spring 2011

Lecture: Tu Th 9:30-10:45 **Lab**: Mon *or* Wed 1:30-3:00
Place: auditorium (lecture); conference room/computer room (lab)

Instructors:
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Office hours: By appt (or walk-in between 11:00am-12:00pm on TuTh)

Description: This course provides an introduction to the field of infectious disease ecology, an area of study that has developed rapidly over the past three decades and addresses some of the most significant challenges to human health and conservation. Students will obtain an appreciation for the incredible diversity of parasitic organisms, arguably the most abundant life forms on the planet, and examine how parasites invade and spread through host populations. Throughout an emphasis will be placed on providing a quantitative understanding of infectious diseases dynamics at the population level. Students will gain a basic understanding of the population biology of micro- and macroparasites, mechanisms of transmission and causes and consequences of ecological and genetic heterogeneity. Specific topics include types of pathogens and their ecological properties, epidemiology and impacts on host populations, evolution of resistance and virulence, role of ecology and evolution in the emergence of new diseases, parasites in the context of ecological communities, within-host dynamics and the ecology of immunity, population-level consequences of control measures and the role of parasites in biodiversity and conservation.

Class objectives:

1. Provide an understanding of the biology of parasites and infectious diseases, integrating basic concepts with real-world examples
2. Increase familiarity with quantitative approaches for studying infectious disease dynamics at the population and community level
3. Review historical development and current research in the field of infectious disease ecology
4. Enhance appreciation for the taxonomic and biological diversity of parasitic organisms and host responses to infection
5. Enhance appreciation for the importance of parasites in biodiversity conservation and management and human health
6. Consider the role of ecology and evolution in predicting disease emergence and responding to epidemics

Format: The course format includes lecture, discussion of scientific papers, computer assignments and problem sets. Students are expected to attend lectures on a regular basis, complete regular assignments, and prepare for and participate in class discussions.

Prerequisites: This course assumes familiarity with general ecology and biology, and past coursework in calculus, linear algebra and/or statistics.

Attendance: Attendance and class participation are required. Students who miss a class should immediately contact fellow students for lecture notes and assignments, and will be expected to submit assignments at the regular set deadlines. More than 4 unexcused absences from lecture, and 4 unexcused absences from weekly labs/discussion sessions may result in an automatic lowering of the final score by one letter grade.

Assignments: Students are responsible for completing assignments related to computer and data labs, as well as turning in reading summaries during weeks where discussion takes place (explained below) and occasional tasks assigned in lecture. Unless otherwise specified, homework assignments will be due by 5pm on the date specified. Students may turn assignments in during class or in the professor's mailbox in the Ecology building. Unless otherwise specified, all assignments will be due 1 week from the date they are undertaken/set in class. For weeks where a discussion is indicated, you should come to the discussion section with a short (1/2 page) summary of the assigned reading. Instructors reserve the right to penalize late assignments.

Reading materials: Reading material for this course is based on journal articles and book chapters. Lectures will often refer to ideas and results from assigned readings, and exams will cover content from each of the readings. A full reading list is maintained at the end of the syllabus, and papers will be uploaded onto eLC prior to the assigned reading date.

Exams: There will be a mid-term exam on March 10 and a second exam on Thursday April 28. There will also be three in class pop quizzes distributed throughout the semester. You will not be able to make up these quizzes if you miss class.

Grade calculation:
30% Lab assignments and quizzes
30% Mid-term exam
30% Second exam
10% Participation and class discussions

Enrollment in 6150: Students enrolled in the graduate course number will be expected to complete additional problems on assignments and exams that require synthesis of class and reading materials, and will also be expected to lead one discussion session during the spring semester. They will additionally write a 2-page research proposal in the NSF GRFP format and present their research ideas to the class in a short presentation during a class symposium.

Accommodations: Please contact the instructor if you require special accommodations due to learning disabilities, religious practices, physical or medical needs, or for any other reason.

General Notes: (i) 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. The link to more detailed information about academic honesty can be found at: http://www.uga.edu/ovpi/honesty/acadhon.htm (ii) The course syllabus is a general plan for the course; deviations announced to the class by the instructors may be necessary.

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DATE	TOPIC	READINGS/NOTES
Part 1: The basics		
17/19 Jan	*No lab (MLK)*	
18 Jan	Intro, card game and photo challenge	"Disease Ecology" Nature Knowledge (www.nature.com.proxy-remote.galib.uga.edu/scitable/knowledge/library/disease-ecology-15947677)
20 Jan	Terminology & diversity of parasites	Nunn & Altizer 2006 Ch. 2
24/26 Jan	*No lab*	
25 Jan	Population biology of microparasites 1: epidemics & equilibria	Lloyd-Smith et al. 2005
27 Jan	Population biology of microparasites 2: rinderpest in the serengeti, dead seals in the North Sea	Nunn & Altizer 2006 Ch. 4 (pp. 98-114)
31 Jan / 2 Feb	*Lab 1: Computer lab – PDV infection in seals and epidemic curve fitting*	
1 Feb	Population biology of microparasites 3: vaccination and herd immunity	Park et al. 2009
3 Feb	Population biology of macroparasites 1: aggregation and life cycles in a wormy world	Nunn & Altizer 2006 Ch. 4 (pp. 102-104; pp 115-122)
7/9 Feb	*Lab 2: Macroparasite brainstorming*	*Morgan et al. 2004*
8 Feb	Population biology of macroparasites 2: dynamics & stability	Dobson & Hudson 1992
10 Feb	Population biology of macroparasites 3: cycles & host regulation	Hudson et al. 1999

Part 2: Transmission and Ecological Heterogeneity		
14/16 Feb	*Lab 3: Discussion – parasites & host behavior*	*Grear et al. 2009*
15 Feb	Parasites and host behavior	Nunn & Altizer 2006 Ch. 6
17 Feb	Birds, bees & STDs	Ryder et al. 2005
21/23 Feb	*Lab 4: Heterogeneity in exposure – field work*	
22 Feb	Key hosts & superspreaders	Ferrari et al. 2004
24 Feb	Spatial ecology of pathogens 1: waves, synchrony & spatial spread	Viboud et al. 2006
28 Feb / 2 Mar	*Lab 5: Analysis of previous field work*	
1 Mar	Spatial ecology of pathogens 2: corridors, dispersal and metapopulations ecology	Stapp et al. 2004
3 Mar	Ecology of multi-host pathogens 1: Basic framework and apparent competition	Holt et al 2003
7/9 Mar	*Lab 6: Review for midterm*	
8 Mar	Ecology of multi-host pathogens 2: dilution effect, vectors & intermediate hosts	Keesing et al 2006
10 Mar	**Midterm exam**	
14-17 Mar	Spring Break	
Part 3: Immunity and Genetic Heterogeneity		
21/23 Mar	*Lab7: Discussion – Immunity and infectious disease*	*Abu-Raddad et al. 2006 Science*
22 Mar	Co-infection and competition between parasites	Graham 2008
24 Mar	Immune defenses: innate and adaptive	Sompayrac 2003 Ch. 1
28/30 Mar	*Lab 8: Discussion – resistance and virulence evolution*	*Paul Ewald's ted.com lecture* + Herre 1993
29 Mar	Evolution of resistance: tradeoffs and constraints	Verhulst et al. 1999
31 Mar	Evolution of pathogen virulence	DeRoode et al. 2008
4 /6Apr	*Lab 9: Computer lab – tree building from viral sequence data (bat rabies)*	
5 Apr	Molecular phylogeny of pathogens	Biek et al. 2006
7 Apr	Within host disease dynamics	

11/13 Apr	*Lab 10: Larry Brilliant's TED video (25 min) + discussion*	*http://www.ted.com/talks/lang/eng/larry_brilliant_wants_to_stop_pandemics.html + Wall Street journal article*
12 Apr	Host-pathogen coevolution and the Red Queen	Lively and Dybdahl 2000
Part 4: Global Change and Disease		
14 Apr	Pandemics & Globalization	Kilpatrick et al. 2006
18/20 Apr	*Lab 11: Computer lab – comparative analysis of host-parasite diversity*	
19 Apr	Managing pathogen outbreaks in wildlife: culling & vaccination	Donnelly et al. 2006
21 Apr	Climate change & infectious diseases	Lafferty 2009 Ecology
25/27 Apr	*Lab 12: Review for exam 2*	
26 Apr	Parasites & species invasions	
28 Apr	**Exam 2**	
10 May	Research symposium: presentations by 6150 students	8-11am (Auditorium)
13 May	Grades due	

Readings:

Abu-Raddad, L.J. Patnailk, P. and Kublin, J.G. 2006. Dual infection with HIV and malaria fuels the spread of both diseases in sub-Saharan Africa. *Science*, 314: 1603-1606.

Biek, R., Drummond, A. and Poss, M. 2006. A virus reveals population structure and recent demographic history of its carnivore host. *Science*. 311: 538-541.

De Roode, J.C., Yates, A.J. and Altizer, S. 2008. Virulence-transmission trade-offs and population divergence in virulence in a naturally-occurring butterfly parasite. *PNAS*. 105: 7489-7494

Dobson, A.P. & Hudson, P.J. 1992. Regulation and stability of a free-living host-parasite system, *Trichostrongylus tenuis* in red grouse. II: Population models. *Journal of Animal Ecology*. 61, 487-498.

Donnelly C.A. Woodroffe R;. Cox D.R. Bourne F.J. Cheeseman C.L. Clifton-Hadley R.S. Wei G. Gettinby G. Gilks P. Jenkins H. Johnston W.T. Le Fevre A.M. McInerney J.P. Morrison W.I. 2006. Positive and negative effects of widespread badger culling on tuberculosis in cattle. *Nature*, 439: 843-846.

Ferrari, N. Cattadori, I.M. & Hudson, P.J. 2004. The role of host sex in parasite dynamics of the yellow necked mice *Apodemus flavicollis*. *Ecology Letters* 7 88-94.

Graham, A.L. 2008. Ecological rules governing helminth-microparasite coinfection. *PNAS*, 105(2):567-570.

Grear, D.A. Perkins, S.E. and Hudson, P.J. 2009. Does elevated testosterone result in increased exposure and transmission of parasites? *Ecology Letters*, 12: 528-537.

Herre, E. A. 1993. Population Structure and the Evolution of Virulence in Nematode Parasites of Fig Wasps. Science, 259 1442-1445.

Holt, D.R. Dobson, A.P. Begon, M. Bowers, R.G. and Schauber, E.M. 2003. Parasite establishment in host communities. *Ecology Letters*, 6: 837-842.

Hudson, P.J., Dobson, A.P. & Newborn, D. 1999. Population cycles and parasitism. *Science* 286, 2425.

Keesing, F. Holt, R.D. and Ostfeld, R.S. 2006. Effects of species diversity on disease risk. *Ecology Letters*, 9: 485-498.

Kilpatrick, A. M., A. A. Chmura, et al. (2006). "Predicting the global spread of H5N1 avian influenza." Proceedings of the National Academy of Sciences 103(51): 19368-19373

Lafferty, K. 2009. Calling for an ecological approach to studying climate change and infectious diseases. Ecology, In press.

Lafferty, K.D. 2008. Effects of disease on community interactions and food web structure. *In: Infectious Diseases Ecology: Effects of Ecosystems on Disease and of Disease on Ecosystems, edited by Ostfeld, R.S. Keesing, F. and Eviner, V.T.* Princeton University Press.

Lively, C.M., and Dybdahl, M.F. 2000. Parasite adaptation to locally common host genotypes. Nature 405: 679-681.

Lloyd-Smith, J. O., P. C. Cross, C. J. Briggs, M. Daugherty, W. M. Getz, J. Latto, M. S. Sanchez, A. B. Smith, and A. Swei. 2005. Should we expect population thresholds for wildlife disease? *Trends in Ecology & Evolution* 20: 511-519

Morgan, E.R. Milner-Gulland, E.J. Torgerson, P.R. and Medley, G.F. 2004. Ruminating on complexity: macroparasites of wildlife and lifestock. Trends in Ecology and Evolution, 19: 181-188.

Nunn, CL and Altizer, SM. 2006. Infectious diseases in Primates: Behavior, Ecology and Evolution. Oxford University Press. Chapter 2, 4 and 6.

Park, A. W., J. M. Daly, et al. 2009. Quantifying the Impact of Immune Escape on Transmission Dynamics of Influenza. Science. 326(5953): 726-728.

Ryder, JJ, Webberley, KM, Boots, M, and Knell, RJ. 2005. Measuring the transmission dynamics of a sexually transmitted disease. *PNAS*. 42: 15140-15143

Sompayrac, L. 2003. How the Immunity system works (2nd ed). Blackwell Publishing.

Stapp, P, Antolin, M, and Ball, M. 2004. Patterns of extinction in prairie dog metapopulations: plague outbreaks follow El Niño events. Frontiers in Ecology and the Environment: Vol. 2, No. 5, pp. 235-240.

Verhulst, S. Dieleman, S.J. and Parmentier, H.K. 1999. A tradeoff between immunocompetence and sexual ornamentation in domestic fowl. *PNAS*, 96: 4478-4481.

Viboud, C., Bjornstad, O.N., Smith, D.L., Simonsen, L., Miller, M.A., & Grenfell, B.T. 2006. Synchrony, waves, and spatial hierarchies in the spread of influenza. Science 312, 447.