Program for "Evolutionary Medicine"

Autumn 2008 (Block 1): Mondays 13-16; Thursdays 09-12 and 13-16; Room: Kursussal [?]

Textbooks: *Evolution in Health and Disease, 2nd Ed* (S.C. Stearns & J.C. Koella, eds.), Oxford University Press 2008. (EHD)
Suggested but not required: *Evolution: An introduction. 2nd Ed.* (S.C. Stearns and R.F. Hoekstra), Oxford University Press 2005.

Teachers: Stephen C. (Steve) Stearns (SS), Jacob C. Koella (JK). ST = Students

Total reading for the course: 450 pages

Essays due: 24 October Exam: 30 October

Week 1: Introduction to Evolutionary Thinking

Reading this week: Stearns & Ebert 2001, Nesse & Stearns 2008

Date	Time	Theme	Teacher
Mon 25.08	**13:15-14**	**Introduction and general overview**	**SS**
	14:15-15	**Presentation of themes and organization of course**	**SS**
	15:15-16	**Group formation and allocation of papers**	**SS**
Thurs 28.08	**09:15-10**	**The nature of evolution: Selection, drift, and history**	**SS**
	10:15-11	**Adaptive evolution: natural selection**	**SS**
	11:15-12	**Neutral evolution: genetic drift**	**SS**
	13:15-14	**How selection changes gene frequencies**	**SS**
	14:15-15	**The role of development in evolution**	**SS**
	15:15-16	**The expression of variation in reaction norms**	**SS**

Student action: On Monday the students will form groups of 3-4. Each group will take responsibility for identifying key issues and difficult points in one of the lectures on Thursday and will take the lead in asking questions and clarifying issues during lecture.

Key issues:

How natural selection works
How drift works
How gene frequencies change under selection in different genetic systems
How developmental control genes give us information on the genotype-phenotype map
How reaction norms mediate the expression of genetic variation in phenotypes

Optional reading:

Stearns, S.C. & D. Ebert. 2001. Evolution in health and disease: Work in progress. Quarterly Review of Biology 76: 417-432.

Nesse, R.M. & Stearns, S.C. 2008. The great opportunity: Evolutionary applications to medicine and public health. Evolutionary Applications 1: 28-48.

Week 2: Recent human evolution and medically relevant genetic variation

Reading for lectures: EHD Chs 3 (12 p) and 5 (12 p)
Total reading for the week: 101 p

Mon 1.09	**13:15-14**	**Human genetic variation: History and geography**	**SS**
	14:15-15	**Medically relevant human molecular variation**	**SS**
	15:15-16	**Genetic variation in response to drugs and pathogens**	**SS**
Thurs 4.09	**09:15-10**	**Genetic variation for susceptibility to alcohol and lactose**	**SS**
	10:15-11	**Presentation: detecting signatures of selection**	**ST**
	11:15-12	**Presentation: the Hygiene/Old Friends Hypothesis**	**ST**
	13:15-14	**Presentation: gene-culture coevolution**	**ST**
	14:15-15	**Presentation: rates of evolution**	**ST**
	15:15-16	**Discussion: the use and abuse of genetics**	**SS+ST**

Signatures of selection

Qiu H et al. 2008. CYP3 phylogenomics: evidence for positive selection of CYP3A4 and CYP3A7. Pharmacogenetics and Genomics 18: 53-66. (14 p)

The Hygiene/Old Friends Hypothesis

Correale, J. & Farez, M. 2007. Association between parasite infection and immune responses in multiple sclerosis. Annals of Neurology 61: 97-108. (10 p)

Mazmanian, S. K., Round , J.L. & Kasper, D.L. 2008. A microbial symbiosis factor prevents intestinal inflammatory disease. Nature 453: 620-5. (6 p)

Comments by Rook and Stearns at http://evmedreview.com/ (2 p)

Gene-Culture Coevolution

Tishkoff S. A. et al. 2007. Convergent adaptation of human lactase persistence in Africa and Europe. Nature Genetics 39: 31-40. (8 p)

Rates of Evolution

Hawks, J. et al. 2007. Recent acceleration of human adaptive evolution. Proceedings of the National Academy of Science USA 104: 20753-20758. (5 p)

Hendry, A.P & Kinnison, M.T. 1999. The pace of modern life: Measuring rates of contemporary microevolution. Evolution 53: 1637-1653. (14 p)

The Use and Abuse of Genetics

Lewontin, R.C. 1974. Analysis of variance and analysis of causes. American Journal of Human Genetics 26: 400-411. (11 p)

Eltis, K. 2007. Genetic determinism and discrimination: A call to re-orient prevailing human rights discourse to better comport with the public implications of individual genetic testing. Journal of Law, Medicine & Ethics 35: 282-294. (8 p)

Week 3: Natural selection and evolutionary conflicts

Chapters to read this week: EHD Chs 6-8 (43 p)
Total reading for the week: 102 p

Mon 8.09	**13:15-14**	**Human life history evolution: Special features and health-related tradeoffs**	**SS**
	14:15-15	**From Hamilton through Trivers and Haig to Crespi: the long journey of a deep idea**	**SS**
	15:15-16	**Prezygotic selection, MHC variation, reproductive outcome, and mate choice**	**SS**
Thurs 11.09	**09:15-10**	**Presentation: Moore & Haig 1991**	**ST**
	10:15-11	**Presentation: Badcock & Crespi 2006**	**ST**
	11:15-12	**Presentation: Mougeot et al. 2005**	**ST**
	13:15-14	**Presentation: Ober et al. 1992, Ober et al. 1997**	**ST**
	14:15-15	**Presentation: Daly & Wilson 1988, Kruger & Nesse 2006**	**ST**
	15:15-16	**Presentation: Weiss 2008**	**ST**

Parental conflicts over reproductive investment mediated by genetic imprinting:

Moore, T. & Haig, D. 1991. Genomic imprinting in mammalian development – a parental tug-of-war. Trends in Genetics 7: 45-49. (4 p)

Badcock, C. & Crespi, B. 2006. Imbalanced genomic imprinting in brain development: an evolutionary basis for the aetiology of autism. Journal of Evolutionary Biology 19: 1007-1032. (14 p)

Manipulation experiments that expose the role of hormones in mediating tradeoffs

Mougeot, F. et al. 2005. Separating behavioral and physiological mechanisms in testosterone-mediated trade-offs. American Naturalist 166: 158-168.

MHC Variation, Spontaneous Abortions, and Mate Choice

Ober, C., Elias, S., Kostyu, D.D. & Hauck, W.W. 1992. Decreased fecundability in Hutterite couples sharing HLA-DR. American Journal of Human Genetics 50: 6-14. (8 p)

Ober, C. et al. 1997. HLA and mate choice in humans. American Journal of Human Genetics 61: 497-504. (7 p)

Kin Selection, Sexual Selection, and Human Mortality Rates

Daly, M. & Wilson, M. 1988. Evolutionary social psychology and family homicide. Science 242: 519-524. (5 p)

Kruger, D.J. & Nesse, R.M. 2006 An evolutionary life-history framework for understanding sex differences in human mortality rates. Human Nature 17: 74-97. (11 p – only read pages 82-92).

What do case control studies and genomic studies of selection really mean?

Weis, K.M. 2008. Tilting at Quixotic Trait Loci (QTL): an evolutionary perspective on genetic causation. Genetics 179: 1741-1756.

Week 4: Pathogen evolution – antibiotics and vaccines, resistance and virulence

Chapters to read this week: EHD Chs 10, 11, 17 (36 p)
Total reading for the week: 89 p

Mon 15.09	**13:15-14**	**The importance of infectious disease and introduction to epidemiology**	**JK**
	14:15-15	**Adaptive strategies of malaria and toxoplasma**	**JK**
	15:15-16	**Evolution of virulence**	**JK**
Thurs 18.09	**09:15-10**	**Evolutionary responses to vaccines**	**JK**
	10:15-11	**The evolution of drug resistance**	**SS**
	11:15-12	**Presentation: Lipsitch et al. 2000, Koella & Antia 2003**	**ST**
	13:15-14	**Presentation: Day et al. 2007, Brown et al. 2002**	**ST**
	14:15-15	**Presentation: Harrison et al 2006, Day 2003**	**ST**
	15:15-16	**Presentation: Thomas & Read 2007, Koella et al MS**	**ST**

The evolution of antibiotic resistance:

Lipsitch, M., Bergstorm, C.T. & Levin, B.R. 2000. The epidemiology of antibiotic resistance in hospitals: Paradoxes and prescriptions. Proceedings of the National Academy of Sciences USA 97: 1938-1943. (5 p)

Koella, J.C. and R. Antia. 2003. Epidemiological models for the spread of anti-malarial resistance. Malaria Journal 2:3. (11 p)

The evolution of virulence

Day, T., Graham, A.L. & Read, A.F. 2007. Evolution of parasite virulence when host responses cause disease. Proceedings of the Royal Society B 274: 2685-2692. (7 p)

Brown, S.P., Hochberg, M. & Grenfell, B.T. 2002. Does multiple infection select for increased virulence? Trends in Microbiology 10:401-405. (5 p)

Harrison, F., Browning, L.E., Vos, M. & Buckling, A. 2006. Cooperation and virulence in acute *Pseudomonas aeruginosa* infections. BMC Biology 4:21 (5 p)

Day, T. 2003. Virulence evolution and the timing of disease life-history events. Trends in Ecology and Evolution 18: 113-118. (4 p)

Evolution-proof control

Thomas, M.B. & Read, A.F. 2007. Can fungal biopesticides control malaria? Nature Reviews Microbiology 5:377-383. (6 p)

Koella, J.C., Bargielowski, I. & Lorenz, L. manuscript. (10 p)

Week 5: Pathogen evolution – evolutionary genetics, evolutionary genomics, and emergence

Chapters to read this week: EHD Chs 13-16 (53 p)
Total reading for the week: 89 p

Mon 22.09	**13:15-14**	**The evolutionary origins of human viruses**	**SS**
	14:15-15	**Phylogenetics and emergence**	**SS**
	15:15-16	**Evolutionary genomics of pathogens**	**SS**
Thurs 25.09	**9:15-9:40**	**Presentation: Influenza - Smith 2006, Russell et al. 2008**	**ST**
	9:40-10.00	**Presentation: Nelson et al. 2006**	**ST**
	10:15-11	**Presentation: Legionella – Cazalet et al. 2008**	**ST**
	11:15-12	**Presentation: Helicobacter – Giannakis et al. 2008**	**ST**
	13:15-14	**Presentation: The logic of science – Chamberlin 1890 and Platt 1964**	**ST**
	14:15-15	**Your 10 questions about evolutionary medicine**	**SS+ST**
	15:15-16	**Group discussion: What are the characteristics of a good question, and what is your favorite question?**	**SS+ST**

Influenza:

Smith, D.J. 2006. Predictability and preparedness in influenza control. Science 312: 392-394 (3 p)

Russell, C.A. et al. 2008. The global circulation of seasonal influenza A (H3N2) viruses. Science 320: 340-346. (6 p)

Nelson, M.I. et al. 2006. Stochastic processes are key determinants of short-term evolution in Influenza A virus. PloS Pathogens 2: e125.

Legionella:

Cazalet, C. et al. 2008. Multigenome analysis identifies a worldwide distributed epidemic *Legionella pneumophila* clone that emerged within a highly diverse species. Genome Research 18: 431-441. (9 p)

Helicobacter:

Giannakis, M., et al. 2008. *Helicobacter pylori* evolution during progression from chronic atrophic gastritis to gastric cancer and its impact on gastric stem cells. Proceedings of the National Academy of Sciences USA 105: 4358-4363. (6 p)

The logic of science:

Chamberlin, T.C. 1890. The method of multiple working hypotheses. Journal of Geology [1995] 103: 349-354. (6 p)

Platt, J.R. 1964. Strong inference. Science 146: 347-353. (6 p)

Selection of a topic for the paper: Students may choose either their own preferred question that results from discussion on 25 September or pick one from a list provided.

Weeks 6+7: Noninfectious and degenerative disease

Chapters to read this week: EHD Chs 18, 19, 21, 23 (42 p)
Total reading for the week: 67 p

Mon 29.09	**13:15-14**	**The evolution of aging: Nussey et al. 2008**	**SS**
	14:15-15	**Presentation: The evolution of cancer: Buys et al. 2007**	**ST**
	15:15-16	**Presentation: Developmental origins of disease**	
		Sinclair et al. 2007, Jasienska et al. 2006	**ST**
If possible: Chris Kuzawa's talk			
Tues 30.09	**9-12**	**Discussion of paper outlines: 20 min per student**	**SS+ST***
	13-16	**Discussion of paper outlines: 20 min per student**	**SS+ST**
Wed 01.09	**9-12**	**Discussion of paper outlines: 20 min per student**	**SS+ST**
	13-16	**Discussion of paper outlines: 20 min per student**	**SS+ST**
Mon 06.09	**9-12**	**Discussion of paper outlines: 20 min per student**	**SS+ST**
	13-16	**Discussion of paper outlines: 20 min per student**	**SS+ST**

*** Students must get an appointment for a 20 minute time slot.**

The evolution of aging:

Nussey, D.H. et al. 2008. Testing for genetic trade-offs between early- and late-life reproduction in a wild red deer population. Proceedings of the Royal Society of London B 275: 745-750. (5 p)

The evolution of cancer:

Buys, T.P.H. et al. 2007. Genetic changes in the evolution of multidrug resistance for cultured human ovarian cancer cells. Genes Chromosomes & Cancer 46: 1069-1079. (10 p)

Developmental origins of disease:

Sinclair, K.Deet al. 2007. DNA methylation, insulin resistance, and blood pressure in offspring determined by maternal periconceptional B vitamin and methionine status. Proceedings of the National Academy of Sciences USA 104: 19351-19346. (6 p)

Jasienska, G., Thune, I & Ellison, P.T. 2006. Fatness at birth predicts adult susceptibility to ovarian suppression: an empirical test of the Predictive Adaptive Response hypothesis. Proceedings of the National Academy of Sciences USA 103: 12759-12762. (4 p)

Paper outlines: Students should bring to their appointment in week 6 or 7 an outline of their proposed paper together with a List of References of 5-10 papers from the original scientific literature that will be used to support their argument. Each outline will be discussed with Steve Stearns, who will check for logical organization and continuity as well as content. The format of the papers should be that of a short review paper like those in the Trends journals..

References that might be used in student papers:

Bergstrom, C.T., Lo, M. & Lipsitch, M. 2004. Ecological theory suggests that antimicrobial cycling will not reduce antimicrobial resistance in hospitals. Proceedings of the National Academy of Sciences USA 101: 13285-13290. (6 p)

Bourke, A.F.G. 2007. Kin selection and the evolutionary theory of aging. Annual Review of Ecology and Systematics 38: 103-128.

Edwards, E.T.T. et al. 2006. Evolution of the human immunodeficiency virus envelope gene is dominated by purifying selection. Genetics 174: 1441-1453.

Elena, S.F. & Sanjuan, R. 2007. Virus evolution: insights from an experimental approach. Annual Review of Ecology and Systematics 38: 27-52.

Haig, D. 1993. Genetic conflicts in human pregnancy. Q. Rev. Biol. 68: 495-532

Harris, E.E. & Meyer, D. 2006. The molecular signature of selection underlying human adaptations. American Journal of Physical Anthropology Suppl. 43: 89-130. (37 p)

Huang, B.E., Amos, C.I. & Lin, D.Y. 2007. Detecting haplotype effects in genomewide association studies. Genetic Epidemiology 31: 803-812.

Ellison, P.T. 2003. Energetics and reproductive effort. American Journal of Human Biology 15: 342-351.

Greger, M. 2007. The human/animal interface: Emergence and resurgence of zoonotic infectious diseases. Critical Reviews in Microbiology 33: 243-299.

Leinonen, T., O'hara R.B., Cano, J.M. & Merila, J. 2008. Comparative studies of quantitative trait and neutral marker divergence: a meta-analysis. Journal of Evolutionary Biology 21: 1-17.

Maizels, R. 2007. Regulation of the immune system in metazoan parasite infections. (In press)

May, R.M. & Nowak, M.A. 1995. Coinfection and the evolution of parasite virulence. Proceedings of the Royal Society B 261: 209-215. (6 p)

Mitchell-Olds, T., Willis, J.H. & Goldstein, D.B. 2007. Which evolutionary processes influence natural genetic variation for phenotypic traits? Nature Reviews Genetics 8: 845-856.

Muehlenbein, M.P, & Bribiescas, R.G. 2005. Testosterone-mediated immune functions and male life histories. American Journal of Human Biology 17: 527-558.

Myles, S. et al. 2008. Identification and analysis of genomic regions with large between-population differentiation in humans. Annals of Human Genetics 72: 99-110. (9 p)

Nelson, M.I. et al. 2006. Stochastic processes are key determinants of short-term evolution in influenza A virus. PloS Pathogens 2: 1144-1151.

Pletcher, S.D., Kabil, H. & Partridge, L. 2007. Chemical complexity and the genetics of aging. Annual Review of Ecology and Systematics 38: 299-326.

Restif, O. & Koella, J.C. 2004. Concurrent evolution of resistance and tolerance to pathogens. American Naturalist 164: E90-E102.

Su, L.H. et al. 2008. An epidemic of plasmids? Dissemination of extended-spectrum cephalosporinases among Salmonella and other Enterobacteriaceae. FEMS Immunology and Medical Microbiology 52: 155-168.

Walther, B.A. & Ewald, P.W. 2004. Pathogen survival in the external environment and the evolution of virulence. Biological Reviews 79: 849-869.

West, S.A., Diggle, S.P., Buckling, A., Gardner, A. & Griffin, A.S. 2007. The social lives of microbes. Annual Review of Ecology and Systematics 38: 53-78.