

MG640
Genetic Basis of Evolution

Spring 2005

335 Campbell Hall
MWF 1:30 - 2:48

Instructor: Paul Fuerst
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Course description: Molecular Genetics 640 reviews the areas of Evolutionary and Population Genetics. Population genetics is concerned with the processes that affect the patterns of genetic variation within a species, and therefore describes how evolutionary changes occur. Population genetic mechanisms provide both applied and theoretical contributions to many fields, including ecology, systematics, agriculture, wildlife management and conservation biology. Types of genetic variation that have been used by geneticists to study patterns and changes in populations will be surveyed. The course develops some of the basic algebraic foundations for the genetic study of populations. The forces that change allele frequencies within populations will be described. The evaluation of inbreeding patterns and the effect of inbreeding on populations will be discussed. Methods of studying the structure of natural populations will be examined. The processes of molecular change (in both amino acid sequences and nucleic acid sequences) during evolution will be reviewed. The use of new molecular methods to examine quantitative variation, and a brief overview of the theory of quantitative genetics will also be discussed.

Final Exam: Scheduled date and time: Wednesday June 8, 1:30 pm - 3:18 pm

Textbook: Philip W. Hedrick. Genetics of Populations (3rd edition), Jones and Bartlett. Additional readings will be provided on the web site for the course.

Grades: Final grades will combine evaluations by traditional exams, problems sets and material from supplemental reading. Grades are based on three examinations, each worth 20% of the final grade, and five problem sets, each worth 8% of final grade.

Exams: Each exam will include short answer questions, problems and possibly one longer questions. You will be required to understand the facts, and to be able to apply this knowledge

to the problems. The three exams may also include some material which will be answered as take-home material. Students are expected to be present for the exams. Make-ups will be allowed only for valid excuses with documentation. Make-ups will normally be different from the regular examination.

Problem Sets: Problems will be assigned approximately every two weeks, beginning in the middle of week 1. Students are welcome to discuss the problems, but the work turned in by each individual should represent the final product that student (unless the instructions for a problem indicate otherwise). I encourage students to visit me during office hours, or at arranged times, to discuss any questions you may have about the problem sets. Unless otherwise approved, problem sets will be expected to be turned in on the date they are due. Late problems sets will be docked 20% of their value for each lecture that occurs after they are due.

Participation: I encourage students to ask questions during class about topics being considered. I especially encourage students to visit me during office hours, or as arranged, to discuss any topic, but especially if you have question about problems. Papers from the primary literature will be regularly assigned as supplemental reading, and will be the basis of in class discussion.

Course notes and supplemental readings can be accessed at:
<http://www.biosci.ohio-state.edu/~pfuerst/courses/index.html>

Other important dates:

- Apr 15 (Friday) (other than filing your taxes): Last day to drop the course without permission. Last day to drop a course or withdraw from the University using an OSU Withdrawal Form, without having a "W" on your permanent record.
- May 13 (Friday)- Last day to drop a course or withdraw from Spring Quarter without petitioning; a "W" will appear on your permanent record.
- May 30 (Monday) - Memorial Day - no classes
- June 4 (Friday) - Last day of regularly scheduled classes:(F)

STUDENTS WITH DISABILITIES: Any student who feels he or she may need an accommodation because of a physical or learning disability should contact Dr. Fuerst privately to discuss your particular needs. Students should be registered with the Office for Disability Services (ODS, 614-292-3307) in 150 Pomerene Hall and should contact that office to arrange for specific accommodations. Please contact Dr. Fuerst for completion of ODS proctor sheets.

ACADEMIC MISCONDUCT: All instructional faculty and staff are required by Ohio State University to forward all cases of suspected cheating to the Committee on Academic Misconduct. Any form of academic misconduct, no matter how seemingly small, will not be tolerated in this course. Unless indicated on an assignment, problems sets and take-home material are expected to be the ultimate product of the student handing in the assignment. Students are expected to adhere to the university's honor code or else suffer the consequences.

Lecture schedule: (TENTATIVE)

(be sure to read chapter 1. This chapter contains background material on genetics. I will assume all students are familiar with this general material; if you are not familiar with some aspects, please see me and I will suggest some supplemental reading material).

Week 1- Types of Genetic Variation (chapter 1-2 & additional readings)
morphological; immunological;

Week 2- Simple algebraic models of population genetics (Chapter 2 and Supplemental readings)
Hardy-Weinberg model

Week 3- Types of Genetic Variation (chapter 2, 10 & additional readings) protein; nucleic acid
heterozygosity and linkage disequilibrium

Midterm 1 - Friday April 22

Weeks 4-5 - changes in allele frequency (chapter 3, 4, 6, 7 and supplemental readings)
selection
mutation
random drift

Weeks 6-7 - relaxation of the assumptions of the Hardy-Weinberg Model (chapter 5, 6 and 9)
inbreeding
population structure; migration

Midterm 2 - Friday May 13

Weeks 8- 9 - Molecular Mechanisms of Evolution (chapter 8, 11 and supplemental reading)
patterns of variation; gene duplication
molecular phylogenies

Week 10 - complex traits - supplemental readings

Final Examination : Wed, June 9 1:30 am - 3:18 pm with additional take home component

Additional readings (tentative):

Week one: variation

Wunderle, Joseph M., Jr. 1981 An Analysis of a Morph Ratio Cline in the Bananaquit (*Coereba flaveola*) on Grenada, West Indies *Evolution*, Vol. 35, No. 2. (Mar.), pp. 333-344.

Theron, E., Hawkins, K., Bermingham, E., Ricklefs, R.E., and Mundy, N.I. (2001). The molecular basis of an avian plumage polymorphism in the wild: a melanocortin-1-receptor point mutation is perfectly associated with the melanic plumage morph of the bananaquit, *Coereba flaveola*. *Current Biology* 11, 550-557.

Brakefield, P. M. & French, V. 1999. Butterfly wings: the evolution of development of colour patterns. *BioEssays* 21, 391-401.

E J Parra, R A Kittles & M D Shriver (2004) Implications of correlations between skin color and genetic ancestry for biomedical research *Nature Genetics* 36, S54 - S60

Week 2: models

Stefansson, H. et al. (2005) A common inversion under selection in Europeans. *Nature Genetics* 37, 129 - 137.

Anderson WW, et al. 1991. Four Decades of Inversion Polymorphism in *Drosophila pseudoobscura*. *Proc. Nat. Acad. Sci. USA* 88: 10367-10371

Hardy, G. H. 1908 Mendelian Proportions in a Mixed Population. *Science* 28: 49-50.

Crow, J.F. (2001) The beanbag lives on. *Nature* 409, 771

Haldane, J. B. S. (1964) A defence of beanbag genetics. *Persp. Biol. Med.* 7, 343-359.

Week 3: variation in proteins and nucleic acids

Driscoll, C.A., M. Menotti-Raymond, G. Nelson, D. Goldstein, and S. J. O'Brien. Genomic Microsatellites as Evolutionary Chronometers: A Test in Wild Cats. *Genome Research* 12: 414-423

Cargill M, Altshuler D, Ireland J, et al. 1999. Characterization of single-nucleotide polymorphisms in coding regions of human genes *Nature Genetics* 22: 231-238

Week 4: Selection

Masters BS, Hicks BG, Johnson LS, et al. 2003 Genotype and extra-pair paternity in the house wren: a rare-male effect? *Proc Roy Soc Lond B Bio* 270: 1393-1397

Jacob S, McClintock MK, Zelano B, Ober C. 2002. Paternally inherited HLA alleles are associated with women's choice of male odor. *Nature Genetics* 30: 175-179

Penn DJ, Damjanovich K, Potts WK. 2002 .MHC heterozygosity confers a selective advantage against multiple-strain infections. *Proc. Nat. Acad. Sci. USA* 99: 11260-11264

Akey JM, Eberle MA, Rieder MJ, Carlson CS, Shriver MD, Nickerson DA, Kruglyak L. 2004 Population history and natural selection shape patterns of genetic variation in 132 genes. *PLOS Biology* 2: 1591-1599

Week 5: Mutation

Kayser, M. 2000. Characteristics and Frequency of Germline Mutations at Microsatellite Loci from the Human Y Chromosome, as Revealed by Direct Observation in Father/Son Pairs. *Am. J. Hum. Genet.* 66:1580-1588.

Neel JV, Satoh C, Goriki K, Fujita M, Takahashi N, Asakawa Ji, Hazama R. 1986. The Rate with Which Spontaneous Mutation Alters the Electrophoretic Mobility of Polypeptides. *Proc. Nat. Acad. Sci. USA* 83: 389-393

Week 6 Population structure and Inbreeding:

Parker H.G. et al. (2004). Genetic Structure of the Purebred Domestic Dog. *Science* 304: 1160-1164

Bittles,AH 2003, Consanguineous marriage and childhood health *Developmental Medicine & Child Neurology* 45: 571-576.

Crnokrak, P. & D.A. Roff (1999) Inbreeding depression in the wild. *Heredity* 83 260-270

Week 7: Migration

Seielstad, M.T., E. Minch & L.L. Cavalli-Sforza. (1998). Genetic evidence for a higher female migration rate in humans. *Nature Genetics* 20: 278-280.

Schwartz, M.K., et al. (2002) DNA reveals high dispersal synchronizing the population dynamics of Canada lynx. *Nature* 415: 520-522.

Week 8-9: molecular changes

Pergams ORW, Barnes WM, Nyberg D. 2003. Rapid change in mouse mitochondrial DNA. *Nature* 423: 397-397

King, MC and AC Wilson. 1975. Evolution at two levels in humans and chimpanzees. *Science* 188: 107-116.

Hedges SB, Blair JE, Venturi ML, et al. 2004. A molecular timescale of eukaryote evolution and the rise of complex multicellular life. *BMC Evol Biol* 4: art. no. 2

Wildman D.E. et al. 2003. Implications of natural selection in shaping 99.4% nonsynonymous DNA identity between humans and chimpanzees: Enlarging genus *Homo*. *Proc. Nat. Acad. Sci. USA* 100: 7181-7188.

Korber, B., et al. 2000. Timing the Ancestor of the HIV-1 Pandemic Strains. *Science* 288: 1789-1796.

Week 10: complex traits

Porter M.L. and K.A. Crandall. 2003. Lost along the way: the significance of evolution in reverse. *Trends in Ecology and Evolution* 18: 541-547.

Gu, J. and X. Gu. 2003. Induced gene expression in human brain after the split from chimpanzee. *Trends in Genetics* 19: 63-65

Fondon, J.W. III and H.R. Garner. 2004. Molecular origins of rapid and continuous morphological evolution. *Proc. Nat. Acad. Sci. USA* 101: 18058-18063