Course Number and Title

PCB6685 – Fall 2015: Population Genetics (formerly Evolutionary Processes)

Instructor Information

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Office hours: immediately after class or by appointment

Course Description

This course will focus on understanding how the major forces of evolution (mutation, migration, natural selection, and genetic drift) influence patterns of genetic variation within populations, inferences about population structure, and the speciation process. The course is intended for MS or PhD students (in the FLMNH, Biology, Genetics, PMCB, SNRE or other graduate programs) interested in an introduction to the principals of quantitative and population genetics. We will cover topics including F-statistics, detecting selection and local adaptation, linkage disequilibrium, the site frequency spectrum, and speciation genetics. Students will learn to generate simulations using population genetics software or the statistical software R to facilitate understanding the relationships among key population genetic parameters. Students will also prepare an NSF-style pre-proposal that other students in the class will review following NSF merit review criteria.

Course Objectives

By the end of the course, the student will be expected to:

- Understand the fundamental principles of population and quantitative genetics that underlie analyses of molecular evolution, evolutionary ecology, and phylogeography.
- Know the assumptions that underlie major approaches to analysis of population genetic data and how they affect the inferences that can be made from those data.
- Be able to describe how natural selection, genetic drift, mutation, migration, and linkage influence the patterns of genetic variation within and among populations
- Identify major unanswered questions in evolutionary genetics

Credit Hours

4 credit hours

Pre-requisites and Co-requisites

A basic genetics and an introductory evolution course are required. An introductory statistics course and familiarity with algebra will also be very helpful. For the former you may find http://www.biostathandbook.com/ a useful resource.

Course Meeting Time(s)

Tuesdays and Thursdays, periods 2 and 3 (8:30a – 10:25a)

Course Meeting Location(s)

Carr 222

Course Materials

Textbooks or Other Readings

Conner, JK and DL Hartl. 2004. A Primer of Ecological Genetics. Sinauer Associates, Inc., Sunderland MA USA

Provine, WB. 1971. The Origins of Theoretical Population Genetics. University of Chicago Press, Chicago IL USA

Other readings from the primary literature will be posted on the Canvas site.

For a more mathematically complete treatment of many of these topics, the lecture notes from Joe Felsenstein (http://evolution.genetics.washington.edu/pgbook/pgbook.html), Bruce Walsh (http://nitro.biosci.arizona.edu/workshops/Aarhus2006/notes.html), and Kent Holsinger (http://darwin.eeb.uconn.edu/eeb348/lecturenotes/notes.html) are excellent.

Course Website

Canvas site under construction

Course Outline (topics covered by week or by class period)

Date	Topic
8/25	Introduction, survey of student interests, historical overview **Reading**: C&H04 Chapt 1; Provine Chapts 1 - 4.
8/27	Overview of the "central dogma" and kinds of genetic markers **Reading**: C&H04 Chapt 2, p12-22, Peterson et al. 2012 *PLoS One*
9/1	Genetic transmission and the Hardy-Weinberg principle **Reading**: C&H04 Chapt 2, p9-12, 22-36; Provine Chapt 5, p130-137
9/3	Nonrandom mating and estimating inbreeding **Reading**: C&H04 Chapt 2, p36-43
9/8	The Mendelian basis of continuous traits **Reading**: C&H04 Chapt 4, p97-115; Provine Chapt 5, 139-154
9/10	Workshop in regression and ANOVA (Ponciano guest lecture) **Reading**: C&H04 Chapt 4, Box 4.1, 4.2
9/15	Estimating heritability **Reading**: C&H04 Chapt 4, p115-133; Houle 1992 *Genetics*
9/17	Response to selection **Reading**: C&H04 Chapt 5, p163-170; Grant and Grant 2002 *Science*
9/22	Correlations among traits **Reading**: C&H04 Chapt 5, p150-163
9/24	Natural selection on phenotypes **Reading**: C&H04 Chapt 6, p189-215, Antonovics 1976 *Annals of the MoBot Gardens*
9/29	The G-matrix and evolution along lines of maximum genetic variance **Reading**: C&H04 Chapt 6, p215-223; Schluter 1996 *Evolution*
10/1	Local adaptation and Genotype x Environment interactions **Reading**: C&H04 Chapt 5, p138-150, Kawecki and Ebert 2004 *Ecology Letters*
10/6	The genetics of adaptation **Reading**: C&H04 Chapt 5, p170-189; Rockman 2012 *Evolution*

10/8	The Dobzhansky-Muller model for post-zygotic reproductive isolation **Reading**: Orr 1995 *Genetics*
10/13	Genetic conflict and the maintenance of genetic variation **Reading**: Trivers 1974 *American Zoologist*; Zeh and Zeh 1996 *Proceedings of the Royal Society: Biological Sciences*
10/15	Natural selection on genotypes **Reading**: C&H04 Chapt 3, p66-77; Provine Chapt 5, p137-139, 167-177
10/20	Genetic drift and *F*-statistics **Reading**: C&H04 Chapt 3, p52-61, Chapt 5, p148-150; Holsinger and Wier 2009 *Nature Reviews Genetics*
10/22	Interactions among mutation, selection, migration and genetic drift **Reading**: C&H04 Chapt 3, p52-61, Chapt 3, 77-89; Provine Chapt 5, p154-167
10/27	Effective population size **Reading**: C&H04 Chapt 3, p62-66; Charlesworth 2009 *Nature Reviews Genetics*
10/29	The neutralist-selectionist debate – molecular clocks, generation time effect **Reading**: Kimura and Ohta 1971 ***Preproposal first draft due***
11/3	The evolution of the genetic code **Reading**: Freeland and Hurst 1998 *Journal of Molecular Evolution*
11/5	Detecting selection in protein coding regions, codon bias **Reading**: McDonald and Kreitman 1991 *Nature*
11/10	The coalescent – genetic drift in reverse **Reading**: Hudson 1990 *Oxford Surveys in Evolutionary Biology*
11/12	Site frequency spectrum – Tajima's D and related statistics **Reading**: Hudson 1990 cont'd
11/17	Selection at linked sites, cont'd – genetic draft **Reading**: Gillespie 2000 *Genetics* ***Preproposal reviews due***
11/19	Linkage III – the local adaptation model for the fixation of chromosomal inversions **Reading**: Kirkpatrick and Barton 2006 *Genetics*
12/1	Estimating demographic parameters from nucleotide data **Reading**: Excoffier et al. 1992, *Genetics* (AMOVA); Pinho and Hey 2010 *Annual Review of Ecology, Evolution and Systematics*
12/3	The fates of duplicated genes **Reading**: Lynch and Connery 2000
12/8	The evolution of sex chromosomes **Reading**: Lahn and Page 1999 *Science*; Bachtrog 2006 *Current Opinion in Genetics and Genomics*
bonus	The evolution of genome size **Reading**: Lynch 2007 The Origins of Genome Architecture Chapt. 2
12/14	***Final preproposals due***

Attendance Policy

This is a discussion-oriented class, and I anticipate that students will learn as much from their colleagues as they do from the lectures. As such, students are expected to turn up on time for every class. A maximum of 3 absences are allowed.

Conduct in Class

- Please be courteous during class.
- Only approved electronic devices may be used in class. Approved electronic devices are laptop computers (when used to take notes or otherwise participate in classroom activities) and voice recording devices. Unapproved electronic devices include cell phones, video recorders, digital cameras and MP3 players.

Grading

- *Homework: 30% of final grade (5 @ 6 points each)*

The homework will largely consist of problem sets designed to illustrate key population genetic findings and may utilize web simulations or pen and paper calculations.

- *Pre-proposal: 50% of final grade – 15 points first submission, 25 points second submission, 10 points for thoughtful critiques of your slate of proposals to review (3 from the first submission)*

The preproposal will follow the NSF guidelines (http://www.nsf.gov/pubs/2015/nsf15500/nsf15500.htm or updated form as these change from time to time). As such, it will be an opportunity to explore a particular topic (potentially a PhD thesis, or future grant proposal idea), with space for a brief sketch of the methods. Several successful (ie, invited for full proposal) DEB preproposals will be available for examples for how to structure a proposal. The purpose of peer grading is to practice constructive criticism and learn what your colleagues are up to. Please follow the Merit Review criteria in the solicitation (link above). In your reviews you should be thorough and clear in your explanation of the strengths and weaknesses of the proposal, and whenever possible provide suggestions to make the proposal better rather than focus on the criticism alone.

- *Participation in classroom exercises: 20 % of final grade*

The exact nature of these exercises will be decided by the group at the beginning of the class, and may include paper discussions, re-analysis of published data, quizzes, short response essays, in-class group activities, or brief presentations.

Grade Curve Policy

No grading curve

Make-up Exam Policy

No make up work will be given unless the student informs the instructor one week in advance from the scheduled work. Students with disabilities that need special accommodations for testing are required to inform the instructor about it on the first day of class.

Grading Scale

Point Range (%)	Letter Grade	GPA equivalent
≥ 90.00	A	4.0
86.7 – 89.9	A-	3.67
83.3 – 86.6	B+	3.33
80.0 – 83.2	B	3.0
76.7 – 79.9	B-	2.67
73.3 – 76.6	C+	2.33
70.0 – 73.2	C	2.0
66.7 – 69.9	C-	1.67
63.3 – 66.6	D+	1.33
60.0 – 36.2	D	1.0
56.7 – 59.9	D-	0.67
< 56.7	E	0

Note that a "C-" will not be a qualifying grade for critical tracking courses. In order to graduate, students must have an overall GPA and an upper-division GPA of 2.0 or better (C or better). Note: a C- average is equivalent to a GPA of 1.67, and therefore, it does not satisfy this graduation requirement. For more information on grades and grading policies, please visit: http://www.registrar.ufl.edu/catalog/policies/regulationgrades.html

UF Counseling Services

- Resources are available on-campus for students having personal problems or lacking clear career and academic goals. The resources include:
  - UF Counseling & Wellness Center, 3190 Radio Rd, 392-1575, psychological and psychiatric services.
  - Career Resource Center, Reitz Union, 392-1601, career and job search services.
- Many students experience test anxiety and other stress related problems. "A Self Help Guide for Students" is available through the Counseling Center (301 Peabody Hall, 392-1575) and at their web site: http://www.counsel.ufl.edu/.

Honesty Policy

- All students registered at the University of Florida have agreed to comply with the following statement: "I understand that the University of Florida expects its students to be honest in all their academic work. I agree to adhere to this commitment to academic honesty and understand that my failure to comply with this commitment may result in disciplinary action up to and including expulsion from the University."
- In addition, on all work submitted for credit the following pledge is either required or implied: "*On my honor I have neither given nor received unauthorized aid in doing this assignment*."
- If you witness any instances of academic dishonesty in this class, please notify the instructor or contact the Student Honor Court (392-1631) or Cheating Hotline (392-6999). For additional information on Academic Honesty, please refer to the University of

Florida Academic Honesty Guidelines at:
http://www.dso.ufl.edu/judicial/procedures/academicguide.html.

Accommodation for Students with Disabilities

- Students who will require a classroom accommodation for a disability must contact the Dean of Students Office of Disability Resources, in Peabody 202 (phone: 352-392-1261). Please see the University of Florida Disability Resources website for more information at: http://www.dso.ufl.edu/drp/services/.
- It is the policy of the University of Florida that the student, not the instructor, is responsible for arranging accommodations when needed. Once notification is complete, the Dean of Students Office of Disability Resources will work with the instructor to accommodate the student.

Software Use

All faculty, staff and student of the University are required and expected to obey the laws and legal agreements governing software use. Failure to do so can lead to monetary damages and/or criminal penalties for the individual violator. Because such violations are also against University policies and rules, disciplinary action will be taken as appropriate.