Course Syllabus

EBIO 4290/5290: Molecular Systematics and Evolution – Fall 2014, 3 credits

Day/Time: Tue. & Thu. 2:00–3:15 PM (lecture) / Wed or Fri. 8:00-9:50 AM (labs)
Room: Atlas 1B31
Instructor: Dr. Stacey D. Smith, Dept. of Ecology and Evolutionary Biology
Office: C340 Ramaley (office hours: 3:30-5:00 Tues or by appointment)
Phone: 402-370-6749 or 303-492-1374 / Stacey.D.Smith@colorado.edu
Teaching assistant: Julia Dupin, Julia.Dupin@colorado.edu
Office: C127 Ramaley (office hours: by appointment)

Prerequisites

Prereq., EBIO 3080 (Evolutionary Biology) or instructor consent.

Course Description

A phylogeny is a tree diagram that depicts the evolutionary history of a set of tips, which might genes, organisms, populations or taxa. Reading and interpreting phylogenies has become a fundamental element of biological literacy. This course explores the principles by which phylogenies are inferred as well as the application of phylogenetic comparative methods to address evolutionary and ecological questions. By the end of the course, students should be able to:
1. Read and interpret evolutionary relationships based on phylogenetic trees
2. Understand how parsimony, likelihood, and Bayesian approaches are used to estimate phylogenetic trees
3. Evaluate the accuracy of trees using statistical measures
4. Use parsimony, likelihood, and Bayesian approaches to infer historical events, such as the evolution of new traits or dispersal to new geographic areas
5. Incorporate phylogenetic approaches to addressing research questions in related fields of biology, such as medicine and conservation.

Course Materials

Baum, D. A., & S. D. Smith. 2013. *Tree-Thinking: An Introduction to Phylogenetic Biology*. Roberts & Co., Greenwood Village, CO.

Additional book chapters and journal articles are assigned as supplemental reading.

Learning Goals

The overarching objective of this course is to enable you to view biological questions through a historical and evolutionary lens, that is, to be come tree-thinkers. As part of developing critical thinking skills in a phylogenetic context, this course will help you learn how to:

- Extract and synthesize information from the primary and secondary literature
- Think critically about the strength of evidence supporting scientific hypotheses
- Develop and evaluate your own biologically motivated and testable phylogenetic hypotheses
- Effectively communicate scientific information through writing, speaking and visual aids

Assessment: Points for this course are divided among four categories, totaling 500 points.

			Total Points	Percent	Grade
In-class activities & homework (20%):	100		450-500	90-100	A
Laboratory activities (20%):	100		400-449.5	80-89.9	B
Exams (2 at 15% each):	150		350-399.5	70-79.9	C
Individual research project (30%)	150		300-349.5	60-69.9	D
Total	500		Below 299.5	Below 59.9	F

<u>In-class activities & homework:</u> In-class activities may include solving problems, paper discussions, writing exercises, or quizzes based on the reading material. Homework may be used to provide additional reinforcement of concepts covered in class.

<u>Laboratory activities:</u> Each week's lab will have a corresponding work sheet outlining the computational exercises to be completed. These will be graded to assess participation in the lab.

<u>Exams:</u> There will be two exams, each worth 75 points. The exams will contain a mixture of problems, multiple choice questions, and short essay questions.

<u>Individual Research Project:</u> You will identify a research question in phylogenetic biology and perform a phylogenetic analysis using skills learned in class. You will prepare a written report of your findings will be due at the end of the semester and you will present your findings to the class. More details are given below.

<u>Extra Credit:</u> There will be one extra credit activity worth 10 points. Information about this activity will be given following the first exam.

Policies:

- **Make-up assignments:** If there is a foreseeable event that may cause you to miss class or lab, you must contact the instructors and the TA in advance. Make-up work will only be allowed for documented excusable absences (e.g., illness, death in the family) and must be completed within one week of the original deadline. No credit will be given after this point.
- **Late assignments:** 5% of the credit will be deducted for every hour past the due date and time
- **Honor code**: This course adheres to the honor code (www.colorado.edu/academics/honorcode/) and cheating on any assignment will result in a zero grade. Written assignments will be subjected to screening on D2L to certify absence of plagiarism.
- **Disability policy:** If you qualify for accommodations because of a disability, please submit to me a letter from Disability Services in a timely manner so that your needs may be addressed. Disability Services determines accommodations based on documented disabilities. Contact: 303-492-8671, Willard 322, or visit www.colorado.edu/disabilityservices for more information
- **Policy on religious observances:** If you foresee any conflicts with the class schedule due to religious observances, please see me at the beginning of the semester to make arrangements. Full details of university policy are available at http://www.colorado.edu/policies/fac_relig.html
- **Classroom behavior:** Cell phone use is not permitted during class. Laptops/tablets must be used only for classroom related activities. Students using laptops/tablets for other purposes will be asked to leave and will not receive credit for any in-class activity on that date. Students are expected to participate in all activities and refrain from behaviors that detract from other students' learning (e.g., talking while the instructor is speaking). www.colorado.edu/policies/classbehavior.html
- **Policy on Discrimination and Harassment:** The University policies on discrimination, (http://www.colorado.edu/policies/discrimination.html), harassment, and amorous relationships applies to all students, staff and faculty. Any student, staff or faculty member who believes s/he has been the subject of discrimination or harassment based upon race, color, national origin, sex, age, disability, religion, sexual orientation, or veteran status should contact the Office of Discrimination and Harassment (ODH) at 303-492-2127 or the Office of Judicial Affairs at 303-492-5550. Information about the ODH can be obtained at http://www.colorado.edu/odh

Individual Research Project (150 points):

- **The choice of topic (15 points) is due on 9/30 at 9:00AM** and should be emailed to me as a word document with the file labeled with your last name ("Smith_4290Topic.doc"). It should include a draft title and a single paragraph, which describes (1) the target taxon, (2) the scientific question to be addressed, (3) the hypothesis, and (4) the approach to be used to test the hypothesis. All projects will include inferring a phylogeny from existing sequence data and performing one comparative analysis (e.g., trait reconstruction).

- **The project outline (15 points) is due 10/28 at 9:00AM** and should be emailed to me as a word document with the file labeled with your last name ("Smith_4290Outline.doc"). It should include (1) a description of the source of the data and (2) a detailed outline of the approach (e.g., the program to be used, the optimality criterion, the model, etc.).

- **The final dataset (15 points) is due 11/6 at 9:00AM**. Please title the file with your last name ("Smith_4290Dataset.nex"). This dataset should take the form of a single combined nexus file, with alignment, one or more trees, and character state data, that can be executed (i.e., opened and analyzed in Mesquite). An example will be provided.

- **The draft paper (25 points) is due 11/20 by 9AM** and should be emailed to me as a word document with the file labeled with your last name ("Smith_4290Draft.doc"). It should include five sections (1) a general introduction to the topic and study system, ending in a paragraph giving the specific questions addressed or hypotheses tested (2) materials and methods, (3) results, (4) discussion, and (5) literature cited, follow this format: http://www.chicagomanualofstyle.org/tools_citationguide.html. Every paper should have at least one figure and one table. Papers will be returned with comments via email by 11/27.

- **The final project report (35 points) is due by 12/5 at 9:00AM** and should incorporate the comments given on the draft version.

- **The project presentations (45 points)** will take place during the last two class sessions and the final exam period. Each student will be allotted 12 minutes with 2 minutes for questions. I suggest that the structure of the talk follow that of the four sections of the paper, with roughly 2 slides per section.

THIS SYLLABUS IS SUBJECT TO CHANGE; UPDATED VERSIONS WILL BE ON D2L

Date	Topic	Reading	Project
8/26	Orientation	Ch. 1	
8/28	History of tree-thinking; Paper Discussion [8pts]	Ch. 2, O'Hara 1998	
	Pre-Test / Clade race [8pts]		
9/2	Phylogeny representation	Ch. 3	
9/4	Phylogenetic kung-fu [8pts]		
	Lab 1: Tree Manipulation [8pts]		
9/9	Trait evolution	Ch. 4	
9/11	Paper Discussion: Origin of echolocation [8pts]	Teeling et al. 2000	
	Lab 2: Trait evolution [8pts]		
9/16	Relatedness, Classsification, Tree reading practice	Ch. 5	
9/18	Paper discussion: Phylogenetic Forensics [8pts]	Metzker et al. 2002	
	Lab 3: Building a data matrix [8pts]		
9/23	Intro. to Parsimony	Ch. 7	
9/25	Parsimony cont.; Discussion of topic choices [8pts]		
	Lab 4: Parsimony [8pts]		
9/30	Intro. to Model-based methods (incl. clocks)	Ch. 8 (excl. Dist. & Bayesian inference)	Topic Choice
10/2	Maximum Likelihood & Paper discussion [8pts]	Lewis 1998	
	Lab 5: Maximum likelihood [8pts]		
10/7	Intro to Bayesian methods	Ch. 8 (p. 247-258)	
10/9	Bayesian methods cont. [8pts]	Holder and Lewis 2003	
	Lab 6: Bayesian analysis [8pts]		
10/14	**Exam I**		
10/16	Knowing your data: signal and support	Ch. 9 (p. 265-281)	
	Lab 7: Phylogenetic signal, bootstrapping [8pts]		
10/21	Studying discrete trait history w/ ML and Bayesian	Ch. 10 (p. 316-322; 325-327)	
10/23	Paper discussion: History of lichen symbiosis [8pts]	Lutzoni et al. 2001	
	Lab 8: Ancestral states and trends [8pts]		
10/28	Adaptation & correlated evolution of discrete traits	Ch. 10 (p. 323-324)	Paper Outline
10/30	Paper discussion: Evolution of wind pollination [8pts]	Friedman and Barrett, 2008	
	Lab 9: Correlated evolution of discrete traits [8pts]		
11/4	Studying the history of continuous traits	Ch. 10 (p. 327-348)	
11/6	Paper discussion: Independent contrasts; Beaks and Songs in Darwin's finches [8pts]	Felsenstein 1985; Podos 2001	Dataset
	Lab 10: Cont. ASR, / PICS correlation [8pts]		
11/11	Phylogenetic Signal/Community Phylogenetics	Ch. 10 (p. 359-362)	
11/13	Paper discussion: Flower color in communities [8pts]	Muchhala et al. 2014	
	Lab 11: Traitgrams / Comm. Structure [8pts]		
11/18	**Exam II**		
11/20	Phylogenetic analysis of coding sequences	Yang 2002	Draft Paper
	Lab 12: Molecular evolution		
11/25	Thanksgiving / Fall Break		
12/2	Phylogenomics	Ch. 6	
12/4	Gene trees and species trees (GT/ST) [8pts]	Maddison 1997	
	Lab 13: Phylogenomics Lab		Final Paper
12/9	Project Presentations		
12/11	Project Presentations		