

Course Syllabus

EBIO 4290/5290: Phylogenetics and Comparative Biology – Fall 2015, 4 credits

Day/Time: TH 2:00–3:15 PM (lecture) / W 2:00-4:50 PM & H 11:00-1:50 PM (labs)
Room: N1B75 (lecture) / N1B76 (labs)
Instructor: Dr. Stacey D. Smith, Dept. of Ecology and Evolutionary Biology
Office: C340 Ramaley (office hours: 12:00-1:30 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)
Learning assistant: Erin Collier-Zans, Erin.CollierZans@colorado.edu

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 become 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.

In-class activities & homework (20%):	100
Laboratory activities (25%):	125
Exams (2 at 15% each):	150
Individual research project (25%)	125
Total	500

Total Points	Percent	Grade
470-500	94-100	A
450-469	90-93.9	A-
435-449	87-89.9	B+
420-434	84-86.9	B
400-419	80-83.9	B-
462-399	77-79.9	C+
385-461	74-76.9	C
350-384	70-73.9	C-
335-349	67-69.9	D+
320-334	64-66.9	D
300-319	60-63.9	D-
0-299	Below 59.9	F

In-class activities & homework: 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. Each week of class will have ~8 in-class or homework points.

Laboratory activities: 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. See lab syllabus for more details.

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

Individual Research Project: You will identify a research question in comparative 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.

Extra Credit: There will be one extra credit activity worth 15 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.
- **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).

Individual Research Project (125 points):

- **The choice of topic (10 points) is due on 10/2 at noon** and should be uploaded to dropbox as a MS word document with the file labeled with your last name ("Smith_4290Topic.doc"). Following the example on D2L in the assignments folder, 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, (4) the rationale for this hypothesis, and (5) 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, correlation analysis).
- **The project outline (15 points) is due 10/30 at noon** and must be uploaded to dropbox as a MS word document with the file labeled with your last name ("Smith_4290Outline.doc"). It should include (1) a revised version of your topic incorporating any feedback that you were provided, (2) a description of the source of the data and (3) a detailed outline of the approach (e.g., the programs to be used, the optimality criterion, the model, etc.). You will be graded on completion and on quality (e.g. of revision). See outline rubric in the assignments folder for more information.
- **The final dataset (9 points) is due IN LAB during the week of 11/5.** By the end of the lab, you must upload your data as a single file ("Smith_4290Dataset.nex") to dropbox. This dataset should take the form of a single combined nexus file, with a sequence 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 (20 points) is due IN LAB during the week of 11/19** and must be uploaded to dropbox as a MS word document with the file labeled with your last name ("Smith_4290Draft.doc") before your lab session. 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, one table, and 5 peer-review articles in addition to other citations. You will bring 3 print copies of your paper to lab for peer review, and this preparation along with your participation will count for your lab points that week.
- **The revised paper (20 points) is due by 12/4 at noon** and must be uploaded to dropbox as a MS word document with the file labeled with your last name ("Smith_4290Revised.doc"). Before revising, turn on the track changes option. Use 'comments' to explain your changes to me. Your score for this assignment will be based on the completeness of the paper and the effort you place in revising. I will return comments by 12/7.
- **The lightning talks (21 points)** will take place during the last two class sessions. Each student will be allotted 7 minutes with 1 minute 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.
- **The final paper (35 points) is due by 12/1 at noon** and should incorporate the comments that I gave on the revised version.

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

Date	Topic	Reading	Project
8/25	History of tree-thinking	Ch. 1, 2	
8/27	Paper Discussion; Tree-thinking vs Ladder-thinking Lab 1: Pre-Test / Clade race [8 pts]	O'Hara 1998	
9/1	Phylogeny representation	Ch. 3	
9/3	Phylogenetic kung-fu Lab 2: Tree Manipulation [9 pts]		
9/8	Trait evolution	Ch. 4	
9/10	Paper Discussion: Origin of echolocation Lab 3: Trait evolution [9 pts]	Teeling et al. 2000	
9/15	Relatedness, Classification, Tree reading practice	Ch. 5	
9/17	Paper discussion: Phylogenetic Forensics Lab 4: Building a data matrix [9 pts]	Metzker et al. 2002	
9/22	Intro. to Parsimony	Ch. 7	
9/24	Parsimony cont.; Discussion of topic choices Lab 5: Parsimony [9 pts]		
9/29	Intro. to Model-based methods	Ch. 8 (excl. Dist. & Bayesian inference)	
10/1	Maximum Likelihood & Paper discussion Lab 6: Maximum likelihood [9 pts]	Lewis 1998	Topic Choice
10/6	Intro to Bayesian methods	Ch. 8 (p. 247-258)	
10/8	Bayesian methods cont. Lab 7: Bayesian analysis [9 pts]	Holder and Lewis 2003	
10/13	Exam I		
10/15	Knowing your data: signal and support Lab 8: Phylogenetic signal, bootstrapping [9 pts]	Ch. 9 (p. 265-280)	
10/20	Studying discrete trait history w/ ML and Bayesian	Ch. 10 (p. 316-322; 325-327)	
10/22	Paper discussion: History of lichen symbiosis Lab 9: Ancestral states and trends [9 pts]	Lutzoni et al. 2001	
10/27	Adaptation & correlated evolution of discrete traits	Ch. 10 (p. 323-324)	
10/29	Paper discussion: Evolution of wind pollination Lab 10: Correlated evolution of discrete traits [9 pts]	Friedman and Barrett, 2008	Outline
11/3	Project conferences		
11/5	Project conferences Lab 11: Project workshop [9 pts]		Dataset
11/10	Studying the history of continuous traits	Ch. 10 (p. 327-348)	
11/12	Paper discussion: Independent contrasts; Beaks and Songs in Darwin's finches Lab 12: Cont. ASR / PICS correlation [9 pts]	Felsenstein 1985; Podos 2001	
11/17	Exam II		
11/19	Elements of scientific writing Lab 13: Writing workshop/Peer Review [9 pts]		Draft Paper
11/25	Thanksgiving / Fall Break		
12/1	Gene trees and species trees (GT/ST)	Ch. 6; Maddison 1997	
12/3	Gene trees and species trees cont. Lab 14: Phylogenomics Lab [9 pts]		Revised Paper
12/8	Lightning talks		
12/10	Lightning talks		
12/11			Final Paper

Honor Code

All students of the University of Colorado at Boulder are responsible for knowing and adhering to the academic integrity policy of this institution. Violations of this policy may include: cheating, plagiarism, aid of academic dishonesty, fabrication, lying, bribery, and threatening behavior. Cheating on any course assignment will result in a zero grade. Written assignments will be subjected to screening on D2L to certify absence of plagiarism. All incidents of academic misconduct will be reported to the Honor Code Council (honor@colorado.edu; 303-735-2273). Students who are found to be in violation of the academic integrity policy will be subject to both academic sanctions from the faculty member and non-academic sanctions (including but not limited to university probation, suspension, or expulsion). Additional information regarding the Honor Code policy can be found online and at the Honor Code Office (www.colorado.edu/academics/honorcode/).

Accommodations

If you qualify for accommodations because of a disability, please submit to Dr. Smith a letter from Disability Services in a timely manner (for exam accommodations provide your letter at least one week prior to the exam). Disability Services determines accommodations based on documented disabilities. Contact Disability Services at 303-492-8671 or by e-mail at dsinfo@colorado.edu, or on the web at www.colorado.edu/disabilityservices for more information. If you have a temporary medical condition or injury, see Temporary Injuries guidelines under the Quick Links at the Disability Services website and discuss your needs with Dr. Smith.

Religious observances

Campus policy regarding religious observances requires that faculty make every effort to deal reasonably and fairly with all students who, because of religious obligations, have conflicts with scheduled exams, assignments or required attendance. If you foresee any conflicts 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

Learning environment

Students and faculty each have responsibility for maintaining an appropriate learning environment. Professional courtesy and sensitivity are especially important with respect to individuals and topics dealing with differences of race, color, culture, religion, creed, politics, veteran's status, sexual orientation, gender, gender identity and gender expression, age, disability, and nationalities. I will gladly honor your request to address you by an alternate name or gender pronoun. Please advise me of this preference early in the semester so that I may make appropriate changes to my records. For more information, see the policies on classroom behavior and the student code.

Discrimination And Harassment

The University is committed to maintaining a positive learning, working, and living environment and will not tolerate acts of discrimination or harassment based upon Protected Classes or related retaliation against or by any employee or student. For purposes of this CU-Boulder policy, "Protected Classes" refers to race, color, national origin, sex, pregnancy, age, disability, creed, religion, sexual orientation, gender identity, gender expression, veteran status, political affiliation or political philosophy. Individuals who believe they have been discriminated against should contact the Office of Institutional Equity and Compliance (OIEC) at 303-492-2127 or the Office of Student Conduct and Conflict Resolution (OSC) at 303-492-5550. Information about the OIEC, the above referenced policies, and the campus resources available to assist individuals regarding discrimination or harassment can be found at the OIEC website. The full policy on discrimination and harassment contains additional information.