

Course Syllabus - Special Topics in Evolutionary Biology: Macroevolution & Phylogenetics

BIOL 5984

TR 11:00 - 12:15 PM

Professor: Prof. Josef Uyeda (Yo-sef Weh-duh)

Email: juyeda@vt.edu

All lectures will be conducted on Zoom

Course location: <https://virginiatech.zoom.us/j/93056390213>

Class website: Canvas and https://github.com/uyedaj/macrophys_course

Discussion site: <https://discord.gg/WNmc6Yj>

Office hours: By appointment. Can be scheduled using *Calendly* at the following link:
<https://calendly.com/josefuyeda/office-hour?month=2020-08>

Textbooks: None are required to be purchased, readings will be provided from the primary literature, as well as from the following texts:

Baum, David A. and Stacey D. Smith. *Tree Thinking: An Introduction to Phylogenetic Biology* (1st Edition). W.H. Freeman, 2012.

Felsenstein, Joseph. *Inferring Phylogenies* (2nd Edition). Sinauer, 2003.

Harmon, Luke. *Phylogenetic Comparative Methods: Learning from trees*. CC-BY-4.0, 2018.

Course Description:

Phylogenetic trees are the map by which we understand evolutionary history and ultimately, all of biology. The goals of this course are threefold:

1. **Embrace tree-thinking:** You will learn what a phylogeny represents, how to use them to interpret evolutionary history and importantly, how to estimate them from biological data. This is the study of *phylogenetics*.
2. **Unleash the power of the comparative method:** Why should we estimate trees in the first place? We will use phylogenies as a map for studying macroevolutionary questions about trait evolution, the relationships between organisms and their abiotic and biotic environment, and the causes and consequences of diversification. This is the study of *phylogenetic comparative methods*.
3. **Think big - Macroevolutionary science:** We will engage with the rich and exciting history of evolutionary thought which fundamentally sought to unite microevolutionary processes, genetics and development to explain macroevolutionary patterns across the tree of life. We will read and discuss about these “big ideas” in macroevolution, and discuss how recent advances in phylogenetics and comparative methods enable us to test these ideas in ways never before possible.

Course Policies

Our Inclusive Classroom

It is my goal to foster an inclusive classroom environment, even while we are interacting virtually.

This means that students from all diverse backgrounds and perspectives are entitled to a safe, welcoming and respectful environment free from prejudice, bullying, discrimination and bias - including in the form of microaggressions, posting material insensitive or insulting to others, or any form of online harassment. By enrolling and attending this course, you agree to be respectful of diversity across gender identity, sexuality, disability, age, socioeconomic status, ethnicity, race, nationality and culture. We are also in the midst of a nationwide dialogue about racism in our institutions, and this has existed and still exists in our macroevolutionary and phylogenetics research communities. This course will effort to acknowledge and work to remedy that harm. Your feedback, suggestions and comments are always appreciated and welcome.

University Honor Code

“As a Hokie, I will conduct myself with honor and integrity at all times. I will not lie, cheat, or steal, nor will I accept the actions of those who do.”

Students enrolled in this course are responsible for abiding by the Honor Code. A student who has doubts about how the Honor Code applies to any assignment is responsible for obtaining specific guidance from the course instructor before submitting the assignment for evaluation. Ignorance of the rules does not exclude any member of the University community from the requirements and expectations of the Honor Code. Academic integrity expectations are the same for online classes as they are for in person classes. All university policies and procedures apply in any Virginia Tech academic environment.

For additional information about the Honor Code, please visit: <https://www.honorsystem.vt.edu/>

Attendance

All courses will be conducted synchronously on Zoom. Please make an effort to attend as many lectures as you can. Lectures and discussions will, however, be recorded and posted on Canvas. They will not be posted on the github site, so if you are not registered for the course you will not have access to these recordings. You are expected to participate in all discussions, have completed all readings BEFORE class, and to fully engage with the material and your classmates. students missing several class periods should consult with the instructor.

Course Syllabus

The course syllabus is subject to change by the instructor. Changes will be announced in class and on Canvas. Exam dates are unlikely to be changed from their original version.

Student Evaluation

Exams (2 X 100 pts, 200pts; at least one of these exams will be take-home)

Participation in discussions of primary literature and in-class activities (50 pts)

Exercises (~ 5 assignments, each worth 10 pts, 50 pts)

Final Project: Final project presentation(100 pts)

Final Project. All course participants will conduct a final research project that will conduct an

analysis of phylogenetic data using the methods and techniques learned in class. This project is largely open-ended and up to the student. However, suggested topics include: building a phylogeny of a group of taxa of interest using available sequence data on Genbank, analyzing existing phenotypic datasets and phylogenies with phylogenetic comparative methods, or conducting a simulation study of phylogenetic model behavior. One of the 5 assignments is to submit a project proposal (due 10/1) that outlines the research question under study, the proposed datasets to be used, the analyses to be conducted, and the expected results (No more than 2 pages, not including citations). **The last three class periods will be spent for final presentations in the form of 15 minute talks on the results of these independent research projects. We will not meet for the final exam time.**

Technology. You will be registered to have access to a Uyeda lab server to conduct computational exercises in conjunction with this course. Detailed instructions and rules are to follow. This is a shared machine and as such, you are asked to respect the the provided rules and regulations regarding its use. Abuse of the server privileges will not be tolerated. All material will be posted on Canvas and github, except for recorded lectures/discussion, which will only be posted on Canvas. The provided Discord server is available for students to connect to their instructor and each other to work on projects, develop ideas, discuss topics, complete assignments and otherwise build our virtual community. As stated above, the code of conduct and University principles of community extend to this virtual setting.

Coursework during a pandemic. We are meeting under unprecedented circumstances. Above all, your health and well-being (including your mental health) are valued as the most important priority. Please communicate your concerns and any impacts that may arise during the course of the semester and your instructor will make every effort to accomodate you.

Course Schedule (Subject to change)

Date	Topic	Reading	Assignments
T 8/25	1. An Introduction to Phylogenetics & Macroevolution		
Th 8/27	2. Parsimony & cladistics	Baum&Smith Ch 1-3	
T 9/1	3. Probability, likelihood & Rev. Bayes	Baum&Smith Ch 4 & 7	Assignment I: Self-evaluation
Th 9/3	4. Felsenstein & the birth of statistical phylogenetics	Felsenstein 1981	
T 9/8	5. Discrete character evolution I	O'Meara 2012	
Th 9/10	6. Discrete character evolution II	Inferring phylogenies	
T 9/15	7. Inferring phylogenies from molecular data	Inferring phylogenies	
Th 9/17	8. Practical considerations: alignments, partitioning and mixture models		

T 9/22	9. EXAM I		
Th 9/24	10. Lab: RevBayes		
T 9/29	11. Phylogenomics		
Th 10/1	12. Biogeography		Assignment: Project proposal
T 10/6	13. Advanced topics in morphological evolution (Guest lecturer: Diego Porto)	TBA	
Th 10/8	14. Dating phylogenetic trees		
T 10/13	15. Gene trees vs. Species trees & the multispecies coalescent		
Th 10/15	16. Guest speaker paper discussion (Rosana Zenil-Ferguson/Tentative)		
T 10/20	17. Brownian Motion & continuous trait evolution		
Th 10/22	18. The comparative method & PICs	Felsenstein 1985	
T 10/27	18. Modeling adaptation	Hansen 1997	
Th 10/29	19. Ornstein-Uhlenbeck models II	Butler and King 2004	
T 10/29	20. Finding evolutionary shifts		
Th 10/31	21. Hypothesis testing vs. data-driven modeling	Uyeda et al. 2018	
T 11/3	22. EXAM II		
Th 11/5	23. Diversification models - birth and death on trees	Eldredge and Gould, 1972	
T 11/10	24. Species selection - SSE models	Maddison et al. 2007	
Th 11/12	25. Punctuations, stasis & gradualism		
T 11/17	26. Connecting micro & macroevolution		
Th 11/19	27. Grand challenges in phylogenetics and macroevolution		
T 11/24	Thanksgiving Holiday		
Th 11/26	Thanksgiving Holiday		
M 12/1	Presentations		
Th 12/3	Presentations		
T 12/8	Presentations		