**Course Syllabus - Special Topics in Evolutionary Biology:**

**Macroevolution & Phylogenetics**

BIOL 5984

MW 4:00 - 5:15 PM

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

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**Office hours:** By appointment

Textbooks: None are required, readings will be provided from the primary literature, as well as from the following texts. Purchase of these texts is optional, though both are great reference material for those interested in phylogenetics and phylogenetic methods.

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.

**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**

*Attendance*

You are expected to attend every class and be on time. You are expected to participate in all discussions, have completed all readings BEFORE class, and to fully engage with the material and your classmates.

*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)

Participation in discussions of primary literature (50 pts)

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

Final Project: Final project presentation(100 pts)

*Final Project Description.* All course participants will conduct an 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 two class periods will be spent for final presentations in the form of 15 minute talks on the results of these independent research projects.

**Course Schedule**

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| **Date** | **Topic** | **Reading** | **Assignments** |
| M 8/20 | NO CLASS  1. An Introduction to Tree-Thinking | Baum&Smith  Ch 1 & 2 |  |
| W 8/22 | NO CLASS  2. An Introduction to Tree-Thinking | Baum&Smith  Ch 3 |  |
| M 8/27 | 3. Tree-thinking, parsimony & cladistics | Baum&Smith  Ch 4 & 7 | Assignment I (Self-Test) |
| W 8/29 | 4. Probability, likelihood & Rev. Bayes |  |  |
| M 9/3 | No Class, Labor Day |  |  |
| W 9/5 | 5. Felsenstein & the birth of statistical phylogenetics | Felsenstein 1981 |  |
| M 9/10 | 6. Discrete character evolution I | O’Meara 2012 |  |
| W 9/12 | 7. Discrete character evolution II | Inferring phylogenies |  |
| M 9/17 | 8. Inferring phylogenies from molecular data | Inferring phylogenies |  |
| W 9/19 | 9. Practical considerations: alignments, partitioning and mixture models |  |  |
| M 9/24 | 10. **EXAM I** |  |  |
| W 9/26 | 11. Biogeography |  |  |
| M 10/1 | 12. Lab: RevBayes |  | Assignment II:Project proposal |
| W 10/3 | 13. Dating phylogenetic trees |  |  |
| M 10/8 | 14. Gene trees vs. Species trees |  |  |
| W 10/10 | 15. The multispecies coalescent |  |  |
| M 10/15 | 16. Brownian Motion & continuous trait evolution |  |  |
| W 10/17 | 17. The comparative method & PICs | Felsenstein 1985 |  |
| M 10/22 | 18. Modeling adaptation | Hansen 1997 |  |
| W 10/24 | 19. Ornstein-Uhlenbeck models II | Butler and King 2004 |  |
| M 10/29 | 20. Finding evolutionary shifts |  |  |
| W 10/31 | 21. Hidden state models | Beaulieu et al. 2013 |  |
| M 11/5 | 22. **EXAM II** |  |  |
| W 11/7 | 23. Punctuations, stasis & gradualism | Eldredge and Gould, 1972 |  |
| M 11/12 | 24. Diversification models - birth and death on trees |  |  |
| W 11/14 | 25. Species selection - SSE models |  |  |
| M 11/19 | No Class - Thanksgiving Holiday |  |  |
| W 11/21 | No Class - Thanksgiving Holiday |  |  |
| M 11/26 | 26. Hypothesis testing vs. data-driven modeling | Uyeda et al. 2018 |  |
| W 11/28 | 27. Grand challenges in phylogenetics and macroevolution |  |  |
| M 12/3 | Presentations |  |  |
| W 12/5 | Presentations |  |  |