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BIOL 483.01: Phylogenetics and Evolution

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Phylogenetics and Evolution

BIOL 483

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Goals: Phylogenetics and related molecular evolutionary methods provide powerful approaches for testing evolutionary hypotheses and have recently become pervasive throughout biology and other scientific disciplines. In this course, we will: (1) become familiar with the theoretical foundations of popular methods of reconstructing phylogenies from molecular sequence data, other selected molecular evolutionary analyses, and special topics driven by student interest; (2) gain extensive hands-on experience with phylogenetic datasets and computational software; and (3) learn how to critically evaluate other people's phylogenies.

Text: There is no text for this course. Readings from the primary literature will be provided as appropriate. Some good general introductions to the subject matter that you may wish to check out:

Baum, D. and S. Smith. 2013. *Tree Thinking: An Introduction to Phylogenetic Biology*. Roberts & Company.

Swofford, D. et al. 1996. Phylogenetic inference. In: *Molecular Systematics*, 2nd ed. (D. M. Hillis, C. Moritz and B. K. Mable, eds.). Sinauer.

Felsenstein, J. 2004. *Inferring Phylogenies*. Sinauer.

Avice, J. 2004. *Molecular Markers, Natural History, and Evolution*, 2nd ed. Sinauer.

General policies. University policies on drops, adds, grade changes, changes of status and disability services for students will be observed in this course.

Assessment: Performance will be evaluated according to the following +/- grading system: A (>92-100); A- (>90-92); B+ (>87-90); B (>82-87); B- (>80-82); C+ (>77-80); C (>72-77); C- (>70-72); D+ (>67-70); D (>62-67); D- (>60-62); F (<60). Assessment will be based on the following criteria:

- (1) Attendance and participation: 20% of grade.** Discussion, sharing of ideas and asking of questions are encouraged. Missing class without a valid, documented reason will result in a 5 point deduction from your final grade.
- (2) Assignments (computer lab exercises etc.): 40% of grade.** To guarantee full consideration, assignments must be turned in by the specified deadline. If you elect to submit by email/Moodle, please do so at least 20 minutes before the beginning of class. If you prefer to submit a hard copy, typed responses are preferred but not required; however, written responses must be legible to receive full consideration.
- (3) A small, independent research project to be explained in detail at a later date and to be developed in consultation with the instructor: 40% of grade.** Briefly, this will consist of development of a phylogenetic hypothesis; molecular sequence data set acquisition (either as part of your own research or from a public database); data analysis; and interpretation. You will submit a short (~ 8-10 pages) paper of your findings and deliver a short (ca. 15 minute) presentation to the group during the last week of classes (details on respective formats to follow).

Graduate Increment: For computer lab exercises, graduate students will be expected to respond to additional questions that require a synthesis of applied data analysis with theoretical issues discussed in the classroom.

Writing course: Writing assignments completed as a part of this course satisfy **1/3 of the Upper Division Writing Requirement** for DBS majors (Biology, Microbiology, and Medical Technology). Detailed written feedback on a draft of the project paper will be provided by the instructor two weeks in advance of the paper deadline to accommodate opportunity for revision. A draft of the paper will be turned in on 4/25, instructor comments will be returned by 5/2, and the final paper will be due on 5/16.

UM Online Course Supplement: Course documents including lectures will be posted on the course's Moodle site. If you have not used such a course supplement before or have difficulty accessing the site, please contact technical support at UM Online (<http://www.umt.edu/xls/techsupport/default.aspx>). Lectures will be posted following the day's session.

Week	Topics
Jan 28	Course logistics and background
Feb 4	The parsimony criterion; Heuristic approaches for finding the best tree Feb 7: No class
Feb 11	Statistical properties of parsimony <i>Computer lab:</i> Sequence alignment and parsimony
Feb 18	DNA substitution models and distance methods; How “good” is my tree? <i>Computer lab:</i> Distance methods
Feb 25	Introduction to maximum likelihood <i>Computer lab:</i> Selecting DNA substitution models and likelihood
Mar 4	Hypothesis testing in a likelihood framework <i>Computer lab:</i> SH test for comparing competing trees
Mar 11	Bayesian methods and phylogeny reconstruction <i>Computer lab:</i> Bayesian methods
Mar 18	Project design; Critically evaluating trees; Gene trees vs. species trees <i>Computer lab:</i> Are two traits correlated?
Mar 25	Phylogenetic comparative methods: Testing hypotheses of phenotypic evolution <i>Computer lab:</i> Are two traits correlated?
Apr 1	Spring Break
Apr 8	Ancestor reconstruction: Inferring ancient phenotypes
Apr 15	Investigating molecular adaptation; Project paper draft due <i>Computer lab:</i> Testing for positive selection
Apr 22	Special topics; Comments on paper draft returned
Apr 29	Special topics
May 6	Project presentations
May 13	May 16: Final paper due; There is no final exam for the course

* Timing of topics subject to change