BIOL4025: MOLECULAR PHYLOGENETICS AND EVOLUTION

Lecturer: TBA
Location: TBA
Schedule: Lectures/Practicals - TBA
Office Hours (Room TBA) – TBA
Course Webpage: Blackboard

AIMS OF THE COURSE

Molecular phylogenetics, the application of molecular data to the study of evolutionary relationships, has revolutionized our understanding of the origins of biological diversity, and has proven to be a powerful tool across many branches of biology. The field has gained increasing importance with recent advances in whole-genome sequencing, which provide insights into the mosaic nature of the genome during evolutionary divergence.

The goal of this course is to provide students with the conceptual foundations, critical thinking and practical skills that will enable them to understand how phylogenies are used in modern biological research. To this end, the course integrates classroom instruction in phylogenetic theory with computer-based practicals focused on the evolutionary analysis of real-world datasets. By the end of the course, the students should be able to design and carry out a basic phylogenetic research project independently, and to critically assess tree-based analyses in the scientific and popular literature.

GRADING POLICY

The course will follow a mixed format, with lectures introducing key concepts in phylogenetic theory accompanied by hands-on practicals illustrating the appropriate use of phylogenetic methods. Students will receive short in-class quizzes (**20%**) which they should be prepared to answer at the start of the following class. Students will also be graded on their participation during laboratory practicals (**25%**), which will include individual and group tasks as part of in-class activities.

One of the primary goals of the course is to improve students' ability to interpret and critically evaluate phylogenetic analyses, which are often an integral component of research articles. Students will be asked to choose a recent paper incorporating phylogenetic methods (paper titles due by March 2), and to prepare a fully-referenced 2-page single-spaced summary (12ppt) of the article, outlining its objectives in the context of existing knowledge, detailing phylogenetic aspects of the study, critically assessing the analysis and interpretation of phylogenetic results, and suggesting areas for potential improvement / follow up research (**15%**) – paper summaries are due on April 20 and should be submitted via SafeAssign on Blackboard. Research papers will also be summarized in a 15 minute oral presentation on May 4, where students will present their article to the class, and answer general audience questions (2-3 minutes) (**15%**). Late assignments **will not be accepted**, providing a strong incentive to meet submission deadlines! Materials used in paper summary / oral presentation must be appropriately referenced, and any instances of plagiarism will result in a failing grade for the assignment. See http://brooklyn-wac.org/wp-content/uploads/2012/ 04/Avoiding-Plagiarism.pdf for the appropriate use of citations in a scientific paper/presentation.

A two-hour exam will be used to evaluate students' understanding of the material covered in the course (**25%**). This exam will consist of multiple choice, short answer and essay questions.

STUDY TIPS

BIOL5020/BIOL7933G is designed to introduce students to the key steps in the design and execution of a phylogenetic study, and includes lectures organized around key methods and applications of phylogenetic analysis. While the course does not follow a particular textbook, there are a number of excellent recent texts in phylogenetic methods at both the introductory and advanced levels. Students will have the opportunity to review several of these books in class, and are encouraged to purchase personal copies to use as a reference both during the course, and in their own research. Supplementary readings will be provided during lectures. In-class quizzes are intended to assist students in reinforcing concepts and identifying areas of possible confusion as soon as possible after the lecture. Students who perform well on these quizzes are likely to excel on the final examination.

BIOL5020/7933G – PRELIMINARY SYLLABUS		
Date	**LECTURES (Web 106)**	**PRACTICALS (Web 106)**
	LECTURE 1: Course Introduction	Software installation / Tutorial organization
	LECTURE 2: Project Design	Literature Search / Databases (Mariana Regalado, Library 120)
	LECTURE 3: Sources of DNA Sequence Data	Genetic Databanks / Building a Data File (GenBank, Ensembl, Bioedit)
	LECTURE 4: Homology / Multiple Alignment	Pairwise / Multiple Sequence Alignment (Bioedit, Clustal)
	LECTURE 5: Gene vs. Species Trees ***PAPER TITLES DUE*** (email: abwilsonbiology@gmail.com)	***Open***
	LECTURE 6: Distance Analyses	Distance Analyses (UPGMA, NJ) (Mega, PAUP)
	LECTURE 7: Optimization Criteria: Maximum Parsimony	Parsimony Analyses (Mega, PAUP)
	LECTURE 8: Optimization Criteria: Maximum Likelihood	Maximum Likelihood (Mega, PAUP)
	LECTURE 9: Bayesian Inference	Bayesian Phylogenetic Analysis (BEAST, MrBayes)
	Spring Recess: No Classes	
	LECTURE 10: Molecular Dating	Molecular Clock Tests (BEAST, PAUP)
	LECTURE 11: Trees as tools – Character evolution ***PAPER SUMMARIES DUE –*** Blackboard SafeAssign	Character Mapping (Mesquite)
	LECTURE 12: Simulations / DNA Barcoding	Simulating Phylogenetic Data (Geneious, Mesquite)
	Student Presentations	
	Review Session	
	FINAL EXAM (1-3:00pm)	

BIOL 4025 – GOALS AND OBJECTIVES	
CORE BIOLOGICAL KNOWLEDGE	
Genetics	•Demonstrate an understanding of Mendelian genetics •Demonstrate and understanding of pedigree analysis •Distinguish between autosomal inheritance and sex-chromosome linked inheritance
Evolution	• Explain how natural selection has contributed to evolution and diversity of life forms • Demonstrate familiarity with evolutionary mechanisms
Organisms and Ecology	• Describe diversity, body plans and evolutionary relationships among animals • Demonstrate an understanding of population genetics and demography
PRACTICAL COMPETENCIES	
	• Independently investigate biological phenomena using proven research tools and methods • Develop familiarity with laboratory and research procedures by formulating hypotheses, reading the scientific literature, designing and executing experiments and preparing results in tabular / graphical form • Communicate scientific results in written and presentation form
PROFESSIONAL DEVELOPMENT / ETHICS	
	• Adhere to the highest professional standards of the scientific community • Evaluate important technological advances and discoveries with respect to their impact on society and the environment