

University of Alberta

BIOL 421/521: Molecular Evolution and Systematics Section A1 Fall, 2015

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Office Hours: By appointment. You can also contact the TA, Zijian Sim (zsim@ualberta.ca). However, whenever possible, I strongly encourage you to ask questions about course material on the eClass forum, as you are probably not the only person with this question.

Lecture Room & Time: 1–1:50 p.m. Mon, Wed, Fri (BSB G110)
Lab Room & Time: 8:00–11:50 a.m. Tues (BSB CW403)

Course Description:

BIOL 421 Molecular Evolution and Systematics *3 (fi 6) (first term, 3-0-3) Methods for inferring evolutionary trees and their applications to the fields of comparative biology, molecular evolution, and systematics. Topics to be covered include phylogenetic inference, molecular evolution integrated at the organismal and population level, and evolutionary developmental genetics. Labs emphasize practical experience in data analysis. Prerequisite: BIOL 335 or consent of instructor. BIOL 380 or 392 recommended. Credit cannot be obtained for both BIOL 421 and BIOL 521.

BIOL 521 Advanced Molecular Evolution and Systematics *3 (fi 6) (first term, 3-0-3) Methods for inferring evolutionary trees and their applications to the fields of comparative biology, molecular evolution, and systematics. Topics to be covered include phylogenetic inference, molecular evolution integrated at the organismal and population level, and evolutionary developmental genetics. Labs emphasize practical experience in data analysis. Lectures and labs are the same as BIOL 421, but with additional assignments and evaluation appropriate to graduate studies. Prerequisite: Consent of instructor. Credit cannot be obtained for both BIOL 421 and BIOL 521.

Course Objectives and Expected Learning Outcomes: Participants in the course will gain familiarity with the theories, practices, and applications of phylogenetic inference from molecular data. Students will also develop skills on how to analyze and critically interpret their own data, which may include morphology.

Required Textbook: None. Required readings will consist of journal articles, which are free of charge through University of Alberta library subscriptions.

Recommended or Optional Learning Resources:

A list of recommended readings is available on eClass, and the following books are on reserve in Cameron Library.

Felsenstein, Joseph. 2004. *Inferring Phylogenies*. Sunderland, Mass.: Sinauer Associates.

Hillis, David M., Craig Moritz, and Barbara K. Mable. 1996. *Molecular Systematics*. Sunderland, Mass.: Sinauer Associates.

Nei, Masatoshi, and S. Kumar. 2000. *Molecular Evolution and Phylogenetics*. Oxford, UK: Oxford University Press.

Page, Roderic D. M., and Edward C. Holmes. 1998. *Molecular Evolution: A Phylogenetic Approach*. Oxford, UK: Blackwell Science.

Salemi, Marco, Anne-Mieke Vandamme, and Philippe Lemey. 2009. *The Phylogenetic Handbook: A Practical Approach to Phylogenetic Analysis and Hypothesis Testing*. Cambridge, UK: Cambridge University Press.

Grade Evaluation:

40% assignments (5 assignments; due dates listed below)

10% project presentation (Tues., 1 Dec. 2015, and poss. Wed., 2 Dec. 2015)

40% final paper (Mon., 7 Dec. 2015)

10% course participation

The total mark for the term will be used to assign a final letter grade, based on natural breaks in the distribution of total marks for the entire class. The letter grade assigned is based on each student's relative performance in the class, incorporating natural breaks in the class distribution of total scores, but is not based on a curve or historic distribution of student grades. ***It is probable*** that the correspondence between raw scores (as percentages) and letter grades will be as follows: 92–100 = A, 90–92 = A–, 87–90 = B+, 82–87 = B, 80–82 = B–, 77–80 = C+, 72–77 = C, 70–72 = C–, 67–67 = D+, 60–67 = D, <60 = F. Adjustments, up or down, may be made depending on the grade distribution pattern. Grades are unofficial until approved by the Department and/or Faculty offering the course.

Project: Each student will submit an original research manuscript based on real data. You will need to acquire a dataset with the following minimal specifications: (1) it should comprise 30–50 taxa for which alignable sequence data are available either from your own work (or from GenBank, etc.); (2) it should contain at least two partitions – sequences from two genes or two distinct types of data (e.g., sequence vs. morphology or RFLPs vs. sequence); and (3) there must be a good biological reason for studying these data. If you would like to work on a gene family, please see the instructor about defining partitions and other specifications. If you are having difficulties obtaining/deciding on datasets, please talk to the instructor.

Your project will be based on analysis of these data, as relevant for your biological question. The final write-up should follow the format of an appropriate journal (e.g., *Molecular Phylogenetics and Evolution*), be double-spaced with size-12 Times New Roman font, and 12–15 pages maximum (excluding cover page, references, and figures). Each student will also give a 12-minute oral presentation describing his or her project. Expectations for final papers and presentations are different for 421 and 521 students. The report should be submitted online through eClass. Analyses for the final project must be your own work, and the writing must be in your own words. Any contributions from others must be clearly attributed, and the nature of any collaboration or assistance should be explained (e.g., in an Acknowledgements section). Please also see the Appropriate Collaboration link on the Office of Student Judicial Affairs website: <http://www.osja.ualberta.ca/Students/AppropriateCollaboration.aspx>

Assignments: Assignments will be due about every two weeks by 11:59 p.m. of the due date. Assignments should be submitted online through eClass. Computer labs are designed for you to gain familiarity with analyses required for the assignments and your final paper. As such, most assignments will involve analyzing your chosen dataset (or datasets provided by the instructor).

Additional questions will be included to make sure that you are learning more than what buttons to press. BIOL 421 students will have shorter assignments than BIOL 521 students will. Assignments are individual work, and collaboration among students should not exceed the kind of help you would expect from the instructor or the TA. For instance, troubleshooting an analysis and getting help understanding phylogenetics concepts are okay, but directly giving/receiving answers or sharing script files (etc.) would obviously be forbidden.

Discussion: Approximately every Friday, lecture will be devoted to the discussion of an empirical paper. Papers for discussions as well as papers for background reading for lecture will be posted 1–2 weeks before class. **Students are expected to have read the paper and any other background literature necessary for comprehension before class.** Discussions will lead by two course participants (including auditors). Leaders will be selected randomly at the start of class, excluding undergraduate participants. BIOL 421 students will choose a date to lead discussion; the other leader will be determined at the start of class. Leaders are not expected to present the paper, but rather *facilitate discussion* through questions and/or comments.

Critical reading of the primary literature is necessary to keep up with the exciting and dynamic field of systematics, which is why a significant proportion of course time is devoted to paper discussion. We will emphasize methods, how analyses are conducted, the strengths and weaknesses of approaches, and interpretation.

Course participation is evaluated based on attendance, preparedness, contribution towards discussions, evidence of comprehension and critical interpretation of paper, and thoughtful feedback (i.e., questions) to end-of-semester presentations.

Missed Assignments:

For an excused absence where the cause is religious belief, a student must contact the instructor within two weeks of the start of Fall classes to request accommodation for the term. The instructor may request adequate documentation to substantiate the student request.

A student who cannot complete an assignment due to incapacitating illness, severe domestic affliction, or other compelling reasons can apply for extension of time to complete it. Without approval, there is a 20% penalty for each day late, where “days” are counted from midnight to midnight including weekends and are judged based on the time submitted to eClass. These rules also apply to the final project. In all cases, the instructor may request adequate documentation to substantiate the reason for the absence and the completion of a departmental declaration form.

Deferral of term work is a privilege and not a right; there is no guarantee that a deferral will be granted. Misrepresentation of facts to gain a deferral is a serious breach of the *Code of Student Behaviour*.

2015 schedule (exact lecture dates and topics are subject to change)

Date	Day	Topic
2 Sept.	W	Course intro, tree-thinking, and relevance of phylogenies
4 Sept.	F	Assembling data and obtaining matrices
7 Sept.	M	<i>No class (Labour Day)</i>
8 Sept.	T	Lab 1 – Introduction and matrix assembly
9 Sept.	W	Alignment – nucleotide and amino acid
11 Sept.	F	Maximum parsimony I
14 Sept.	M	Maximum parsimony II
15 Sept.	T	Lab 2 – Parsimony search strategies: trees, roots and weights
16 Sept.	W	Tree robustness: bootstrap
18 Sept.	F	Rates and patterns of nucleotide substitution: functional constraints, selection, and mutation
21 Sept.	M	Maximum likelihood I Assignment 1 due (11:59 PM)
22 Sept.	T	Lab 3 – Tree robustness: bootstrap
23 Sept.	W	Maximum likelihood II
25 Sept.	F	Paper discussion – TBA
28 Sept.	M	Bayesian I
29 Sept.	T	Lab 4 – Likelihood searches
30 Sept.	W	Bayesian II
2 Oct.	F	Paper discussion – TBA
5 Oct.	M	Combining data, consensus methods & testing alternative hypotheses I Assignment 2 due (11:59 PM)
6 Oct.	T	Lab 5 – Bayesian searches
7 Oct.	W	Testing alternative hypotheses II
9 Oct.	F	Paper discussion – TBA
12 Oct.	M	<i>No class (Thanksgiving)</i>
13 Oct.	T	Lab 6 – Combining data & incongruence tests
14 Oct.	W	Gene duplications and multi-gene families
16 Oct.	F	Paper discussion – TBA
19 Oct.	M	Gene trees vs. species trees Assignment 3 due (11:59 PM)
20 Oct.	T	Lab 7 – Parametric bootstrapping
21 Oct.	W	Reconstructing character evolution (discrete characters) I
23 Oct.	F	Paper discussion – TBA
26 Oct.	M	Reconstructing character evolution (discrete characters) II
27 Oct.	T	Lab 8 – Reconstructing character evolution
28 Oct.	W	Molecular dating I
30 Oct.	F	Paper discussion – TBA
2 Nov.	M	Molecular dating II Assignment 4 due (11:59 PM)
3 Nov.	T	Lab 9 – Molecular dating
4 Nov.	W	Phylogenies in conservation (Guest lecture)
6 Nov.	F	Paper discussion – TBA
9 Nov.	M	<i>No class (Reading Week) – work on your final project</i>
10 Nov.	T	<i>No lab (Reading Week) – work on your final project</i>
11 Nov.	W	<i>No class (Reading Week) – work on your final project</i>
13 Nov.	F	<i>No class (Reading Week) – work on your final project</i>
16 Nov.	M	Distance methods
17 Nov.	T	Lab 10 – Distance methods
18 Nov.	W	Gene family phylogenies
20 Nov.	F	Paper discussion – TBA
23 Nov.	M	Tests of selection Assignment 5 due (11:59 PM)

24 Nov.	T	Lab 11 – Tests of selection
25 Nov.	W	Genomics I
27 Nov.	F	<u>Paper discussion</u> – TBA
30 Nov.	M	Genomics II
1 Dec.	T	Lab 12 – Project presentations
2 Dec.	W	Project presentations (if necessary); otherwise we will have a project help session
4 Dec.	F	<i>Open class (optional) – work on your final project</i>
7 Dec.	M	<i>No class – work on your final project</i> Final project due (11:59 PM)

Student Responsibilities:

ACADEMIC INTEGRITY: “The University of Alberta is committed to the highest standards of academic integrity and honesty. Students are expected to be familiar with these standards regarding academic honesty and to uphold the policies of the University in this respect. Students are particularly urged to familiarize themselves with the provisions of the Code of Student Behaviour (online at www.governance.ualberta.ca) and avoid any behaviour which could potentially result in suspicions of cheating, plagiarism, misrepresentation of facts and/or participation in an offence. Academic dishonesty is a serious offence and can result in suspension or expulsion from the University.”

All forms of dishonesty are unacceptable at the University. Any offence will be reported to the Associate Dean of Science who will determine the disciplinary action to be taken. Cheating, plagiarism and misrepresentation of facts are serious offences. Anyone who engages in these practices will receive at minimum a grade of zero for the paper in question and no opportunity will be given to replace the grade or redistribute the weights.

CELL PHONES: Cell phones are to be turned off during lectures and labs.

STUDENTS ELIGIBLE FOR ACCESSIBILITY-RELATED ACCOMMODATIONS (students registered with Student Accessibility Services - SAS): Eligible students have both rights and responsibilities with regard to accessibility-related accommodations. Consequently, scheduling accommodations in accordance with SAS deadlines and procedures is essential. Please note adherence to procedures and deadlines is required for U of A to provide accommodations. Contact SAS (www.sds.ualberta.ca) for further information.

CENTRE FOR WRITERS: The Centre for Writers offers free, one-on-one writing support to all students at the U of A in any subject, at any level, and with any type of assignment. All tutors have received extensive training in helping ESL students. Contact C4W (<http://c4w.ualberta.ca/>) for further information.

STUDENT SUCCESS CENTRE: Students who require additional help in developing strategies for better time management, study skills or examination skills should contact the Student Success Centre (<http://www.studentsuccess.ualberta.ca/>) for further information.

RECORDING AND/OR DISTRIBUTION OF COURSE MATERIALS: Audio or video recording, digital or otherwise, of lectures, labs, or any other teaching environment by students is allowed only with the prior written consent of the instructor or as a part of an approved accommodation plan. Student or instructor content, digital or otherwise, created and/or used within the context of the course is to be used solely for personal study, and is not to be used or distributed for any other purpose without prior written consent from the content author(s).

Disclaimers: Any typographical errors in this Course Outline are subject to change and will be announced in class.

Policy about course outlines can be found in [§23.4\(2\)](#) of the University Calendar.