Professor:
Brent D. Mishler, IB -- phone: 2-6810; e-mail: **bmishler@berkeley.edu**

Guest lecturers:
David Ackerly, IB: dackerly@berkeley.edu, Kip Will, ESPM: kipwill@berkeley.edu
Carrie Tribble, IB: cmt2@berkeley.edu, Chris Martin, IB: chmartin@berkeley.edu

GSI:
Ixchel González-Ramírez, IB -- phone: 2-6810; e-mail: **ixchel_gonzalezrmz@berkeley.edu**

Lectures are Mon, Wed, and Fri, 11:00–12:00pm in 3059 VLSB
Lab is Wed., 2:00-5:00 pm in 3059 VLSB

Office hours are by appointment. E-mail is often the easiest way to contact us or just track us down before or after class to schedule an appointment.

Our class webpage is **http://ib.berkeley.edu/courses/ib200/** -- please check this often as it will have class announcements, handouts, readings, and lab materials.

Textbook (required): *Tree Thinking: An Introduction to Phylogenetic Biology*, by David Baum & Stacey Smith (1st Ed.), published by Roberts and Company. We will assign chapters that should be read ahead of the corresponding lecture; given time constraints the material in that chapter will not be repeated in lecture but rather it will be used as a starting point for the lecture.

Readings & Lecture:

Before each lecture you will be provided (on the class webpage) with a handout outlining the key concepts to be covered that day. Also prior to each lecture there will be assigned reading from the textbook and/or one or two articles from the literature, which will give some background on the topic and facilitate discussion of these concepts during the lecture. The required reading will be posted on the class webpage and should be read before class. The class webpage also lists several additional important readings for each topic so that you may delve deeper into those topics which interest you most or which may be related to your final project.

Labs:

Lab exercises will be done on personal computers – you must have access to one that you can bring to class, a laptop is obviously preferable. Handouts will be given for each lab highlighting the program and specific assignments for the day. Prior to labs you will be asked to download programs and files onto your computer. It is to your advantage to download all software prior to your arrival in lab in order to maximize the time spent exploring the program capabilities and minimize troubleshooting.

Grading:

(1/3) **Participation.** Do the reading, come to each class and lab, and participate in discussions. A few homework assignments will also be given.
(1/3) **Quizzes.** Two equally-weighted, one-hour quizzes will be given that emphasize problem solving and conceptual understanding.
(1/3) **Final Project.** An oral presentation during the minisymposium and a written report in a professional journal format. [See below]

Final Project:

This will be a substantive, tree-building and comparative analysis using data from a group of the student's choice (we encourage the study of thesis-related or other study groups). Based on phylogenetic trees that you generate, the project should apply several appropriate comparative methods to evaluate comparative questions. There should also be a rigorous critique of previous comparative literature on the organismal group of choice. A written report will be turned in during finals week, in the form of a professional journal publication, that is, with an introduction (containing the literature review and critique), materials and methods section, results (using summary figures – no raw data), and a discussion (being sure to compare results from the different methodologies applied, and to reach some biological conclusions).

Symposium:

We will have a class symposium at the end of the term (**tentatively scheduled for May 6th**) where students will give a short presentation of their results.

Tentative Schedule:

Week 1:

Jan. 22. Introduction to instructors - contemporary issues in phylogenetic systematics - what is at stake? (BDM & IGR)
LAB: discussion: student interests; get acquainted roundtable; Tour of systematics collections, labs, and resources in VLSB

Jan. 24. Introduction - history & philosophy of phylogenetics (BDM)

Week 2:

Jan. 27. Introduction - the Hennig Principle: homology; synapomorphy; rooting; integrating fossils (BDM)

Jan. 29. Morphological data I: ontogeny & structure of plants vs. animals; character analysis; what is a data matrix? (BDM)
LAB: How to handle phylogenetic data and trees; Introduction to command line + R; Introduction to Nexus and Newick files; Introduction to FigTree and Mesquite

Jan. 31. Morphological data II: Character coding [primary homology, polarity, additivity, etc.]; (guest lecture: Kip Will)

Week 3:

Feb. 3. Molecular data I: General introduction; types of molecular data (DNA hybridization; allozymes; restriction sites, DNA sequences, ESTs; comparative genomics) (BDM)

Feb. 5. Molecular data II: Sequence alignment (BDM)
LAB: **PROJECT TOPIC DUE, in writing + discuss in class**; introduction to GENBANK and FASTA files; BLAST; sequence analysis and alignment (Clustal, Muscle, AliView)

Feb. 7. Phylogenetic trees I: reconstruction; models, algorithms & assumptions (BDM)

Week 4:

Feb. 10. Phylogenetic trees II: Phenetics; distance-based algorithms (BDM)

Feb. 12. Phylogenetic trees III: Parsimony; Measures of support and robustness (BDM)
LAB: Distance and parsimony inference using PAUP; UPGMA, neighbor-joining, bootstrap, jackknife, and Bremer support

Feb. 14. Phylogenetic trees IV: Maximum likelihood; molecular evolution and phylogenetics (Carrie Tribble)

Week 5:

Feb, 17. [holiday]

Feb. 19. Phylogenetic trees V: Bayesian methods and Markov Chain Monte Carlo (Carrie Tribble)
LAB: Maximum likelihood and Bayesian inference using jModelTest; RAxML, MrBayes; BEAST; Tracer; molecular clocks and fossil calibrations; CIPRES supercomputer web interface

Feb. 21. Phylogenetic trees VI: Dating in the 21st century: clocks, & calibrations; proper use of fossils (Carrie Tribble)

Week 6:

Feb. 24. Phylogenetic trees VII: Tree-to-tree comparisons; consensus methods; supertrees (guest lecture: Kip Will)

Feb. 26. Classification I -- introduction to phylogenetic classifications; monophyly, information content (BDM)
LAB: Online systematic databases: nomenclature, geography, phylogeny, specimens; RegNum

Feb. 28. Classification II -- phylogenetic taxonomy including incorporation of fossils; Phylocode (BDM)

Week 7:

Mar. 2. Introduction to statistical thinking in phylogenetics (guest lecture: David Ackerly)

Mar. 4. Classification III -- species concepts; speciation (BDM)
LAB: Intro to R; Basic Phylogenetic Functions in R

Mar. 6. Classification IV -- DNA barcoding and DNA taxonomy (BDM)

Week 8:

Mar. 9. Qualitative character evolution within a cladogram I: discrete states; ancestral state reconstructions (guest lecture: David Ackerly)

Mar. 11. Qualitative character evolution within a cladogram II: comparing two or more characters (guest lecture: David Ackerly)
LAB: Intro to R (cont.); phylogenetic conservatism; ancestral state reconstruction; independent contrasts

Mar. 13. Quantitative character evolution within a cladogram I: intro; ancestral trait reconstruction; phylogenetic conservatism (guest lecture: David Ackerly)

Week 9:

Mar. 16. Classification V -- nomenclature; practical systematics, monography (guest lecture: Kip Will)

Mar. 18. Quantitative character evolution within a cladogram II: independent contrasts and trait correlations (guest lecture: David Ackerly)
LAB: **PHYLOGENY FOR YOUR PROJECT DUE in writing + discuss progress on comparative analyses;** Community phylogenetics: picante, Phylocom

Mar. 20. Phylogenies and Community Ecology (guest lecture: David Ackerly)
QUIZ 1 handed out (due that evening)

Mar. 23-27. SPRING BREAK

Week 10:

Mar. 30. Phylogenetics and adaptation (BDM)

Apr. 1. Evolution and development - heterochrony (BDM)
LAB: Introduction to RevBayes: phylogenetic analysis using graphical models and Markov Chain Monte Carlo

Apr. 3. Biogeography I: finding and cleaning spatial data; niche modeling; niche evolution; climate change (IGR)

Week 11:

Apr. 6. Comparing sister clades within a cladogram: the shape of evolution (guest lecture: David Ackerly)

Apr. 8. Tempo and mode in macroevolution; patterns of diversification and extinction (guest lecture: David Ackerly)
LAB: Birth-death models; joint character evolution and diversification analyses using BiSSE; detecting diversification rate shifts using BAMM

Apr. 10. Adaptive radiations (BDM)

Week 12:

Apr. 13. Phylogenetic trees VIII: Below the "species level;" phylogeography; dealing with reticulation; (guest lecture: Chris Martin)

Apr. 15. Coalescence theory and connections to population genetics; (guest lecture: Chris Martin)
LAB: **Discuss progress on projects in class;** Coalescence theory: gene tree-species tree reconstruction using RevBayes and the multispecies coalescent

Apr. 17. Molecular evolution (BDM)

Week 13:

Apr. 20. Gene family evolution; phylogenomics; evo-devo (BDM)

Apr. 22. Biogeography II: basic principles; ecological vs. historical approaches; vicariance vs. dispersal (BDM)
LAB: Probabilistic biogeographic models using BioGeoBEARS and RevBayes

Apr. 24. Biogeography III: spatial phylogenetics; phylobetadiversity & biome recognition, and other spatial issues (BDM)

Week 14:

Apr. 27. Phylogenetics and conservation biology (BDM)

Apr. 29. Comparing cladograms; cospeciation methods (BDM)
LAB: **INITIAL COMPARATIVE ANALYSES DUE in writing + discuss progress on projects in class**; introduction to BIODIVERSE, phylogenetic alpha- and beta-diversity, mapping

May 1. Coevolution; symbiosis (BDM); **QUIZ 2** handed out (due that evening)

Weeks 15 & 16:

May 6. S**tudent minisymposium**

May 8. **Final papers due**