

EEB 5350. Molecular Systematics. 2 Credits- half-semester module, 16 March-30 April 2010

Lectures: Tu & Th 12:30-1:45 Bio-Pharm 3rd floor conference room

Labs: Tu & Th 2:00-4:00 (first half-hour in conference room, remainder in BioPharm 325).

Readings will be sent as PDF's.

Handy reference books: 1) Molecular Systematics, 2nd ed. (Hillis, Moritz & Mable, eds. 1996, Sinauer) especially Chapter 11 by Swofford et al. on Phylogenetic Inference; 2) Molecular Evolution: A phylogenetic Approach (Page & Holmes 1998, Blackwell); 3) Inferring Phylogenies (Felsenstein 2004, Sinauer).

Instructor: Chris Simon, Biopharm 305D, 6-4640, 6-3947, chris.simon@uconn.edu

Graduate Assistant: Beth Wade elizabeth.wade@uconn.edu; BioPharm 323, 6-3947.

The course will focus on the basics of molecular systematics theory and practice from the point of view of the data. We will explore the ways in which an understanding of processes of evolution of molecular data can help in the construction of evolutionary trees. Lectures will examine some of the most serious problems in evolutionary tree construction: nucleotide bias, alignment, homoplasy, among-site rate variation, taxon sampling, long branches, big trees, heterogeneous rates of evolution among branches, covarion shifts.

Short Assignments: For each topic a bibliography will be provided including one focal paper. Each student will need to turn in an outline and a summary of the importance of each focal paper (1-2 pages; 1-2 papers per week). There will be a short "secondary structure alignment assignment" during the semester. Additional readings will be provided for each lecture in a weekly bibliography.

The laboratory will cover basic techniques in molecular systematics from DNA extraction to sequencing, alignment and data analysis. This lab will be of interest to both experienced and novice molecular systematists because we will try newly developed kits/techniques and compare them to older ones. Each student will keep a laboratory notebook and hand-in data collected during the course in the form of an alignment, a nexus data file. Various exercises will be performed in laboratory and some will be finished outside of class. These are detailed in the laboratory syllabus. Each student will present one 10 minute mini-presentation on a lab technique as described in the lab syllabus; Beth will be available to advise you and point you toward relevant references but use the web search engines and try to do as much as possible on your own.

The final exam will be a take home test in which each student critiques the first draft of a paper submitted to Systematic Biology and answer pre-specified questions. The answer key will be the actual review containing reviewers, associate editors, and editor's comments (with permission of authors, reviewers and editors) and a list of critical points.

Monday 3 May: Lab project and notebook due. Take Home FINAL EXAM handed out

Sunday 9 May: Take home final due

Lecture Topics by Date (Lab on next page):

T 16 March

Day 1. Organization and Philosophy: The importance of data checks

Th 18 Mar

Day 2. An introduction to looking at your data: How molecules evolve.

T 23 Mar

Day 3. Homoplasy, The history of molecular systematics, models of evolution, among site rate variation

Th 25 Mar

Day 4. Among site rate variation, among partition rate variation

T 30 Mar

Day 5. Molecular clocks

Th 1 Apr

Day 6. Among Lineage rate variation: nucleotide bias among taxa

T 6 Apr

Day 7. Among Lineage rate variation: Covarion evolution: codon models,

Th 8 Apr

Day 8. ALRV: heterotachy, covarion models; long branch problems, taxon sampling, meaning of "basal taxon"

T 13 Apr

Day 9: Long branches, taxon sampling, Felsenstein-zone & anti-felsenstein zone; long branch pruning strategy

Th 15 Apr

Day 10: Big Trees, Long Branches, & Simulations

T 20 Apr

Day 11: Taxon Sampling (cont.); Problems associated combining data, multiple gene histories for single taxa

Th 22 Apr

Day 12: Problems associated with combining data and comparing trees (tests of topology)

T 27 Apr

Day 13: Tests of topology and problems associated with nodal support

Th Apr 29

Day 14: Secondary structure, structural evolution, & alignment

Monday 3 May: Lab project and notebook due. Take Home FINAL EXAM handed out

Sunday 9 May: Take home final due

Each student will create and present one ten minute Powerpoint mini-presentations to introduce a lab technique, first come first served, so send an email to Beth as soon as you identify the subject that interests you most. We will collect these mini-presentations (with your permission) so that each of you can take them with you and modify them for your own teaching in the future.

Lab Topics by Date:

1- T 16 Mar- Beth

Minipresentation: Making buffers, lab techniques, designing experiments

LAB: prepGem extraction

set up Phenol extraction- goes overnight

2- Th 18 Mar- Beth

Mini-presentation: DNA extraction- ultrapure to ultrdirty, (phenol-chloroform/CsCl gradients to filters to salting out to PEG to chelex, etc.)

LAB: Start Clontech kit extractions- goes overnight

finish Phenol:Chloroform extractions

3- T 23 Mar-Beth

Mini-presentation: DNA extractions from museum & ancient sources

LAB: Finish Clontech kit extraction

Run gels on extractions

4- Th 25 Mar-

Mini-presentation: The Polymerase Chain Reaction- how it works & optimizing reactions

LAB: Set-up PCR (mtDNA, something easy)

5- T Mar 30-

Minipresentation: Primer design, nuclear gene amplification, degenerate primers, etc.

LAB: Amplify nuclear genes on gradient and/or touchdown.

Gel and Clean-up of Thurs. PCR

6- Th 1 Apr-

Minipresentation: How Big Dye works, chromatograms, and troubleshooting

LAB: Set-up sequencing reaction

7- T 6 Apr-

Minipresentation: Different Methods of Cleaning PCR products and sequencing reactions

LAB: Sephadex and put samples on the ABI

8- Th 8 Apr-

Minipresentation: Searching gene databases and depositing sequences in Genbank

LAB: Look at sequences using Sequencher, making contigs, blasting sequences in Genbank

9- T 13 Apr-

Minipresentation: Cloning DNA

LAB: Do cloning reactions

10-Th 15 Apr

EEB 5350 Syllabus, 10 March 2010

Minipresentation: - Long PCR
LAB: PCR clones

11-T 20 Apr-
Minipresentation: RNA: extraction and what it can be used for
LAB: RNA isolation

12-Th 22 Apr-
Minipresentation: Making Gene Libraries
LAB: Make cDNA library; RT-PCR

13-T 27 Apr-
Minipresentation: Reverse Transcriptase (RT)-PCR/Real Time PCR
LAB: Set-up gene-specific PCR

14-Th 29 Apr-
Minipresentation: Aligning DNA/RNA
LAB: Compare products with those from PCR with DNA template. Alignment discussion using secondary structure for alignments