Syllabus – GMS 6234

Course Title: Introduction to phylodynamics: a practical approach to molecular phylogenetics of pathogens

Instructor: Marco Salemi, Ph.D.
Emerging Pathogens Institute, Room 272 (2nd Floor)
2055 Mowry Road
Gainesville, FL 32610-3633, U.S.A.
Tel +1 352 273 9567, Email: salemi@pathology.ufl.edu

Teacher's Assistant: David J. Nolan (djnolan@ufl.edu)

Office Hours: Every Wednesday 1:30pm-4:00pm

Course registration: Please contact Linda Harlan at lburch@pathology.ufl.edu

Course Objectives and class meeting times
Teaching objectives: by the end of the course the students will have a solid understanding of the basic principles of molecular evolution, tree-building algorithms (distance, maximum likelihood and Bayesian based methods), molecular clocks theory, and coalescence theory. They will also be able to analyze real molecular sequence data (using HIV and *V. cholerae* data sets) to infer maximum likelihood (IQ-TREE) and Bayesian trees (BEAST), calibrate a molecular clock and use coalescence models to investigate the demographic history of microbial epidemics and the relationship between intra-host viral evolution and pathogenesis (BEAST). Class meeting times: course starts ***January 4th 2017*** and ends ***April 19th 2017*** (15 weeks); class meets every Wednesday 9:35 am - 12:35 pm (Periods 3-5). ***Final exam, April 26th 2017***.

Amount of credit: 3

Course Outline

Week 1 – 01/04/2017: Principles of molecular evolution

- An overview of the evolutionary theory at the molecular level
- Phylogenetic trees: basic definitions and topology

Week 2 – 01/11/2017: Phylodynamics and its applications to the study of microbial pathogens

- Basic concepts in phylodynamics
- Examples of phylodynamic analysis applied to the study of microbial pathogens (HIV, HCV and MRSA)

Week 3 – 01/18/2017: Evolutionary distance and Phylogenetic Inference using distance methods

- An introduction to Markov models
- Distance methods in phylogenetic-tree reconstruction

Week 4 – 01/25/2017: Phylogenetic Inference using maximum parsimony methods

- Occam's razor and phylogenetic inference
- Maximum Parsimonious Reconstructions of genealogical histories

Week 5 – 02/01/2017: Phylogenetic Inference using Maximum Likelihood methods and hypothesis testing

- Likelihood function and phylogeny inference
- Testing phylogenetic hypotheses: bootstrapping and likelihood ratio based test

Weeks 6 – 02/08/2017: *Practical Computer Session* – Phylogeny inference with distance and likelihood based methods

- Introduction to Mega7, IQTREE and FigTree
- Inferring and interpreting phylogenies of viral data sets

Weeks 7 – 02/15/2017: Phylogenetic Inference using Bayesian methods

- Bayes Theorem
- Markov Chain Monte Carlo (MCMC) methods and their applications to molecular phylogenetics

Weeks 8 – 02/22/2017: Molecular clocks and Basic coalescence

- Strict and relaxed molecular clocks
- Kingman's coalescence

Weeks 9 – 03/01/2017: Advanced coalescence

- Parametric and non parametric demographic models
- BEAST implementations

Week 10 – 03/15/2017: *Practical Computer Session* – Bayesian phylogeny inference with MrBayes

- Introduction to MrBayes
- Phylogenetic analysis with MEGA7 and IQ-TREE (practical computer section)

Week 11 – 03/22/2017: *Practical Computer Session* – Bayesian phylogeny inference with BEAST

- Clock testing with BEAST
- Population demography reconstruction with BEAST

Week 12 – 03/29/2017: Introduction to Phylogeography

- Inferring gene flow from microbial phylogenies
- Bayesian phylogeography

Week 13 – 04/05/2017: *Practical Computer Session* – Bayesian phylogeography with BEAST

- Phylogeography inference with BEAST
- Phylogeography mapping with SPREAD

Week 14 – 04/12/2017: Phylodynamics and Phylogeography Journal Club I

- Discussing phylodynamic/phylogeography papers (journal club)

Week 15 – 04/19/2017: Phylodynamics and Phylogeography Journal Club II

- Discussing phylodynamic/phylogeography papers (journal club)

Students' evaluation
Evaluation will include the following: participation in discussions during classes, 10% (10 points); journal club presentation, 30% (30 points); final written exam, 60% (60 points). Point cut-offs for letter grades:

A	A–	B+	B	B–	C+	C	C–	D+	D	D–	F
95-100	90-94	87-89	83-86	80-82	77-79	73-76	70-72	67-69	63-66	60-62	<60

Information on current UF grading policies for assigning grade points can be found at the following web site: http://www.registrar.ufl.edu/catalog/policies/regulationgrades.html.

Course material and Recommended textbooks
University of Florida SAKAI e-learning suite: syllabus, lesson plans, lecture slides, assigned papers, and homework for Introduction to Phylodynamics will all be accessible online. The exact address will be provided to the students by email prior to class starting

Required textbook:

- *The phylogenetic handbook: a practical approach to phylogenetic analysis and hypothesis testing,* 2009, Lemey P, Salemi M and Vandamme AM, Cambridge University Press, New York

Suggested (but not mandatory) readings:

- *Inferring phylogenies*, 2004, Felsenstein J, Sinauer Associates Inc, Sunderland, MA.
- *The evolution and emergence of RNA viruses*, 2009, Holmes E. G., Oxford University Press, Oxford, UK.

Class attendance and make-up exams policy
Attendance to all lessons is expected. Excused absences follow the criteria of the UF Graduate Catalogue (e.g., illness, serious family emergency, military obligations, religious holidays), and should be communicated to the instructor prior to the missed class day when possible. Regardless of attendance, students are responsible for all material presented in class and meeting the scheduled due dates for class assignments. Personal issues with respect to class attendance or fulfillment of course requirements will be handled on an individual basis.

Accommodations for Students with Disabilities
Students requesting classroom accommodation must first register with the Dean of Students Office. The Dean of Students Office will provide documentation to the student who must then provide this documentation to the Instructor when requesting accommodation.