

Molecular Evolution

HunterCollege of the City University of New York

Instructor: Weigang Qiu, Ph.D., Department of Biological Sciences

Room 926 HN; Mon. & Thur. 2:45-4:00 pm

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Coursewebsite: http://darwin.hunter.cuny.edu/BIOL375_2009.htm

Course Description

Molecular evolution is the study of the diversification of DNA and protein sequences through time. Theories and techniques of molecular evolution are widely used in species classification, biodiversity studies, comparative genomics, and molecular epidemiology. Contents of the course include:

- Population genetics, which provides a framework of understanding mechanisms of sequence evolution through mutation, gene duplication, genetic drift, and natural selection;
- Molecular systematics, which introduces statistical models of sequence evolution and methods of phylogenetic inference;
- Bioinformatics, which provides hands-on training on data acquisition and the use of software tools for phylogenetic analyses;
- Applications of molecular evolution in biological classification, epidemiology, and comparative genomics.

This 3-credit course is designed for upper-level biology-major undergraduates. Hunter pre-requisites are BIOL300 or BIOL302, and MATH150 or STAT113.

Textbooks

- **(Required)** Roderic M. Page and Edward C. Holmes, 1998, **Molecular Evolution: A phylogenetic Approach**, Blackwell Science Ltd.
- (Reference) J. Felsenstein. 2003. **Inferring Phylogenies**. Sinauer Associates, Inc

Learning Objectives

- Understand the population processes of DNA sequence evolution
- Be able to describe evolutionary relationships using phylogenetic trees
- Understand the computational algorithms for building phylogenetic trees
- Be able to use web-based as well as stand-alone software to infer phylogenetic trees

Important links

- NCBI sequence databases: <http://www.ncbi.nlm.nih.gov/>
- CLUSTALW web server at EBI: <http://www.ebi.ac.uk/Tools/clustalw2/>
- A Molecular Phylogeny Web Server: <http://mobyli.pasteur.fr/cgi-bin/portal.py>
- A Web Phylogeny Server with a Newick Viewer: [The T-Rex Server](#)
- MEGA webpage: <http://www.megasoftware.net/index.html>

Exams & Grading

A total of 150 points breaking down to:

Assignments (60): 5 exercises

Mid-term (40)

Final exam (40)

Classroom Q & A (10): Read the chapters before lecture.

Bonus (10). Full attendance: 10; 1-2 absences: 5; Three or more absence: zero

Academic Honesty

HunterCollege regards acts of academic dishonesty (e.g., plagiarism, cheating on examinations, obtaining unfair advantage, and falsification of records and official documents) as serious offenses against the values of intellectual honesty. The College is committed to enforcing the CUNY Policy on Academic Integrity and will pursue cases of academic dishonesty according to the Hunter College Academic Integrity Procedures. **Course Schedule**

8/31 (M). 1.1. Introduction & the "Tree-Thinking" Challenge (Part I)

9/3 (TH). 2.1. Introduction to Trees [Assignment 1: Tree-Thinking Quizzes]

9/10 (TH). 2.2 & 2.3. Reconstruction and Distance [Assignment 1 Due]

9/14 (M). 2.4 & 2.5. Species Tree [[Chapter 2 Slides](#)]

9/17 (TH). 3.1. Genome and Gene Structure. [[Assignment 2: NCBI BLAST](#)]

9/21 (M). 3.2 & 3.3. Genome Evolution [[Chapter 3 Slides](#)]

9/24 (TH). 5.1. Homology and Alignment [Assignment 2 Due]

9/29 (Tuesday). 5.2. Genetic Distance

10/1 (TH). 5.3. Changes on a Tree [[Assignment 3](#)] [[Chapter 5 Slides](#)]

10/5 (M). "Tree-Thinking" Challenge (Part II)

10/8 (TH). 6.1. Introduction to Phylogenetic Inference [Assignment 3 Due]

10/14 (Wed). 6.2. Distance Methods

10/15 (TH). 6.2. Distance Methods

10/19 (M). Midterm Exam

10/22 (TH). 6.4. Maximum Parsimony

10/26 (M). 6.5. Maximum Likelihood

10/29 (TH). 6.5. Tree Testing: Accuracy [[Assignment 4](#)]

11/2 (M). 6.7. Class Cancelled

11/5 (TH). 6.7. Tree Testing: Precision [Assignment 4 Due] [[Chapter 6 Slides](#)]

11/9 (M). p.85-87, Box 3.2. Molecular Techniques; 4.1 Intro to Population Genetics

11/12 (TH). 4.2. Mechanisms of Evolution: Genetic Drift

11/16 (M). 4.4. Genetics and Speciation

11/19 (TH). 4.6. Case studies: Human evolution and Lyme Biogeography [[Assignment 5](#)] [[Chapter 4 Slides](#)]

11/23 (M). 7.1 & 7.2. Models of evolutionary processes and Functional constraints

11/30 (M). 7.4, 7.5, Molecular clock and Nearly neutral theory; [Assignment 5 Due]

[Distributions of Time to Fixation by simulation:

[N=10](#)

;

[N=20](#)

;

[N=20 \(Cheung\)](#)

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12/3 (TH). Class Cancelled

12/7 (M). 7.6 & 7.7. Molecular tests of natural selection

12/10 (TH). 8.2 Gene Trees and Species Trees; [[Chapter 7 Slides](#)] Review

12/17 (TH). Final

12/31 (W). Grades Submitted to Registrar Office (Hunter and Graduate Center)