

**INTER AMERICAN UNIVERSITY OF PUERTO RICO  
METROPOLITAN CAMPUS  
SCHOOL OF SCIENCE AND TECHNOLOGY  
NATURAL SCIENCE DEPARTMENT  
MASTER'S IN SCIENCE IN MOLECULAR MICROBIOLOGY**

**SYLLABUS**

**I. GENERAL INFORMATION**

Course Title	:	Molecular Phylogenetics
Code and number	:	MOMI 6410
Credits	:	3
Academic term	:	
Instructor	:	
Office hours and location	:	
Office telephone	:	
E-mail	:	

**II. DESCRIPTION**

Application of phylogenetic methods to infer evolutionary relationships between genes or organisms. Construction of phylogenetic trees using molecular data. It requires 45 hours of conference-laboratory.

**III. OBJETIVES**

It is expected that at course completion, the student will be able to:

1. Explain basic concepts in phylogeny and molecular evolution
2. Identify and differentiate between methods of phylogenetic inference and evolutionary models
3. Utilize open-source platforms to reconstruct phylogenetic trees

**Competencies of the student profile enrolled in this course:**

1. Be able to apply molecular microbiology methods to the scientific research applied to the solution of problems
2. Be able to evaluate and determine the most suitable platform to analyze molecular microbiology data using emerging tools

## IV. CONTENT

1. Historical aspects of evolutionary biology and molecular phylogenetics
  - a) History of evolutionary biology
  - b) Genetic information
  - c) Mechanisms of evolution and speciation
  - d) Basic concepts in phylogenetics
2. Genomic sequencing, technology and bioinformatics
  - a) Data used for molecular phylogenetics
  - b) The Sanger method and pyrosequencing
  - c) Next generation sequencing technologies
  - d) Bioinformatics and computational sciences
3. Sequence databases, searches and data management
  - a) GenBank, EMBL, DDBJ, UniProt
  - b) Database search using Entrez, ViPR
  - c) BLAST: basic local alignment search tool
  - d) Sequence data formats and management
4. Methods for multiple sequence alignments
  - a) Pairwise sequence alignment
  - b) Practical aspects of multiple sequence alignment algorithms using Clustal, MUSCLE and T-COFFEE
  - c) Visualizing, trimming and editing sequences
5. Evolutionary mechanisms and models for nucleotide sequences
  - a) Basic concepts in genetic and observed distance
  - b) Neutral theory of molecular evolution
  - c) Synonymous and non-synonymous nucleotide substitutions
  - d) Evolutionary rate, process and mechanisms
  - e) Nucleotide substitution models: JC, HKY85, TN93, GTR
6. Phylogenetic reconstruction methods based on distance
  - a) Methods based on distance matrices
  - b) Minimum evolution, Neighbor-joining and UPGMA
  - c) Evaluation of inferred trees reliability with bootstrap
  - d) Phylogenetic tree reconstruction and visualization
7. Phylogenetic reconstruction using maximum likelihood
  - a) Maximum likelihood and evaluation of substitution model parameters
  - b) Understanding divergence, rooted trees and testing tree topology
  - c) Applications in molecular epidemiology
8. Bayesian inference and molecular clock
  - a) Bayes theorem, coalescent theory and probability distributions
  - b) Bayesian inference of phylogenies using Markov chain Monte Carlo sampling
  - c) Molecular clock: strict and relaxed
  - d) Phylogenetic reconstruction and visualization

9. Additional phylogenetic functions
  - a) Phylogeography
  - b) Detection of recombination events
  - c) Genomic diversity and effective population size
  - d) Estimation of time of most recent common ancestor

## V. LEARNING ACTIVITIES

1. Lectures supported by Power Point presentations
2. Bioinformatics practical sessions using computers
3. Phylogenetic visualization

## VI. EVALUATION

The evaluation of the course will be based on:

	Score	% of Final Grade
Class projects	300	60
Final Exam	100	40
<b>Total</b>	<b>500</b>	<b>100</b>

### Class and Exams attendance

Class attendance is mandatory. A student who needs to be absent from a class should contact the professor prior to the class by phone or email. There will be no make-up exams, except for reasons of illness. In such case, make-ups will be offered with a proper doctor's excuse during the final exam period during the professor's office hours.

## VII. SPECIAL NOTES

### A. Auxiliary services or special needs

All students who require auxiliary services or special assistance must request these at the beginning of the course or as soon as they know that they need them, through the proper registry, in the Office of Orientation with Sr. José Rodríguez.

### B. Honesty, fraud, and plagiarism

Dishonesty, fraud, plagiarism and any other inappropriate behavior in relation to academic work constitutes major infractions sanctioned by the General Student Regulations. The major infractions, as stated in the General Student Regulations, may have as a consequence, suspension from the University for a definite period greater than one year or the permanent expulsion from the University, among others sanctions.

### C. Use of electronic devices

Cellular telephones and any other electronic device that could interrupt the teaching and learning processes or alter the environment leading to academic excellence will be deactivated. Any urgent situation will be dealt with, as appropriate. The handling

of electronic devices that allow students to access, store or send data during evaluations or examinations is prohibited.

#### **D. Compliance with the Provisions of Title IX**

The Federal Higher Education Act, as amended, prohibits discrimination because of sex in any academic, educational, extracurricular, and athletic activity or in any other program or function, sponsored or controlled by a higher education institution, whether or not it is conducted within or outside the property of the institution, if the institution receives federal funds.

In harmony with the current federal regulation, in our academic unit an Assistant Coordinator of Title IX has been designated to offer assistance and orientation in relation to any alleged incident constituting discrimination because of sex or gender, sexual harassment or sexual aggression. The Assistant Coordinator, Sr. George Rivera, can be reached by phone at 787-250-1912, extension 2262 o 2147, or by e-mail [griverar@metro.inter.edu](mailto:griverar@metro.inter.edu).

The Normative Document titled Norms and Procedures to Deal with Alleged Violations of the Provisions of Title IX is the document that contains the institutional rules to direct any complaint that appears to be this type of allegation. This document is available in the Web site of Inter American University of Puerto Rico ([www.inter.edu](http://www.inter.edu)).

### **VIII. EDUCATIONAL RESOURCES**

#### **Computers**

Students enrolled in this course are required to bring a laptop computer to the classroom for every class session. This course includes frequent practical sessions where the student will be required to access data through the University wireless internet service (wifi), download software packages and perform bioinformatics analyses.

#### **Electronic Resources**

1. Web service dedicated to reconstructing and analyzing phylogenetic relationships between molecular sequences; <http://www.phylogeny.fr>
2. BioEdit software <http://www.softpedia.com/get/Science-CAD/BioEdit.shtml>
3. MEGA software <http://www.megasoftware.net>
4. BEAST package <http://beast.community>
5. Tracer software <http://tree.bio.ed.ac.uk/software/tracer/>
6. FigTree software <http://tree.bio.ed.ac.uk/software/figtree/>

### **IX. BIBLIOGRAPHY**

#### **Textbooks**

Either book will serve the course objectives

1. Masatoshi Nei and Sudhir Kumar (2000) Molecular Evolution and Phylogenetics, Oxford University Press, ISBN-13:978-0195135855
2. Philippe Lemey, Marco Salemi and Anne-Mieke Vandamme (2009) The Phylogenetic Handbook, Cambridge University Press, ISBN-978-0-521-73071-6

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