Course Syllabus

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TOPICS IN ADVANCED BIOLOGY: MOLECULAR AND GENOME EVOLUTION

BIOL 5380 001

Fall 2024

Room: RBN2011/BEP139

Time: 5-7:50pm, Tue (Session 1: 5-6:20pm; Session 2: 6:30-7:50pm).

Instructor: Dr. Wei-Chin Ho (who@uttyler.edu)

Office hours: 1-4pm, Tue at HPR115, or by appointment

E-mail Policy: When sending an email to the instructor, please add "**BIOL 5380**" at the beginning of the title and clearly indicate your name in the first few sentences of the main text. Please note that the instructor may not be able to respond to emails in two working days.

Course Format: This course is in a face-to-face format. Attendance is strongly recommended for this course. You will find a calendar with the planned program in this syllabus. Please check Canvas frequently for changes and updates.

Course Description: This course provides an overview of how macromolecules evolve in organisms and how to use the knowledge of macromolecular evolution in other fields of biology. The course also includes several computer labs where students learn practical skills on how to analyze sequence data. After a review of basic concepts in genetics and evolutionary biology, we will learn how to analyze the evolutionary patterns of DNA and protein sequences. We will then discuss various methods of constructing phylogenetic trees using sequence data. We will also learn how to use polymorphism data to study molecular evolution. At the end of semester, we will explore important questions of molecular evolution at the whole-cell level, concerning how genome, transcriptome, and proteome evolve.

Learning Outcomes: After completing the course, students will be able to…

1. understand the model for sequence evolution and describe their evolutionary patterns
2. construct molecular phylogenetic trees using various computational methods
3. analyze population data to study molecular evolution
4. describe evolutionary patterns and identify unresolved questions in genome evolution

5. collect the homologous sequence data from online databases and analyze them
6. apply the obtained knowledge and analytical methods to their own research projects

Recommended Textbook: The required reading for each topic and computer lab will be uploaded to the Canvas. Students will need to read those and answer questions before each class. If students are looking for a textbook for a comprehensive and broad review on the topics of molecular and genome evolution, the following book is recommended. A reserved copy is available at Robert R. Muntz Library for 3-hour in-library use; please ask at the front desk on the second floor.

- Dan Graur (2016) *Molecular and Genome Evolution*, Sinauer Associates is an imprint of Oxford University Press.

Other useful books:

- Joseph Felsenstein (2003) *Inferring Phylogenies*, Sinauer Associates is an imprint of Oxford University Press.
- Masatoshi Nei & Sudhir Kumar (2000) *Molecular Evolution and Phylogenetics*, Oxford University Press.
- Ziheng Yang (2014) *Molecular Evolution: A Statistical Approach*, Oxford University Press.

Grading:

There are five components determining the final grade.

1. **Preview questions (28%)**: Answer questions on Canvas for required readings before each class. There are two sets of questions for two sessions per week. There are totally 28 sets of preview questions. You are able to earn 1% each. The due time is typically 3pm before the class on Tuesdays.

2. **Class Participation (9.5%)**: Actively participate in the discussion of materials during each class. There are totally 19 sessions for 19 different topics. You are able to earn 0.5% per session.

During each class, I will use iClicker system to interact with students and collect students' attendance and responses to in-class discussion questions. Students need to use the app on mobile devices or the web apps in laptops (NOT remotes) to register an iClicker account with their university emails and student IDs. As long as students respond to all of the questions, they get full points.

Using iClicker on mobile phones:

1) Go to the website https://www.iclicker.com/students/apps-and-remotes/apps . Choose “Student App” square on the top. Download, install, and open the app.

2) If you do not have an account linked with your university email yet, click sign-up. Use “U of Texas - Coll of Arts & Sciences.” when the app ask you for your institution. Enter your full name, university email, and student ID.

3) After you get an account with your university email, log in in the app. Add the course with the course name “BIOL5380_MolEvol_F24.” When the poll begins, it will show that you can join the poll.

Using iClicker Web on laptops:

1) Go to the website https://www.iclicker.com/students/apps-and-remotes/web . Choose “Student Web” square on the top.

2) If you do not have an account linked with your university email yet, click create an account. Use “U of Texas - Coll of Arts & Sciences.” when it asks you for your institution. Enter your full name, university email, and student ID.

3) After you get an account with your university email, go to the website https://www.iclicker.com/students/apps-and-remotes/web again and click sign in. Add the course with the course name “BIOL5380_MolEvol_F24.” When the poll begins, it will show that you can join the poll.

3. **Computer lab worksheets (13.5%)**: Finish and submit the assigned activities on the worksheet for each computer lab session. There are totally 9 computer lab sessions. You are able to earn 1.5% per computer lab session.

4. **Research project (25%)**: Students will design and perform a research project on the topic they are interested in using what was learned from the course. At the end of the semester, students will present their findings in the classroom and submit a written report.

The typical two examples of research projects are:

(1) Starting from a locus in one species that you are interested in, searching for homologues sequences within the organisms and/or closely related species, building a

phylogenetic tree using several sequences, and inferring the evolutionary history among these sequences.

(2) Starting from a locus in one species that you are interested in, obtaining the polymorphism data, building a coalescent tree, and inferring the evolutionary history of the locus.

Students may perform other types of research project (e.g., some sort of meta-analysis in the field of molecular and genome evolution or genome-wide scanning studies) but should first get the agreement from the instructor.

All students should submit a research plan within the first two weeks of semester and get the explicit agreement from the instructor within the first three weeks.

5. **Mini-review paper (25%)**: Students will choose a topic in the field of molecular and genome evolution to write a mini literature-review paper (font size 12pt, doubled-line spaced, at least five pages excluding figures and references), which is due at the end of semester. All students should submit a topic within the first two weeks of semester and get the explicit agreement from the instructor within the first three weeks.

The possibly maximum is 101%.

At the end of semester, the letter grade will be assigned according to the following scale:

A = above 90%; B = 80-89%; C = 70-79%; D = 60-69%; F = below 60%.

Excused Absence: Regular attendance is expected in this course. There are generally no make-up sessions. However, when the excuse is legit (discussed below), alternative online assignments may be available for earning points for Class Participation or Computer Labs. If you will be absent due to a sport event or a religious event, please let me know in advance with an official document. If you will be absent due to attending a conference, going to field work, or other research related activities, please also let me know in advance and show me evidence that your mentor also knows (e.g., an email to me and your mentor). If you realize you will be absent because you or your significant family member is sick, please send me a notice as soon as possible as well. Please do NOT come to classes if you are ill.

Late Submission Policy: In general, late submissions are not accepted, as most works allow more than one week for students to finish. Please discuss with the instructor in advance if you think the situation is exceptional.

Corrupted File Policy: If any student turns in a corrupted file, after the instructor notices the situation, students will be given one more working day to turn in a file that can be successfully opened. Failure to do so will result in a grade of zero.

Use of Artificial Intelligence (AI): UT Tyler is committed to exploring and using artificial intelligence (AI) tools as appropriate for the discipline and task undertaken. We encourage discussing AI tools' ethical, societal, philosophical, and disciplinary implications. All uses of AI should be acknowledged as this aligns with our commitment to honor and integrity, as noted in UT Tyler's Honor Code. Faculty and students must not use protected information, data, or copyrighted materials when using any AI tool. Additionally, users should be aware that AI tools rely on predictive models to generate content that may appear correct but is sometimes shown to be incomplete, inaccurate, taken without attribution from other sources, and/or biased. Consequently, an AI tool should not be considered a substitute for traditional approaches to research. You are ultimately responsible for the quality and content of the information you submit. Misusing AI tools that violate the guidelines specified for this course (see below) is considered a breach of academic integrity. The student will be subject to disciplinary actions as outlined in UT Tyler's Academic Integrity Policy.

For this course, AI tools are encouraged during the course unless otherwise noted, and appropriate acknowledgment is expected. For example, you are allowed to use AI tools for drafting and revising assignments as long as a note of acknowledgement to the AI tools is included. Below is an example of note: "ChatGPT and Copilot were used for drafting and revising this assignment."

Schedule (Tentative):

Wk	**Date**	**Topics/*Labs*/Due Assignments**
01	Aug 27 Tu	T01. Macromolecules in biology
		T02. Genetic basis of evolution
02	Sep 02 M	**Due: Research Project Practice 1 and Review Paper Practice 1**
	Sep 03 Tu	T03. Allele dynamics in populations
		T04. Molecular basis of mutations

03	Sep 10 Tu	T05. Model of sequence evolution
		LAB01. Sequence search & alignment
04	Sep 16 M	
	Sep 17 Tu	T06. Pattern of the rates of sequence evolution
		LAB02. Inferring the rate of sequence evolution
05	Sep 23 M	**Due: Research Project Practice 2 and Review Paper Practice 2**
	Sep 24 Tu	T07. Molecular phylogenetics– Distance methods and maximum parsimony
		LAB03. Inferring NJ and MP trees
06	Sep 30 M	**Due: Review Paper Practice 3**
	Oct 01 Tu	T08. Molecular phylogenetics– Maximum likelihood
		LAB04. Inferring ML trees
07	Oct 07 M	**Due: Research Project Practice 3**
	Oct 08 Tu	T09. Molecular phylogenetics– Bayesian inference
		LAB05. Inferring BI trees
08	Oct 14 M	**Due: Review Paper Practice 4**

	Oct 15 Tu	T10. Population coalescence
		LAB06. Inferring population diversity and differentiation
09	Oct 21 M	**Due: Peer-Feedback to Review Paper Practice 4**
	Oct 22 Tu	T11. Neutrality tests: divergence vs. polymorphism
		LAB07. Neutrality tests with population data
10	Oct 28 M	**Due: Research Project Practice 4**
	Oct 29 Tu	T12. Gene duplication and evolution
		T13. Transposable elements and evolution
11	Nov 04 M	**Due: Peer-Feedback to Research Project Practice 4**
	Nov 05 Tu	T14. Evolution of protein function
		LAB08. Codon model for protein evolution
12	Nov 11 M	**Due: Review Paper Practice 5**
	Nov 12 Tu	T15. Evolution of gene-regulatory networks
		LAB09. Transcriptomic analysis
13	Nov 18 M	**Due: Peer-Feedback to Review Paper Practice 5**

	Nov 19 Tu	T16. Prokaryotic genome evolution
		T17. Organelle genome evolution
14		Holiday - No class!
15	Dec 03 Tu	T18. Eukaryotic genome evolution
		T19. Experimental molecular evolution
16	Dec 10 Tu	**Research Project Presentation**
	Dec 12 Th	**Due: Final Research Project Report, Final Review Paper**