Biology 574 Population Genetics (Fall 2020, Credits: 3)

Course Description:
Population genetics has always been a field that is strong on theory. With technological advances (especially in DNA sequencing technologies and computational power), the field is enjoying a renaissance and explosion. This course is designed to give advanced undergraduates and graduate students an introduction to demographic, quantitative and evolutionary genetic models, and the analysis of genetic data at the population level. These models provide a framework for the understanding and analysis of genetic diversity and evolutionary processes. Learning is through a combination of lectures, discussion, hands-on exercises (computer simulations) and paper reading. The textbook readings should acquaint the student with the basic theories of population genetics and give some examples of experimental observations that illustrate tests of these theories.

By the end of the course students should be able to make predictions about micro-evolutionary process and should understand what types of forces act in determining the genetic composition of populations.

Goals:
A. To present students with a balance between theory and data. This reflects a decades-long trend in the field to generate, test and combine theories with molecular data.
B. To enable students to read and understand original literature.
C. To enable students to solve (somewhat open-ended) questions with knowledge of population genetics theories.
D. To enable students to begin to manipulate and analyze population genetics data. Choice of analytical approaches will depend on the salient questions, data generated, assumptions and software limitations
E. Through hands-on computer exercises, students will learn how manipulating evolutionary forces will result in changes in population genetics data.

Lectures:
Wednesday 4:30-7:10 pm Prince William: Colgan Hall 304B. Typically lectures followed by computer lab/paper discussion.

Instructors:
Haw Chuan (HC) Lim, Asst. Professor of Biostatistics and Bioinformatics
Office: Colgan Hall, Rm 409 Email: hlim22@gmu.edu Phone: (703) 993-2344

Office hours: see Blackboard or by appointment

Blackboard:
I will use the learning management system Blackboard in this class. Lecture notes, announcements, assignments, in-class exercises, papers, etc will be posted to this site. Log in at http://mymason.gmu.edu.

Text:
Population Genetics 1st Ed; Mathew B. Hamilton; Wiley-Blackwell Press.

Websites: https://hamiltonlabpage.weebly.com/text-book.html
Chapter resources: http://www.blackwellpublishing.com/hamiltongenetics/default.asp

Graded Work:	**Points**
4 take-home assignments, each containing multiple short-answer type questions. The questions will ask for quantitative and verbal answers.	10
In-class computer lab exercises and class participation. Binder with exercises will be inspected before thanksgiving recess and after the final week of class. You will need a binder and spiral notebook/writing pad. Literature review assignments. Each papers will be led by a student and discussed during class.	32 (lab exercises + literature review)
Independent project and presentation (Population genetics software or population genetics R packages). 20 min presentation/demo (17 min presentation + 3 min Q & A) on main purpose, underlying theories, functionalities, input data format, special features, assumptions and interoperability of the software (e.g, how easy it is to import data from other software, does it work well as part of a pipeline). Use your own data or dummy data to demonstrate functionalities of the software.	8
Final exam	20
	100

Reading assignments: Scientific papers and discussion
Each student will choose a scientific paper that either introduces or elaborates important concepts in populations genetics (classic paper), or a recent paper that uses population genetics or phylogenetics principles (paper selection subject to approval). The student will then lead a discussion of the paper with other students actively participating. For each scientific paper, a review will also be turned in.

Students are expected to participate actively during paper discussion. Since class members will have read the article, avoid simply summarizing and instead pose critical questions regarding the study design, important findings, how the study fits into the class topics and in the field in general, and the next steps that future research should address. Students will be graded on the depth of their understanding of the article and the insights they share with the class.

In-class computer exercise
After each lecture (except on days with paper discussion), students will conduct computer exercises and simulations to reinforce the concepts and formulae learned during class. The computer exercises will be based on excel (using macros), web pages, teaching

software and R (eg, learnPopGen). All exercises will be placed in a binder to be submitted and graded.

Independent project and presentation
At the end the semester, each student will showcase a piece of population genetics or phylogenetics software that is used to analyze or simulate data. The student is free to select software that is related to his or her research (software choice subject to approval). Dummy data (eg, from software tutorial) or real data will be used to demonstrate the interface, utility, functions and output of the software. Both GUI or command line software are acceptable.

Grading and late work policy:
Unless you have received prior permission, you should not expect to be allowed to turn in assignments after the due date for full credit. Late work will not be accepted except in the case of a documented personal emergency or excused absence. You will not be allowed to make up an exam or other in-class graded work (eg, presentation) unless you have a documented, excused absence. It is your responsibility to provide written documentation from a third party of your emergency or university-excused absence. I do not consider work-related absences, work in other classes, oversleeping, or meetings with other professors a personal emergency. I do not add points at the end of a semester to "bump up" your letter grade.

Grading schema
Your final grade will be based on your percent out of 100. See below for grading scale. All inquiries about partial credits or potential grading mistakes need to be addressed soon after the graded work is returned, not toward the end of semester.

A+	97-100	B	80-86
A	93-96	C	60-79
A-	90-92	F	59 or less
B+	87-89		

Academic integrity
If you are caught cheating, you will be taken to the honor committee. GMU has an Honor Code with clear guidelines regarding academic integrity. Three fundamental and rather simple principles to follow at all times are that: (1) all work submitted be your own; (2) when using the work or ideas of others, including fellow students, give full credit through accurate citations; and (3) if you are uncertain about the ground rules on a particular assignment, ask for clarification.

Disability Accommodations
If you have a learning or physical difference that may affect your academic work, you will need to furnish appropriate documentation to the Office of Disability Services. If you qualify for accommodation, the ODS staff will give you a form detailing appropriate accommodations for your instructor. In addition to providing your professors with the appropriate form, please take the initiative to discuss accommodation with them at the

beginning of the semester and as needed during the term. Because of the range of learning differences, faculty members need to learn from you the most effective ways to assist you. If you have contacted the Office of Disability Services and are waiting to hear from a counselor, please let your instructor know.

Diversity

George Mason University promotes a living and learning environment for outstanding growth and productivity among its students, faculty and staff. Through its curriculum, programs, policies, procedures, services and resources, Mason strives to maintain a quality environment for work, study and personal growth.

An emphasis upon diversity and inclusion throughout the campus community is essential to achieve these goals. Diversity is broadly defined to include such characteristics as, but not limited to, race, ethnicity, gender, religion, age, disability, and sexual orientation. Diversity also entails different viewpoints, philosophies, and perspectives. Attention to these aspects of diversity will help promote a culture of inclusion and belonging, and an environment where diverse opinions, backgrounds and practices have the opportunity to be voiced, heard and respected.

The reflection of Mason's commitment to diversity and inclusion goes beyond policies and procedures to focus on behavior at the individual, group and organizational level. The implementation of this commitment to diversity and inclusion is found in all settings, including individual work units and groups, student organizations and groups, and classroom settings; it is also found with the delivery of services and activities, including, but not limited to, curriculum, teaching, events, advising, research, service, and community outreach.

Acknowledging that the attainment of diversity and inclusion are dynamic and continuous processes, and that the larger societal setting has an evolving socio-cultural understanding of diversity and inclusion, Mason seeks to continuously improve its environment. To this end, the University promotes continuous monitoring and self-assessment regarding diversity. The aim is to incorporate diversity and inclusion within the philosophies and actions of the individual, group and organization, and to make improvements as needed.

Canceled and missed class

If for some reason class is canceled, then the following class will cover the material for the missed class. This is particularly important should an exam day be canceled for whatever reason (the exam will take place in our next scheduled class).

If you are having problems: please come and see me. I am here to help you learn this material and master biostatistics. I will do what I can to make sure that you make it successfully. Please don't wait too long if you are having difficulties.

Please try to be in class. You've probably heard it a million times already, but it's particularly true in this class. You will probably not do well if you are absent too often.

Tentative schedule

Week	Date	Topics	Book	Assignments Due
1	8/26/2020	Introduction H-W, genotype frequencies	2.1 - 2.4	
2	9/2/2020	Fixation index and gametic disequilibrium	2.5-2.7	
3	9/9/2020	Genetic drift	3.1-3.5	
4	9/16/2020	Coalescence model of genetic drift	3.6.-3.7	Due Assignment 1
5	9/23/2020	Population structure & direct measures of gene flow	4.1-4.2	
6	9/30/2020	Population structure and patterns and indirect measures of gene flow	4.3-4.5	
7	10/7/2020	Mutation 1	5.1-5.2	Due Assignment 2
8	10/14/2020	Mutation 2 - mutation models, genetic distance	5.3	
9	10/21/2020	Mutation 3 - reversible mutations, mutation drift & effective pop size (population mutation rate)	5.3-5.4	Computer exercises binder due
10	10/28/2020	Mutation 4 Coalescent with mutations and molecular evolution (intro)	5.5	
11	11/4/2020	Neutral theory and molecular evolution	8	Due Assignment 3
12	11/11/2020	Natural selection 1	6.1-6.3	
13	11/18/2020	Natural selection 2 and 3	7.1-7.4	
14	11/25/2020	Thanksgiving Recess		
15	12/2/2020	Independent Project Presentations		
	12/9/2020	Final exam		Due Assignment 4 Computer exercises binder due
	Optional topic	Quantitative genetics		