

BIO3PG3

Population Genetics

Winter 2021 Course Outline

Course Details

Instructor: Dr. Ian Dworkin (dworkin@mcmaster.ca)

Office hours: By appointment and we will set aside 1 hour a week (time TBD) where I will be in my office or online and able to meet.

Lab/TA's: There will be an in person/synchronous lab/tutorial.
Teaching Assistant TBD.

Lectures: Live and in person (hopefully), Tuesday and Thursday 2:30 – 3:20. Location to be Determined. If necessary these will be done online via echo360 or Microsoft Teams (we will only use one platform, but we are figuring out which would be best). Combination of lectures and small group activities. If necessary lectures will also have a video (asynchronous) component some weeks.

Lab/Tutorial: Monday 12:30 – 2:20 or Thursday 11:30 – 1:20. Room TBD. Will be in person, but if necessary will be done online and Live via echo360 or Microsoft Teams (synchronous) although I may make short videos for viewing at your pleasure and to aid in helping you with using R.

Materials for the class will all be posted to the Course website on Avenue to Learn. Link to follow.

Course Description

“Nothing in Biology Makes Sense Except in the Light of Evolution”

Theodosius Dobzhansky, 1973

“Nothing in evolutionary biology makes sense except in the light of population genetics”

Michael Lynch, (Sometime in the 2000's)

Why do human (or any) populations have disease causing mutations segregating? What types of genetic effects contribute to evolutionary adaptations? Why are certain populations genetically more closely related to one another?

All of these questions can be addressed based using concepts that integrates evolutionary biology with genetics (and genomics). This course will examine the conceptual foundations of evolutionary theory from a genetics perspective, which form the principles of population and quantitative genetics. Examples to elucidate the material will be drawn from studies from humans and organisms (animals, plants, bacteria and yeast, maybe some viruses if it does not feel like it hits too close to home). While population genetics generally draws heavily from mathematical approaches, this course will also utilize computer simulations and empirical examples to help students develop a deeper understanding of the material.

- Calendar description: Conceptual foundations of evolutionary theory and principles of population genetics. Three lectures; or two lectures, one tutorial; one term.
- **Prerequisite(s):** [BIOLOGY 3FF3](#) and registration in Level III or above of any Honours program
- Course will be expected to be in person. If not, a combination of live video sessions and short pre-recorded videos
 - If online, all class meetings will be recorded and posted with closed captions, and pre-recorded lectures will be posted with closed captions.
 - If you do not want to be visible during recordings, it is fine to keep your cameras off, but otherwise we would like to see you!
- **Changes to this outline:** The instructor reserves the right to change the means by which our course objectives are to be achieved, but this **will not** occur either precipitously or without reasonable notice to the students enrolled in the course. Such changes could result, for example, from new ideas emerging as the course develops and/or from particular arrangements discussed between instructor and students.

Course Learning Objectives

By the end of this course you should be able to:

- Demonstrate a fundamental understanding of evolutionary theory from a genetics perspective.
- Explain patterns of mutational effects (distribution of effects and allele frequencies) for genetically influenced diseases and other traits.
- Understand how various evolutionary forces influence allele frequencies in populations.
- Demonstrate basic facility and comprehension of the R programming language.
- Demonstrate basic facility in simple computer simulations of evolutionary processes.
- Be able to predict when a population will (or will not) respond to selective pressures.

Course Schedule (tentative)

Please note: I may re-organize how this material is taught to be more consistent with a new textbook. Largely the same material will be taught, but in a different order that presented below. However this allows you to see what topics are being covered.

Week	Subject
Week 1 (Starting January 6 th , 2021)	Introduction: How is SARS-Cov2 evolving? Variation in Populations (different types of genetic polymorphism, quantitative traits) Tutorial: Getting set up with R, and introduction to programming. Maybe some Hardy Weinberg Equilibrium review
Week 2	Variation in populations (how to measure variation at the molecular level) Adaptation and the evolution of Mean Fitness Tutorial: Writing functions in R, using R to estimate variability.
Week 3	Genomic Frequencies of alleles and haplotypes Natural selection from a population genetic perspective Tutorial: Measuring variation in DNA sequences (TBD). What can DNA sequences tell us about evolution?
Week 4	Natural selection from a population genetic perspective II Tutorial: Natural selection in ideal populations
Week 5	Finite populations, Genetic Drift and its influence on populations Tutorial: Drift and selection in finite populations, mutation-selection balance.
Week 6	Mutation and Introduction to the coalescent Midterm examination (To be confirmed)
Week 7	mid-term recess (February 15 th – 21 st)
Week 8	Introduction to Molecular Population Genetics Tutorial: Introduction to the coalescent and molecular population genetics
Week 9	A coalescent view of neutral evolutionary forces Tutorial: Linkage disequilibrium, tests for recombination, estimators of theta and non-neutral evolutionary change.
Week 10	Population history, recombination and linkage disequilibrium Tutorial: How to study the history of human populations
Week 11	Natural selection and the coalescent Tutorial: Estimators of theta and natural selection
Week 12	Gene Flow and Introduction to Quantitative Genetics Tutorial: Gene Flow, Fst (TBD)
Week 13	Quantitative Genetics, population genetics and mapping of complex disease Predicting short term evolution (multivariate breeders eq'n) Tutorial: TBD
TBD	The interplay of Sexual selection and natural selection, sexual conflict, sex-biased gene expression and sexual dimorphism Tutorial - Review

Note: Please bring your laptop to tutorials and lectures.

Notable dates: Mid-term recess February 15th – 21st. Classes end: April 9th.

IMPORTANT NOTE: *The instructor and university reserve the right to modify elements of the course during the term. The university may change the dates and deadlines for any or all courses in extreme circumstances. If any modification becomes necessary, reasonable notice and communication with the students will be given with explanation and the opportunity to comment on changes. It is the responsibility of the student to check their McMaster email and course websites weekly during the term and to note any changes. Changes will be communicated through regular McMaster communication channels, such as McMaster Daily News, Avenue to Learn and/or McMaster email.*

Course Materials

Primary Text: A primer of Molecular Population Genetics. Author: Asher Cutter. Publisher: Oxford University Press. 2019. ISBN: 9780198838951

I will also be providing some additional readings for topics not covered in the text (it is a purposefully short and focused book). I will also be providing some additional *optional* readings. reading materials. These will be made available on A2L.

Course Evaluation

Here are the default breakdowns for assessment (flexible assessment in parenthesis)

Problem Sets: 40% (20% - 60%)

Mid Term Examination : 30% (20% - 40%). **Note! MSAF Cannot be used, but an alternate date will be provided as necessary.**

Final examination: 30% (20% - 40%)

Flexible assessment: If an individual student prefers, they may during the first week of instruction work with the instructor to modify the default grading scheme. The constraints that apply are 1) The same assessments will be used (Class Problem sets, Mid Term Examination, Final examination). That each of the assessments needs to be valued (in 5% increments). We will discuss this further during the first class. It should be noted that the same expectations are required regardless of how you choose to modify your individual marking scheme. All that will change is what percentage of your final grade it counts toward. Once the grading scheme has been mutually agreed upon by each student and the instructor (we will jointly sign this agreement), it cannot be changed later in the course. Please note that if you make your mid-term worth less than 25%, it is still officially worth 25% in the syllabus so MSAF cannot be used.

Details on Course Assessment:

Class participation: This is a 300 level class, and as such you will be expected to participate and discuss the material in the classroom at a fairly sophisticated level. Among the activities that you will be assessed on is your participation in group discussions and problems posed in the class. This includes both asking and answering questions. It is important to be an active and vocal participant in both small group and whole class activities. However, be aware that dominating class time to the exclusion of other participants could have a negative influence

on your participation grade (the instructor will speak with the individual first in case they are unaware of their effect on the rest of the class). While critical and skeptical discussion is an essential part of the process, it is expected that you will keep all discourse polite, even when expressing your disagreement with your peers or the instructor.

Problem Sets: These will be (approximately) fortnightly take home (or in class) problem sets, focusing on both using R for population genetics and on core concepts in population and quantitative genetics.

Mid Term examination: This will be an examination that will cover all of the material discussed in the class prior to the mid-term break. This will be in the form of short questions and problems.

Final exam: As much of the material in this course builds on the previous material that has been discussed, this can be considered a comprehensive examination.

Academic Integrity

You are expected to exhibit honesty and use ethical behaviour in all aspects of the learning process. Academic credentials you earn are rooted in principles of honesty and academic integrity. **It is your responsibility to understand what constitutes academic dishonesty.**

Academic dishonesty is to knowingly act or fail to act in a way that results or could result in unearned academic credit or advantage. This behaviour can result in serious consequences, e.g. the grade of zero on an assignment, loss of credit with a notation on the transcript (notation reads: “Grade of F assigned for academic dishonesty”), and/or suspension or expulsion from the university. For information on the various types of academic dishonesty please refer to the [Academic Integrity Policy](https://secretariat.mcmaster.ca/university-policies-procedures-guidelines/), located at <https://secretariat.mcmaster.ca/university-policies-procedures-guidelines/>

The following illustrates only three forms of academic dishonesty:

- plagiarism, e.g. the submission of work that is not one’s own or for which other credit has been obtained.
- improper collaboration in group work.
- copying or using unauthorized aids in tests and examinations.

Authenticity/Plagiarism Detection

Some courses may use a web-based service (Turnitin.com) to reveal authenticity and ownership of student submitted work. For courses using such software, students will be expected to submit their work electronically either directly to Turnitin.com or via an online learning platform (e.g. Avenue to Learn, etc.) using plagiarism detection (a service supported by Turnitin.com) so it can be checked for academic dishonesty.

Students who do not wish their work to be submitted through the plagiarism detection software must inform the Instructor before the assignment is due. No penalty will be assigned to a student who does not submit work to the plagiarism detection software. **All submitted work is subject to normal verification that standards of academic integrity have been upheld** (e.g., on-line search, other software, etc.). For more details about McMaster's use of Turnitin.com please go to www.mcmaster.ca/academicintegrity.

Courses with an On-line Element

Some courses may use on-line elements (e.g. e-mail, Avenue to Learn, LearnLink, web pages, capa, Moodle, Echo360, Microsoft Teams, ThinkingCap, etc.). Students should be aware that, when they access the electronic components of a course using these elements, private information such as first and last names, user names for the McMaster e-mail accounts, and program affiliation may become apparent to all other students in the same course. The available information is dependent on the technology used. Continuation in a course that uses on-line elements will be deemed consent to this disclosure. If you have any questions or concerns about such disclosure please discuss this with the course instructor.

Online Proctoring

Some courses may use online proctoring software for tests and exams. This software may require students to turn on their video camera, present identification, monitor and record their computer activities, and/or lock/restrict their browser or other applications/software during tests or exams. This software may be required to be installed before the test/exam begins.

Conduct Expectations

As a McMaster student, you have the right to experience, and the responsibility to demonstrate, respectful and dignified interactions within all of our living, learning and working communities. These expectations are described in the [Code of Student Rights & Responsibilities](#) (the "Code"). All students share the responsibility of maintaining a positive

environment for the academic and personal growth of all McMaster community members, **whether in person or online.**

It is essential that students be mindful of their interactions online, as the Code remains in effect in virtual learning environments. The Code applies to any interactions that adversely affect, disrupt, or interfere with reasonable participation in University activities. Student disruptions or behaviours that interfere with university functions on online platforms (e.g. use of Avenue 2 Learn, WebEx, Echo360, Microsoft Teams or Zoom for delivery), will be taken very seriously and will be investigated. Outcomes may include restriction or removal of the involved students' access to these platforms.

Academic Accommodation of Students with Disabilities

Students with disabilities who require academic accommodation must contact [Student Accessibility Services](#) (SAS) at 905-525-9140 ext. 28652 or sas@mcmaster.ca to make arrangements with a Program Coordinator. For further information, consult McMaster University's [Academic Accommodation of Students with Disabilities](#) policy.

Requests for Relief for Missed Academic Term Work

McMaster Student Absence Form (MSAF): In the event of an absence for medical or other reasons, students should review and follow the Academic Regulation in the Undergraduate Calendar "Requests for Relief for Missed Academic Term Work".

View the [McMaster Student Absence Form \(MSAF\)](#) for more information.

Academic Accommodation for Religious, Indigenous or Spiritual Observances (RISO)

Students requiring academic accommodation based on religious, indigenous or spiritual observances should follow the procedures set out in the [RISO](#) policy. Students should submit their request to their Faculty Office **normally within 10 working days** of the beginning of term in which they anticipate a need for accommodation or to the Registrar's Office prior to their examinations. Students should also contact their instructors as soon as possible to make alternative arrangements for classes, assignments, and tests.

Copyright and Recording

Students are advised that lectures, demonstrations, performances, and any other course material provided by an instructor include copyright protected works. The Copyright Act and copyright law protect every original literary, dramatic, musical and artistic work, **including lectures** by University instructors

The recording of lectures, tutorials, or other methods of instruction may occur during a course. Recording may be done by either the instructor for the purpose of authorized distribution, or by a student for the purpose of personal study. Students should be aware that their voice and/or image may be recorded by others during the class. Please speak with the instructor if this is a concern for you.

Extreme Circumstances

The University reserves the right to change the dates and deadlines for any or all courses in extreme circumstances (e.g., severe weather, labour disruptions, etc.). Changes will be communicated through regular McMaster communication channels, such as McMaster Daily News, Avenue to Learn and/or McMaster email.