PLEASE NOTE: BIO4E03 will be BIO 3PG3 starting in 2019!!!

Biology 4E03 - Population Genetics
Biology Department, McMaster University - Winter Term, 2018

Instructor: Dr. Ian Dworkin LSB 428 (dworkin@mcmaster.ca)

TA: Sarah Marzec (marzecs@mcmaster.ca)

Class Schedule:
Lectures: Monday & Wednesday 10:30 – 11:20, ABB-270
Tutorial: Monday 2:30 – 4:30, ETB119

Office Hours: Dr. Dworkin Wednesday 11:30 – 12:20 (LSB 428)
Sarah Marzec: TBD (review sessions only)

Website:
https://github.com/DworkinLab/BIO4E03_PopulationGenetics

Changes to this outline:
The instructors reserve 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 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 now 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. 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.

**Course learning objectives:**
By the end of this course students 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.

**Prerequisites:** BIOLOGY 3FF3 and registration in Level III or above of any Honours program

**Primary text for the course:**
Hartl, D.L. & Clark, A.G.  Principles of Population Genetics, 4th ed. (Really any modern population genetics or populations genomics textbook may be suitable. Please contact me if you would like another suggestion).

**Course Assessment:**

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

- Problem Sets: 50% (20% - 60%)
- Mid Term Examination : 20% (10% - 40%)
- 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.
Details on Course Assessment:

Class participation: This is a 400 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 fundamental computational skills (using R) 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 Accommodation of Students with Disabilities:
Students who require academic accommodation must contact Student Accessibility Services (SAS) to make arrangements with a Program Coordinator. Academic accommodations must be arranged for each term of study. Student Accessibility Services can be contacted by phone 905-525-9140, ext. 2865 or e-mail sas@mcmaster.ca. For further information, consult McMaster University’s Policy for Academic Accommodation of Students with Disabilities.

Policy on 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. 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.
It is your responsibility to understand what constitutes academic dishonesty. For information on the various types of academic dishonesty please refer to the Academic Integrity Policy, located at http://www.mcmaster.ca/academicintegrity

The following illustrates only three forms of academic dishonesty:

1. Plagiarism, e.g. the submission of work that is not one’s own or for which other credit has been obtained.
2. Improper collaboration in group work.
3. Copying or using unauthorized aids in tests and examinations.

Policy on Absence/Missed Academic work:
We follow the McMaster University Senate Policies on Absence/Missed Academic work. To avoid penalty, student who miss a published due date for any assignment or any examination are required to provide acceptable documentation to their Dean of Studies as to why the assignment or exam was missed. Once such documentation has been provided, the University will inform the Instructor. The Instructor and the student then can reach an agreement as to how to handle any required revision to grading. An exam or assignment completely missed without reason will be recorded as a grade of 0%, Late assignments will be penalized. In most cases we cannot offer makeup exams. Please visit the URL http://www.mcmaster.ca/academicintegrity for details about the academic integrity policy for McMaster University.

The use of TURNITIN.COM:
In this course we will be using a web-based service (Turnitin.com) to reveal plagiarism. Students will be expected to submit their work electronically to Turnitin.com and in hard copy so that it can be checked for academic dishonesty. Students who do not wish to submit their work to Turnitin.com must still submit a copy to the instructor. No penalty will be assigned to a student who does not submit work to Turnitin.com. All submitted work is subject to normal verification that standards of academic integrity have been upheld (e.g., on-line search, etc.). To see the Turnitin.com Policy, please go to www.mcmaster.ca/academicintegrity.

On-Line activities in the course:
In this course we will be using avenue/desire to learn youtube for screencasts. Students should be aware that, when they access the electronic components of this course, 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 this course will be deemed consent to this disclosure. If you have any questions or concerns about such disclosure please discuss this with the course instructor.
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<tr>
<th>Week</th>
<th>Subject</th>
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<tbody>
<tr>
<td>Jan 8</td>
<td>Introduction 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</td>
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<tr>
<td>Jan 15</td>
<td>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.</td>
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<td>Jan 22</td>
<td>Genomic Frequencies of alleles and haplotypes Introduction to Quantitative Genetics and mapping of complex disease. Tutorial: Measuring variation in DNA sequences (TBD)</td>
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<td>Jan 29</td>
<td>Natural selection from a population genetic perspective Natural selection on quantitative traits Tutorial: Natural selection in ideal populations</td>
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<td>Feb 5</td>
<td>Finite populations, Genetic Drift and its influence on populations Tutorial: Drift and selection in finite populations, mutation-selection balance.</td>
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<td>Feb 12</td>
<td>Gene Flow Tutorial: Gene Flow, Fst (TBD) Midterm examination (Wednesday February 14th)</td>
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<td>Feb 19</td>
<td>mid-term recess</td>
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<td>Feb 26</td>
<td>Mutation The coalescent and an introduction to molecular population genetics Tutorial: Introduction to the coalescent and molecular pop</td>
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<td>Mar 5</td>
<td>Population history, recombination and linkage disequilibrium Tutorial: How to study the history of human populations</td>
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<td>Mar 12</td>
<td>A coalescent view of neutral evolutionary forces Tutorial: Linkage disequilibrium, tests for recombination, estimators of theta and non-neutral evolutionary change.</td>
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<td>Mar 19</td>
<td>Natural selection and the coalescent Tutorial: Estimators of theta and natural selection</td>
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<td>Mar 26</td>
<td>The interplay of Sexual selection and natural selection, sexual conflict, sex-biased gene expression and sexual dimorphism Tutorial: TBD</td>
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<td>Apr 2</td>
<td>Quantitative Genetics, population genetics and mapping of complex disease Predicting short term evolution (multivariate breeders eq’n) Tutorial: TBD</td>
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<td>Apr 9</td>
<td>Quantitative Genomics and overview Tutorial - Review</td>
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Note: Please bring your laptop to tutorials and lectures.

Other Notable dates:
Mid-term recess Monday February 19th - February 24th 2018
classes end April 9th 2018.