

**University of Guelph
College of Biological Science**

Department of Integrative Biology

COURSE OUTLINE

Population Genetics, BIOL*3020

Fall 2016

Course description

This course is designed to explore the concepts of random mating, inbreeding, random drift, assortative mating and selection as they relate to natural populations. The dynamic genetic structure of populations and its relationship to the process of speciation is examined. The role and significance of molecular genetics as it relates to population genetics, evolution, systematics and phylogeny is also considered.

Prerequisite(s): MBG*2040

Teaching team

Instructor: Cortland Griswold

Office: 1474 Summerlee Science Complex

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Telephone extension: 56240

Office hours: TBA

Teaching Assistants: TBA

Course schedule

Lectures: MWF, 12:30 – 1:20, ROZH 102

Tutorial:

R, 2:30-4:20, Alex 218 (and CBS computer lab)

F, 2:30-4:20, Alex 218 (and CBS computer lab)

Learning goals

[1] Working usage of terminology, such as allele, locus, haplotype, linkage disequilibrium, selection coefficient and absolute, relative and marginal fitness

[2] Analysis of basic models, such as one and two-locus selection, inbreeding, population structure, random genetic drift, mutation, the coalescent

[3] Apply and interpret statistical summaries of population genetic data, such as gene trees, reticulate graphs, mismatch distributions, F-statistics

[4] Interpret published studies of natural and experimental populations of prokaryotic and eukaryotic species in context of terminology, models and statistical summaries

Course Resources

Textbook: M.B. Hamilton (2009) Population Genetics. Wiley-Blackwell.

Courselink: Posted lecture notes, assignments, study guides, student discussion

On reserve at library: Textbook and several other textbooks in population genetics

Library: Access to published papers

Course Content

Lecture: Below are lecture topics. The course is divided into two major sections: the population genetics of prokaryotes and viruses and the population genetics of eukaryotes. Also listed are the organism of focus for a topic and assigned readings. Full citations of papers are given below the table. Students are expected to find and download papers on their own using library resources.

Prokaryotes & viruses

Topic	Organism	Reading
[1] Genotype frequencies	Bacteria:	Textbook: 185 – 189
[2] Selection	<i>Escherichia coli, Salmonella enterica</i>	Paper: Gullberg et al. (2011)
[3] Population structure & phylogeography	Bacteria:	Textbook: 87 – 96, 142 – 149, 178 – 182, 248 – 250, 272 - 274
[4] Molecular population genetics (statistics)	<i>Borrelia burgdorferi</i>	
[5] Coalescent, coalescent w/ mutation		Paper: Margos et al. (2008), Hoen et al. (2009)
[6] ML/Bayesian gene trees, NJ trees		
[7] Coalescent w/ migration		
[8] PCA, Mantel's test		
[9] Reticulate gene networks		
[10] Ancestral recombination graph		
[11] Genetic drift	Bacteria:	Textbook: None
[12] Contact processes, Moran model	<i>Escherichia coli</i>	Paper: Hallatschek et al. (2007)

[13] Local adaptation, niche evolution	Virus: HIV	Textbook: 131 – 135 Paper: Borderia et al. (2007)
[14] Review		

Eukaryotes

Topic	Organism	Reading
[1] Single locus allele & genotype frequencies	“Protists”: <i>Eunotia bilunaris</i> , <i>Sellaphora capitata</i> , <i>Skeletonema marinoi</i>	Textbook: 9 – 19, 26 – 41, 105 – 111, 118 - 124 Papers: Vanormelingen et al. (2015), Sjoqvist et al. (2015)
[2] HW & inbreeding		
[3] Population structure, F-stats		
[4] Single-locus selection	Nothing specific	Textbook: 189 – 203
[5] Two-locus allele, haplotype & genotype frequencies, LD	Nematode: <i>Caenorhabditis elegans</i>	Textbook: 41 - 50, 212 – 222, 274 - 279 Paper: Andersen et al. (2011)
[6] Two-locus selection		
[7] Genetic drift (Wright-Fisher model)	Nematode: <i>Caenorhabditis brenneri</i>	Textbook: 53 – 67, 73 – 78, 80 – 87 Paper: Dey et al. (2013)
[8] Ne		
[9] Coalescent, ancestral graphs	Primate: <i>Homo sapiens</i>	Textbook: 87 – 96, 142 – 149, 248 – 250, 225 – 226, TBA Papers: TBA
[10] Mutation-selection balance		
[11] Case studies	Algae, moss, flowering plant, fungi, insect, fish, ag/domestic species	Textbook: TBA Papers: TBA
[12] Review		

Tutorials: Study guides will be provided that consist of questions to help direct your study of and practice with course material. These study guides will be worked on and discussed in tutorial and serve as preparation for graded assignments and exams.

Textbook

Hamilton, M.B. (2009) Population Genetics. Wiley-Blackwell.

Literature cited

Andersen, E.C. et al. (2012) Chromosome-scale selective sweeps shape *Caenorhabditis elegans* genomic diversity. *Nature Genetics* 44: 285 – 290.

Borderia, A. et al. (2007) Selection promotes organ compartmentalization in HIV-1: Evidence from *GAG* and *POL* genes. *Evolution* 61: 272 – 279.

Dey, A. et al. (2013) Molecular hyperdiversity defines populations of the nematode *Caenorhabditis brennei*. *Proceedings National Academy of Sciences (USA)* 110: 11056-11060.

Gullberg, E. et al. (2011) Selection of resistant bacteria at very low antibiotic concentrations. *PLoS Pathogens* 7: e1002158.

Hallatschek, O. et al. (2007) Genetic drift at expanding frontiers promotes gene segregation. *Proceedings National Academy of Sciences (USA)* 104: 19926-19930.

Hoen, A.G. et al. (2009) Phylogeography of *Borrelia burgdorferi* in the eastern United States reflects multiple independent Lyme disease emergence events. *Proceedings National Academy of Sciences (USA)* 106: 15013-15018.

Margos, G. et al. (2008) MLST of housekeeping genes captures geographic population structure and suggests a European origin of *Borrelia burgdorferi*. *Proceedings National Academy of Sciences (USA)* 105: 8730-8735.

Sjoqvist, C. et al. (2015) Local adaptation and oceanographic connectivity patterns explain genetic differentiation of a marine diatom across the North Sea-Baltic Sea salinity gradient. *Molecular Ecology* 24: 2871-2885.

Vanormelingen, P. et al. (2015) Genotypic diversity and differentiation among populations of two benthic freshwater diatoms as revealed by microsatellites. *Molecular Ecology* 24: 4433-4448.

Methods of Assessment

Assessment	Topics covered	Learning objectives
Assignment #1	Prokaryotic and viral population genetics	1 - 4
Midterm exam #1	Prokaryotic and viral population genetics	1 - 4
Assignment #2	Eukaryotic population genetics	1 - 4
Midterm exam #2	Eukaryotic population genetics (up to and including Topic #8 [Ne])	1 - 4
Final exam	Comprehensive	1 - 4

Assignments: Will be handed out one week before they are due. Students are expected to complete the assignments by themselves, as these form a basis of individual assessment. Contravention of this policy is Academic Misconduct. Study Guides provide an opportunity to work together.

Exams: Assigned reading, lecture, study guide and assignment materials form the basis of exams.

Important Dates

See dates assignments are due and dates exams are held (below in Grading section). In addition, below are important dates with respect to course registration.

Date	Event
September 16	Add period ends
November 4	Last day to drop course

Course and University Policies

When You Cannot Meet a Course Requirement

When you find yourself unable to meet an in-course requirement because of illness or compassionate reasons, please advise the course instructor (or designated person, such as a teaching assistant) in writing, with your name, id#, and e-mail contact, and be prepared to provide supporting documentation. See the undergraduate calendar for information on regulations and procedures for Academic Consideration: <http://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-ac.shtml>

Assignments: If an academic consideration is met, a student can shift grade weighting, such that ½ of weighting of the assignment goes to the corresponding midterm and ½ to final exam.

Midterm exams: With an academic consideration a student can make-up a midterm, provided that graded versions have not been returned to class. If graded versions have been returned, the corresponding assignment is increased in weight by 1/3 the weighting of the midterm and the final by 2/3 the weighting of the midterm. To schedule a make-up exam, contact the course instructor.

Final exam: A student is expected to follow standard University policy for a missed final (see Undergraduate Calendar).

Accessibility

The University of Guelph is committed to creating a barrier-free environment. Providing services for students is a shared responsibility among students, faculty and administrators. This relationship is based on respect of individual rights, the dignity of the individual and the University community's shared commitment to an open and supportive learning environment. Students requiring service or accommodation, whether due to an identified, ongoing disability or a short-term disability should contact the Centre for Students with Disabilities as soon as possible.

For more information, contact CSD at 519-824-4120 ext. 56208 or email csd@uoguelph.ca or see the website: <http://www.csd.uoguelph.ca/csd/>

Academic Misconduct

The University of Guelph is committed to upholding the highest standards of academic integrity and it is the responsibility of all members of the University community – faculty, staff, and students – to be aware of what constitutes academic misconduct and to do as much as possible to prevent academic offences from occurring. University of Guelph students have the responsibility of abiding by the University's policy on academic misconduct regardless of their location of study; faculty, staff and

students have the responsibility of supporting an environment that discourages misconduct. Students need to remain aware that instructors have access to and the right to use electronic and other means of detection.

Please note: Whether or not a student intended to commit academic misconduct is not relevant for a finding of guilt. Hurried or careless submission of assignments does not excuse students from responsibility for verifying the academic integrity of their work before submitting it. Students who are in any doubt as to whether an action on their part could be construed as an academic offence should consult with a faculty member or faculty advisor.

The Academic Misconduct Policy is detailed in the Undergraduate Calendar:

<http://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-amisconduct.shtml>

E-mail Communication

As per university regulations, all students are required to check their <uoguelph.ca> e-mail account regularly: e-mail is the official route of communication between the University and its students.

Drop Date

The last date to drop one-semester courses, without academic penalty, is the 40th class day. To confirm the actual date please see the schedule of dates in the Undergraduate Calendar. For regulations and procedures for Dropping Courses, see the Undergraduate Calendar:

<http://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-drop.shtml>

Copies of out-of-class assignments

Keep paper and/or other reliable back-up copies of all out-of-class assignments: you may be asked to resubmit work at any time.

Recording of Materials

Presentations which are made in relation to course work—including lectures—cannot be recorded or copied without the permission of the presenter, whether the instructor, a classmate or guest lecturer. Material recorded with permission is restricted to use for that course unless further permission is granted.

Grading

Assessment	Date due or occurrence	Time and location to turn in assignment or take exam	Final grade Weight¹	Penalty for being late or absent²
Assignment #1	October 5	12:30PM, lecture room	10%	Marked zero
Midterm exam #1	October 24	12:30 – 1:20PM, lecture room	20% or 25% ³	Marked zero
Assignment #2	November 9	12:30PM, lecture room	10%	Marked zero
Midterm exam #2	November 21	12:30 – 1:20PM, lecture room	20% or 25% ³	Marked zero
Final exam	December 6	2:30 – 4:20PM, TBA	35%	Marked zero

1 – Weighting is applied to percentage of total marks received for an item.

2 - Without academic consideration (see above), or prior approval for change of date/time by course instructor.

3 – Midterm with highest percentage of total marks is weighted 25%, while the other midterm exam is weighted 20%.

Campus Resources

The Academic Calendar is the source of information about the University of Guelph's procedures, policies and regulations which apply to undergraduate, graduate and diploma programs:
<http://www.uoguelph.ca/registrar/calendars/index.cfm?index>

If you are concerned about any aspect of your academic program:

- make an appointment with a program counsellor in your degree program.
<http://www.bsc.uoguelph.ca/index.shtml> or <https://www.uoguelph.ca/uaic/programcounsellors>

If you are struggling to succeed academically:

- There are numerous academic resources offered by the Learning Commons including, Supported Learning Groups for a variety of courses, workshops related to time management, taking multiple choice exams, and general study skills. You can also set up individualized appointments with a learning specialist. <http://www.learningcommons.uoguelph.ca/>

If you are struggling with personal or health issues:

- Counselling services offers individualized appointments to help students work through personal struggles that may be impacting their academic performance.
<https://www.uoguelph.ca/counselling/>
- Student Health Services is located on campus and is available to provide medical attention.
<https://www.uoguelph.ca/studenthealthservices/clinic>
- For support related to stress and anxiety, besides Health Services and Counselling Services, Kathy Somers runs training workshops and one-on-one sessions related to stress management and high performance situations. <http://www.uoguelph.ca/~ksomers/>

If you have a documented disability or think you may have a disability:

- The Centre for Students with Disabilities (CSD) can provide services and support for students with a documented learning or physical disability. They can also provide information about how to be tested for a learning disability. For more information, including how to register with the centre please see: <https://www.uoguelph.ca/csd/>