BIOL*3020 Population Genetics

Fall 2018
Section(s): C01

Department of Integrative Biology
Credit Weight: 0.50
Version 1.00 - August 17, 2018

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1 Course Details

1.1 Calendar 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.

Pre-Requisite(s): MBG*2040

1.2 Course Description

Population genetics is the study of the genetic compositions of populations. This course seeks to provide a thorough introduction to population genetics by examining the genetic compositions of populations across the domains of life and with that as a basis examine processes that give rise to the genetic compositions of populations. These processes include reproduction, mutation, recombination, segregation, selection, dispersal and drift. Modern approaches to modeling the genetics of populations is introduced, including the coalescent process. In addition, we will learn about methods that are used to characterize genetic variation within populations.

1.3 Timetable

Lectures: MWF, 12:30 - 1:20pm, RICH 2529

Tutorials:

R, 2:30 - 4:20pm MCKN 229

F, 2:30 - 4:20, MCKN 229

Timetable is subject to change. Please see WebAdvisor for the latest information.

1.4 Final Exam

Exam time and location is subject to change. Please see WebAdvisor for the latest information.

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2 Instructional Support

2.1 Instructor(s)

Cortland Griswold
Email: cgriswol@uoguelph.ca
Telephone: +1-519-824-4120 x56240
Office: SC1 1474
Office Hours: TBA

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3 Learning Resources

3.1 Required Resource(s)

Courselink (Website)
https://courselink.uoguelph.ca/
Posted lecture materials, assignments, study guides, student discussion

Published papers available through library (Article)

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.

3.2 Recommended Resource(s)

Population Genetics M.B. Hamilton (2009) (Textbook)
This textbook is also on reserve at the library along with other textbooks in population genetics. The textbook is a good resource for support on theoretical topics in the course.

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4 Learning Outcomes

4.1 Course Learning Outcomes

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

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

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5 Teaching and Learning Activities

The course involves both lectures and tutorials.

5.1 Lecture

Topic(s): _

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 in the "Resources" section of the syllabus. Students are expected to find and download papers on their own using library resources.

Prokaryoties and Virsues

Topic	Organism	Reading

[1] Genotype frequencies	Bacteria: *Escherichia coli*, *Salmonella enterica*	Textbook: 185 – 189 Paper: Gullberg et al. (2011)
[2] Selection		
[3] Population structure & phylogeography	Bacteria: *Borrelia burgdorferi*	Textbook: 87 – 96, 142 – 149, 178 – 182, 248 – 250, 272 - 274 Paper: Margos et al. (2008), Hoen et al. (2009)
[4] Molecular population genetics (statistics)		
[5] Coalescent, coalescent w/ mutation		
[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: *Escherichia coli*	Textbook: None Paper: Hallatschek et al. (2007)
[12] Contact processes, Moran model		
[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":	Textbook: 9 – 19, 26 – 41, 105 – 111, 118 - 124

[2] HW & inbreeding	*Eunotia bilunaris, Sellaphora capitata, Skeletonema marinoi*	Papers: Vanormelingen et al. (2015), Sjoqvist et al. (2015)
[3] Population structure, F-stats		
[4] Single-locus selection	Nothing specific	Textbook: 189 – 203
[5] Two-locus allele, haplotype & genotype frequencies, LD	Nematode: *Caenorhabditis elegans*	Textbook: 41 - 50, 212 – 222, 274 - 279
[6] Two-locus selection		Paper: Andersen et al. (2011)
[7] Genetic drift (Wright-Fisher model)	Nematode: *Caenorhabditis brenneri*	Textbook: 53 – 67, 73 – 78, 80 – 96, 248 – 250
[8] Ne		Paper: Dey et al. (2013)
[10] Human population genetics	Primate: *Homo sapiens*	Textbook: TBA Papers: TBA
[12] Case studies	Algae, moss, flowering plant, fungi, insect, fish, ag/domestic species	Textbook: TBA Papers: TBA
[13] Review		

5.2 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.

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6 Assessments

6.1 Marking Schemes & Distributions

Name	Scheme A (%)	Scheme B (%)
Assignment #1	10	10
Assignment #2	10	10
Midterm #1 - Midterm with highest percentage of total marks is weighted 25%, while the other midterm exam is weighted 20%	20	25
Midterm #2	25	20
Final Exams	35	35
Total	100	100

6.2 Assessment Details

Assignment #1 (10%)
Date: Wed, Oct 3, 12:30pm Lecture Room
Prokaryotic and viral population genetics

Midterm #1 (20%)
Date: Mon, Oct 22, 12:30 - 1:20pm Lecture Room
Prokaryotic and viral population genetics

Assignment #2 (10%)
Date: Wed, Nov 7, 12:30pm Lecture Room
Eukaryotic population genetics

Midterm #2 (20%)
Date: Mon, Nov 19, 12:30 - 1:20pm Lecture Room
Eukaryotic population genetics

Final Exams (35%)
Date: , tba
Comprehensive

6.3 Midterm Grading Scheme

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

6.4 Assessment Details

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 readings, lectures, study guides and assignments form the basis of exams.

6.5 Academic Consideration

Without documented grounds for academic consideration, or prior approval for change of date/time by course instructor, students will receive a mark of zero for any missed form of assessment.

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7 Course Statements

7.1 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:

- Student Accessibility Services (SAS) 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: Accessibility Services

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8 Department of Integrative Biology Statements

8.1 Academic Advisors

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

- Make an appointment with a program counsellor in your degree program. B.Sc. Academic Advising or Program Counsellors

8.2 Academic Support

If you are struggling to succeed academically:

- Learning Commons: 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.
- Science Commons: Located in the library, the Science Commons provides support for physics, mathematic/statistics, and chemistry. Details on their hours of operations can be found at: Chemistry & Physics Help and Math & Stats Help

8.3 Wellness

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.
- Student Health Services is located on campus and is available to provide medical attention.
- 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.

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9 University Statements

9.1 Email Communication

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

9.2 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. The regulations and

procedures for Academic Consideration are detailed in the Undergraduate Calendar.

9.3 Drop Date

Courses that are one semester long must be dropped by the end of the fortieth class day; two-semester courses must be dropped by the last day of the add period in the second semester. The regulations and procedures for Dropping Courses are available in the Undergraduate Calendar.

9.4 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.

9.5 Accessibility

The University promotes the full participation of students who experience disabilities in their academic programs. To that end, the provision of academic accommodation is a shared responsibility between the University and the student.

When accommodations are needed, the student is required to first register with Student Accessibility Services (SAS). Documentation to substantiate the existence of a disability is required, however, interim accommodations may be possible while that process is underway.

Accommodations are available for both permanent and temporary disabilities. It should be noted that common illnesses such as a cold or the flu do not constitute a disability.

Use of the SAS Exam Centre requires students to book their exams at least 7 days in advance, and not later than the 40th Class Day.

More information: www.uoguelph.ca/sas

9.6 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.

9.7 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.

9.8 Resources

The Academic Calendars are the source of information about the University of Guelph's procedures, policies and regulations which apply to undergraduate, graduate and diploma programs.