

UNIVERSITY OF GUELPH
COLLEGE OF BIOLOGICAL SCIENCE
COURSE DESCRIPTION

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| Course number: | BIOL*3040 |
| Title of course: | Methods in Evolutionary Biology |
| Semester offered: | Winter 2018 |
| Department: | Integrative Biology |

COURSE DESCRIPTION

This course will provide students with an understanding of some of the major analytical approaches used in modern evolutionary biology and an appreciation of the relevance of these methods to other branches of the life sciences. This includes the analysis of molecular data, phylogenetics and “tree thinking”, population genetics, genomics, phenotypic selection, experimental evolution, and hypothesis generation and testing in historical sciences. In addition to lectures, laboratory sessions will be devoted to practical training in analytical tools using specialized computer software and real datasets. Students will also be exposed to recent scientific literature and will undertake an independent project in order to experience these approaches in action. Knowledge of basic genetics and evolutionary theory is required.

Prerequisite: BIOL*2400 (Evolution)

NOTE: Limitations of departmental resources may restrict entry into this course.

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| Course instructors: | Jinzhong Fu |
| | SCIE 1458, jfu@uoguelph.ca |
| | office hours by appointment |
| | Cortland Griswold |
| | SCIE 1474, cgriswol@uoguelph.ca |
| | office hours by appointment |
| | Teaching Assistant: TBA |
| | |
| Scheduled classes: | Lecture: Monday, Wednesday, 10:30 - 11:20 h |
| | Lab: Wednesday, 12:30 - 14:20 or 14:30 - 16:20 h |

LEARNING GOALS

1. Retrieving and organizing data
2. Working with scientific computer software that analyses data in the areas of population genetics, phylogenetics and the comparative method
3. Identifying, stating and evaluating research hypotheses or questions. Placing hypotheses and questions in the context of research programs.
4. Identifying data and statistical tests needed to test a research hypothesis or evaluate a question
5. Making inferences about evolutionary processes in context of a research hypothesis or question and from the results of statistical analyses of data
6. Summarize and assess conceptual or theoretical basis of an evolutionary method
7. Scientific writing, including the presentation of data in the form of tables and/or figures, as well as presenting a case study of an individual's research program

COURSE RESOURCES

- Recommended text: Hall, B.G. (2011). *Phylogenetic Trees Made Easy: A How-To Manual, 4th Edition*. Sinauer Associates. <http://www.sinauer.com/detail.php?id=6069>
- Lab instructions provided by professors.
- Various primary research papers.
- Software manuals.

Software:

- Arlequin (<http://cmpg.unibe.ch/software/arlequin35>)
- DNAsp (<http://www.ub.edu/dnasp>)
- GenBank and BLAST (<http://www.ncbi.nlm.nih.gov/genbank>)
- MEGA5 (<http://www.megasoftware.net>)
- Mesquite (<http://mesquiteproject.org/mesquite/mesquite.html>)
- PDAP (http://mesquiteproject.org/pdap_mesquite)
- PAUP (https://people.sc.fsu.edu/~dswofford/paup_test/)

D2L course site: Materials relevant to the course will be posted on the D2L course site. In addition, all written assignments will be submitted via the D2L dropbox.

Academic Calendar: The 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>

SUMMARY OF COURSE TOPICS

1. Scientific Methods in Evolutionary Biology

This topic will focus on understanding the sorts of questions that arise in a historical science such as evolutionary biology, the role of inference and comparative methods, and the kinds of data and analyses that can be brought to bear on such questions.

2. Phylogenetics and Comparative Methods

This topic will introduce some basic methods of phylogenetic reconstruction, including the use of both morphological and molecular data. Limitations of the available approaches will also be presented. Correct interpretation of phylogenies (“tree thinking”) will be strongly emphasized and common misconceptions will be addressed. Tree thinking will form a basis of understanding phylogenetically independent contrasts (PICs) in species-level correlation analyses as well as character state reconstructions and the mapping of characters onto evolutionary trees.

3. Population Genetic Methods

This topic will focus on the use of molecular and genomic data to infer the influence of microevolutionary processes in the past. This will include a review of the major mechanisms of microevolution (mutation, natural selection, genetic drift, gene flow) and how these can be detected and quantified.

METHODS OF ASSESSMENT

| Course component | Description | Learning goals |
|---------------------|--|----------------|
| Lab assignments (4) | Small data analysis assignments focused on particular methods or software tools. | 1-5,7 |
| Term exams (2) | The exams will be written in lab periods and include both theoretic and practical questions. | 1-6 |
| Case study report | Students will independently evaluate a case study and prepare a 5-page report. | 3-7 |

Case study report: Students investigate a case study of an individual’s research program that uses evolutionary methods. Details of the specific requirements for the case report will be provided in a separate document.

TENTATIVE COURSE SCHEDULE

| | Class – Monday | Class – Wednesday | Lab – Wednesday |
|---|---|--|---|
| 1. Introduction | | | |
| Week 1 Jan 8- | Course overview | Research programs & evolutionary methods | Data Sources and formats |
| 2. Phylogenetics and Comparative Methods | | | |
| Week 2 Jan 15- | General concepts and theory | Parsimony | Intro to PAUP & Mesquite |
| Week 3 Jan 22- | Model-based phylo & substitution models | Maximum likelihood | PAUP – Lizards Assignment 1 |
| Week 4 Jan 29- | Confidence evaluation | Bayesian inference | PAUP & Mesquite |
| Week 5 Feb 5- | Comparative methods | Character evolution | Mesquite – Genome Size Assignment 2 |
| Week 6 Feb 12- | Tree thinking | Applications/Case Studies | Term Exam 1 |
| Winter Break (Feb 19-25) | | | |
| 3. Population Genetic Methods | | | |
| Week 7 Feb 26- | Allele, haplotype, genotype frequencies | HW, LD | Intro to Arlequin |
| Week 8 Mar 5- | AMOVA, Fst, Mantel | AMOVA, Fst, Mantel | Arlequin – Caribou (Microsatellite data) Assignment 3 |
| Week 9 Mar 12- | DNA sequence polymorphism | Coalescent | Intro to DNAsp & MEGA |
| Week 10 Mar 19- | Tests for selection | Historical demography | DNAsp & MEGA – Water fleas (DNA sequence data) Assignment 4 |
| Week 11 Mar 26- | Population genomics | Review | Term exam 2 |
| Week 12 Apr 2- | Case study | Case study | No lab |

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>

Written assignments that are submitted after the deadlines indicated in the table above **will not be accepted** and the distribution of course marks **will not be altered** for any student unless Academic Consideration for illness or other compassionate grounds has been approved by the course instructor.

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. 5620 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 Weight ¹ | Penalty for being late or absent ² |
|-------------------|------------------------|--|---------------------------------|---|
| Lab Assignment #1 | January 29 | 10:30AM, Courselink | 5% | Marked zero |
| Lab Assignment #2 | February 12 | 10:30AM, Courselink | 5% | Marked zero |
| Term exam #1 | February 14 | Your registered lab period, Lab Room | 25% or 35% ³ | Marked zero |
| Lab Assignment #3 | March 12 | 10:30AM, Courselink | 5% | Marked zero |
| Lab Assignment #4 | March 26 | 10:30AM, Courselink | 5% | Marked zero |
| Term exam #2 | March 28 | Your registered lab period, Lab Room | 25% or 35% ³ | Marked zero |
| Case Study Report | April 16 | 12PM, Courselink | 20% | Marked INC |

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

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

– Term exam with highest percentage of total marks is weighted 35%, while the other midterm exam is weighted 25%.

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 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/>