UNIVERSITY OF GUELPH
COLLEGE OF BIOLOGICAL SCIENCE
COURSE DESCRIPTION

Course number:	BIOL*3040
Title of course:	Methods in Evolutionary Biology
Semester offered:	Winter 2016
Department:	Integrative Biology
Course instructors:	**T. Ryan Gregory**
	SCIE 1450, rgregory@uoguelph.ca
	office hours by appointment
	Jinzhong Fu
	SCIE 1458, jfu@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

COURSE OVERVIEW

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.

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)

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

PROCEDURES

Email Communication: As per university regulations, all students are required to check their <uoguelph.ca> email account regularly. Email 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, for Winter 2016 is Friday, March 11, 2016. 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.

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 SAS at 519-824-4120 ext. 54335 or email <csdexams@uoguelph.ca> or see the website: http://www.uoguelph.ca/csd

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.

POLICY ON LATE OR MISSED COURSE REQUIREMENTS

Students who are unable to meet a course deadline for a graded component because of illness or compassionate reasons must request Academic Consideration as soon as possible by advising the course coordinator in writing, with their name, id#, and email contact. If approved, alternate deadlines will be arranged.

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.

See the undergraduate calendar for further information on regulations and procedures for Academic Consideration:
http://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-ac.shtml

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 have 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

SUMMARY OF COURSE TOPICS

1. Scientific Methods in Evolutionary Biology
This unit 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. Studying Modern Populations
This unit will cover evolutionary processes occurring in contemporary populations, including methods derived from both population genetics and studies of phenotypic selection. This will include a review of the major mechanisms of microevolution, the ways in which the influence of different microevolutionary processes (mutation, natural selection, genetic drift, gene flow), how these can be detected and quantified, and their implications for evolutionary change at the population level.

3. Molecular Phylogenetics and Tree Thinking
This unit will introduce some basic methods of phylogenetic reconstruction using molecular data and the limitations of the available approaches. Correct interpretation of phylogenies ("tree thinking") will be strongly emphasized and common misconceptions will be addressed.

4. Comparative Methods and Patterns of Macroevolution
This unit will build upon the tree thinking skills developed in the previous unit. This will include the use of phylogenetically independent contrasts (PICs) in species-level correlation analyses as well as character state reconstructions and the mapping of characters onto evolutionary trees.

5. Historical Population Genetics
This unit will focus on the use of molecular and genomic data to infer the influence of microevolutionary processes in the past. This includes methods for detecting evidence of positive or purifying selection on particular genes, evidence of previous founder effects or population bottlenecks, and so on.

6. Experimental Evolution
This unit will discuss various approaches to studying evolution experimentally, both in the lab using model organisms with rapid life cycles (bacteria, protists, plants, insects) and in silico using simulation studies.

7. Integrative Case Study
In week 9, the class will work through a specific question or problem together by identifying the key issues, deciding on the most appropriate methods, obtaining data, conducting analyses, and interpreting results. This will provide both a guided application of the approaches covered in the course and will present an example for students as they begin work on an independent project.

8. Independent Learning and Critical Analysis
Students will conduct a small research project involving analysis of a dataset assembled from the literature or a database such as GenBank. Further details will be provided at a later date.

Guest Seminars
During lecture periods near the end of the semester, researchers from Integrative Biology, the Biodiversity Institute of Ontario, and other departments will be invited to present a summary of their work and to describe how they use particular methods to answer questions in their areas of study. Examples may include the use of DNA barcoding, next-generation DNA sequencing, phylogenetic comparative methods, and other approaches.

Discussions
In order to explore the use of evolutionary methods in real research, students will be provided with a small number of peer-reviewed articles to read, which will then be discussed in class. In general, these will focus on a topic that is currently being debated in evolutionary biology and will present new results and/or opposing views on the issue.

EVALUATION

Course component	Weight	Description
Weekly lab assignments	20%	Small data analysis assignments focused on particular methods or software tools. There will be 5 assignments. Final marks will be based on the best 4 of 5 @ 5% each.
Term exam	20%	The exam will be written in class and cover material to the end of topic 5.
Independent project	35%	**Students will work in pairs** to do a small research project involving analysis of a dataset assembled from the literature or a database.
Final exam	25%	The final will be a **take-home exam**. Students will be given a series of questions to complete using whatever resources they choose.

DUE DATES

Date	Course Submission
Wed, Feb. 3 @ 10:00 am	Lab Assignment 1
Wed, Feb. 17 @ 10:00 am	Lab Assignment 2
Wed, Mar. 2 @ 10:00 am	Lab Assignment 3
Wed, Mar. 09 @ 10:00 am	Lab Assignment 4
Fri. Mar. 18 @ 10:00 am	Lab Assignment 5
Mon. Mar. 14	**Term Exam in Class**
Mon. Apr. 4 @ 10:00 am	Independent Project
Fri. Apr. 08	**Receive take home Final Exam**
Fri. Apr. 15 @ 10:00 am	**Submit take home Final Exam**

COURSE SCHEDULE

1. Scientific Methods in Evolutionary Biology			
	Class – Monday	**Class – Wednesday**	**Lab – Wednesday**
Week 1 Jan 11¸13	Course introduction and overview	Overview and philosophical considerations	Introduction to software for evolutionary analysis
2. Studying Modern Populations			
Week 2 Jan 18, 20	Population genetics 1	Population genetics 2	Arlequin
Week 3 Jan 25, 27	Phenotypic evolution	Quantitative traits	Measuring selection and heritability from phenotypic data
3. Phylogenetics and Tree Thinking			
Week 4 Feb 1, 3	Phylogenetic concepts	Models of molecular evolution	GenBank, Blast
Week 5 Feb 8, 10	Methods of tree reconstruction	Reading evolutionary trees	MEGA5
Break Week - NO CLASSES			
4. Comparative Methods and Patterns of Macroevolution			
Week 6 Feb 22, 24	Comparative methods 1: independent contrasts	Comparative methods 2: evolutionary trends, molecular clocks	Mesquite
5. Historical Population Genetics			
Week 7 Feb 29, Mar 2	Coalescence analysis: bottlenecks and founder effects	Natural selection in the past	DNAsp
6. Experimental Evolution			
Week 8 Mar 7, 9	Historical population genetics	Experimental evolution in the lab and *in silico*	TBD
7. Integrative Case Study			
Week 9 Mar 14, 16	**MIDTERM covers topics 1 to 5**	Introduction to the problem. Identify major questions, required tools required data for first set of questions	Gather data, conduct analyses on the first set of questions. Identify tools and data required for a second set of questions
8. Independent Learning and Critical Analysis			
Week 10 Mar 21, 23	Discuss results, update questions	Discussion or Help with project	Independent project
Week 11 Mar 28, 30	Discussion	Discussion	Independent project
Week 12 Apr 4, 6	Guest seminar	Guest seminar	Review