

Faculty of Science Course Syllabus
Department of Biology
BIOL 3046
Molecular Evolution
Fall 2019

Instructor(s): Joseph P. Bielawski j.bielawski@dal.ca LSC 7058
Lectures: 2:35 – 3:55 LSC Room C216
Laboratories: none
Tutorials: none

Course Description

This course examines the process of evolutionary change at the molecular level. It begins with the sources of mutation, and moves on to dynamics of population variation. The course culminates with a macro-evolutionary perspective on topics such as adaptive evolution and genetic co-option. This course is complementary to BIOC 4010.03 (Bioinformatics).

Course Prerequisites

BIOL 2030
BIOL 2040

Course Objectives/Learning Outcomes

- Comprehend different evolutionary models for genetic load and how these led to the neutral theory of molecular evolution. Understand and describe the “Neutral theory” and the “nearly neutral theory”. Know the major predictions of neutral theory and give examples where predictions have been validated with real molecular data. Comprehend both the benefits and pitfalls of neutral theory.
- Comprehend the complexity of homology relationships under a variety of different molecular evolutionary processes.
- Demonstrate the relationship between critical thinking and good scholarship within a course project.
- Know mechanisms for functional divergence at the molecular level that span a wide range of biological complexity. Understand how specific models of adaptive evolution explain real examples of functional divergence.
- Know the historical, cultural, and social framework that lead to the Darwinian theory of evolution
- Know updates and extensions to Darwinian theory that led to modern theory. Comprehend and explain principles arising from the neo-Darwinian synthesis and neutral theory.
- Understand how explicit models of population genetic processes serve as the theoretical foundation for microevolution. Apply these models to understand different mechanisms of evolution acting on real biological data.
- Understand how molecular evolutionary processes give rise to patterns of genetic diversity that we observe in the natural world, and how to use those patterns to make inferences about different processes.

- Understand the evolutionary significance of mutations at different levels of complexity. Apply evolutionary theory to understand impacts of mutations on fitness, rates of molecular evolution and genetic control of mutation.
- Understand the importance of molecular evolution in the post-genomic era, and be able to explain this to non-specialists.
- Use knowledge of molecular evolution for clear and explicit communication and exchange of ideas about the topic within a course project.

Course Materials

There is no required textbook for this course. Lecture notes will be posted on the course website: www.biol3046.info. In addition, key scientific papers and/or review articles relevant to the lecture material will be posted on the web. Students are advised to download these materials and read them thoroughly in preparation for each lecture.

The following books have been placed on reserve in the Killam Library: (1) Page, R. D. M. & E.C. Holmes. *Molecular Evolution: A Phylogenetic Approach*. 1998; (2) Li, Wen-Hsiung. *Molecular Evolution*. 1997; (3) Avise, John C. *Molecular Markers, Natural History & Evolution*. 1994; (4) Nei, Masatoshi. *Molecular Evolution and Phylogenetics*. 2000; (5) Felsenstein, Joseph. *Inferring Phylogenies*. 2003; (6) Daniel L. Hartl and Andrew G. Clark. *Principles of population genetics* (1997). These textbooks provide thorough coverage of many of the topics covered in this course

The following scientific journals provide an excellent source for additional information, and are available either in print or electronically through the Dalhousie Libraries: *Genome Research*, *Journal of Molecular Evolution*, *Molecular Biology and Evolution*, *Molecular Phylogenetics and Evolution*, *Trends in Ecology and Evolution*, *Bioinformatics*, *Development Genes and Evolution*, *Evolution*, *Genetics*, *Nature*, *PNAS(USA)*, *Science* and *Systematic Biology*. Students can search the journal literature via databases such as *Biological Abstracts*, *PubMed* and *Web of Science*. The library also makes available a document delivery service that permits students to order journal articles for a nominal fee of \$2.00 per article.

Course Assessment

Component	Weight (% of final grade)	Date
<i>Tests/quizzes (65%)</i>		
Exam 1	15%	October 2 nd
Exam 2	30%	November 4 th
Exam 3	15%	December 3 rd
<i>Assignments</i>		
Project 1	30%	Topic due: October 16 th "Soft" deadline: November 15 th "Hard" deadline: December 3 rd
Project 2	10%	December 02 nd

Other course requirements

none

Conversion of numerical grades to Final Letter Grades follows the Dalhousie Common Grade Scale

A+ (90-100)	B+ (77-79)	C+ (65-69)	D	(50-54)
A (85-89)	B (73-76)	C (60-64)	F	(<50)
A- (80-84)	B- (70-72)	C- (55-59)		

Course Policies**Course project 1:**

The web has become an extremely important source for dissemination of molecular data, scientific knowledge and analytical resources related to the discipline of molecular evolution. By completing this project a student will demonstrate a proficiency to use and produce web-based resources to address topics in molecular evolution.

Additional guidelines: You will select a topic that interests you. You will conduct a survey of the literature using web-based resources, and write a scholarly summary of a particular point. You should think of this scholarly summary as analogous to the traditional "term paper". You will then construct a web-site dedicated to your topic. Minimally, the site should include (i) a summary page; (ii) the results of the literature survey (think of this as a term paper spread over one or more web pages); and (iii) links to material on the web that is relevant to the topic (including the relevant literature). This list is a bare minimum (you get 1/2 the credit for this); you can add as much additional content relevant to your topic as you like. You should have fun with this project, its not all that hard! Potential topics are wide open, and can relate to evolutionary theory, a biologically motivated problem, a new method of data analysis, a particularly useful database, etc. After deciding on a topic, you must receive approval from the instructor. The last day to obtain approval for a topic is **16th of October**.

WARNING: You may NOT use free on-line website builders (e.g., WIX, WEEBLY, etc.). Further details will be given in class. **Any website that is submitted as a URL rather than on a CD/DVD/flash drive will get ZERO points!** Ask if you are uncertain; don't let this happen to you!

NOTE: I will allow, with prior permission only, an alternative format such as a video or podcast type of project. You must get permission before making any changes to the format of the project.

A first draft of the web project should be saved as a fully functional website and "burned" onto a CD/DVD that is due by the **15th of November**. This is a "soft deadline". There is no cost for missing this deadline; but, if you turn in your project by this date I guarantee to review it and give you feedback. I cannot guarantee feedback on any projects submitted after this date.

The final deadline is **December 3rd**. This is a "hard deadline". No projects will be accepted after this date.



You will be graded on functionality of the site (e.g., do all the links work) as well as content. Do NOT simply mimic, or paraphrase, the information from a pre-existing web-site; this is plagiarism and will not be tolerated.

Course project 2: Simulation of DNA sequence evolution.

This is a new activity for 2018 and 2019. The activity involves using basic probability to simulate the evolution of DNA sequences using dice. Individual sites in a gene will be simulated by different students, and the complete gene sequence will be assembled by aggregating the class data. Students will work in pairs and write reports in pairs.

Course Exams:

Requests for an alternative midterm/exam time due to extenuating circumstances: A student requesting an alternative time for a midterm or final examination will be granted that request only in exceptional circumstances. Such circumstances include having another Dalhousie class or exam scheduled at the same time or other mitigating circumstances outside the control of the student. Elective arrangements (such as travel plans) are **NOT** considered acceptable grounds for granting an alternative examination time. Students should contact the instructor at least **two weeks** prior to the exam date to arrange another time.

Special arrangements for missed exams due to illness or other exceptional circumstances: Alternate arrangements will be considered provided that:

A student who misses class work (assignment, lab, tutorial, midterm or exam) because of illness:

1. notifies the Instructor on the day in question,
2. notifies his/her physician at the time of illness (or within a few days) and obtains a valid* medical excuse,
3. provides a medical certificate (signed by a physician) to the Instructor within one week.

A student who, for medical reasons (e.g. scheduled day-surgery, etc), anticipates missing class work:

1. notifies the Instructor at least one week in advance,
2. provides the Instructor with appropriate documentation.

A student who is absent due to other exceptional circumstances (e.g. death in immediate family, etc):

1. notifies the Instructor on or before the day in question,
2. is able to produce appropriate documentation upon request (e.g. death certificate, etc).

N.B. - A student who fails to comply with any or all of these rules may not be able to make up at for lost work. The decision on when and if special arrangements can be made will be at the discretion of the Instructor.

* "This certificate should indicate the dates and duration of the illness, when possible should describe the impact it had on the student's ability to fulfill academic requirements, and should



include any other information a health care professional considers relevant and appropriate.”
(Dalhousie UG Calendar)

Course Content

1. Foundations
 - 1.1 Introduction
 - 1.2 History
 - 1.3 Mutation and recombination
 - 1.4 Review of probability and Likelihood

2. Population genetics
 - 2.1 Introduction
 - 2.2 Hardy-Weinberg equilibrium
 - 2.3 Linkage disequilibrium
 - 2.4 Inbreeding
 - 2.5 Mutation
 - 2.6 Assortative mating
 - 2.7 Natural selection
 - 2.8 Genetic Drift
 - 2.9 Equilibrium polymorphism

3. Phylogenetics
 - 3.1 Introduction
 - 3.2 Phylogenetic homology
 - 3.3 Phylogenetic methods

4. Neutral evolution
 - 4.1 Genetic load
 - 4.2 Neutral theory
 - 4.3 Macroevolution
 - 4.4 Molecular clock

- 5 Functional divergence
 - 5.1 FFTNS and Shifting Balance
 - 5.2 Structure and function of genes and proteins
 - 5.3 Evolution of new genes
 - 5.4 Evolution of the molecular tool box
 - 5.5 Statistical tests
 - 5.6 Case studies

6. Fun stuff
 - 6.1 Ancient DNA studies
 - 6.2 Paleomolecular Archaeology
 - 6.3 Human origins

All course content will be distributed as slides and notes in PDF format via the course website.

ACCOMMODATION POLICY FOR STUDENTS

Students may request accommodation as a result of barriers related to disability, religious obligation, or any characteristic protected under Canadian Human Rights legislation. The full text of Dalhousie's Student Accommodation Policy can be accessed here:

http://www.dal.ca/dept/university_secretariat/policies/academic/student-accommodation-policy-wef-sep--1--2014.html

Students who require accommodation for classroom participation or the writing of tests and exams should make their request to the **Advising and Access Services Centre (AASC)** prior to or at the outset of the regular academic year. More information and the ***Request for Accommodation*** form are available at www.dal.ca/access.

ACADEMIC INTEGRITY

Academic integrity, with its embodied values, is seen as a foundation of Dalhousie University. It is the responsibility of all students to be familiar with behaviours and practices associated with academic integrity. Instructors are required to forward any suspected cases of plagiarism or other forms of academic cheating to the Academic Integrity Officer for their Faculty.

The Academic Integrity website (<http://academicintegrity.dal.ca>) provides students and faculty with information on plagiarism and other forms of academic dishonesty, and has resources to help students succeed honestly. The full text of Dalhousie's ***Policy on Intellectual Honesty*** and ***Faculty Discipline Procedures*** is available here:

http://www.dal.ca/dept/university_secretariat/academic-integrity/academic-policies.html

STUDENT CODE OF CONDUCT

Dalhousie University has a student code of conduct, and it is expected that students will adhere to the code during their participation in lectures and other activities associated with this course. In general:

"The University treats students as adults free to organize their own personal lives, behaviour and associations subject only to the law, and to University regulations that are necessary to protect

- the integrity and proper functioning of the academic and non – academic programs and activities of the University or its faculties, schools or departments;
- the peaceful and safe enjoyment of University facilities by other members of the University and the public;
- the freedom of members of the University to participate reasonably in the programs of the University and in activities on the University's premises;
- the property of the University or its members."

The full text of the code can be found here:

SERVICES AVAILABLE TO STUDENTS

The following campus services are available to help students develop skills in library research, scientific writing, and effective study habits. The services are available to all Dalhousie students and, unless noted otherwise, are free.

Service	Support Provided	Location	Contact
General Academic Advising	Help with <ul style="list-style-type: none"> - understanding degree requirements and academic regulations - choosing your major - achieving your educational or career goals - dealing with academic or other difficulties 	Killam Library Ground floor Rm G28 Bissett Centre for Academic Success	In person: Killam Library Rm G28 By appointment: <ul style="list-style-type: none"> - e-mail: advising@dal.ca - Phone: (902) 494-3077 - Book online through MyDal
Dalhousie Libraries	Help to find books and articles for assignments Help with citing sources in the text of your paper and preparation of bibliography	Killam Library Ground floor Librarian offices	In person: Service Point (Ground floor) By appointment: Identify your subject librarian (URL below) and contact by email or phone to arrange a time: http://dal.beta.libguides.com/sb.php?subject_id=34328
Studying for Success (SFS)	Help to develop essential study skills through small group workshops or one-on-one coaching sessions Match to a tutor for help in course-specific content (for a reasonable fee)	Killam Library 3rd floor Coordinator Rm 3104 Study Coaches Rm 3103	To make an appointment: <ul style="list-style-type: none"> - Visit main office (Killam Library main floor, Rm G28) - Call (902) 494-3077 - email Coordinator at: sfs@dal.ca or - Simply drop in to see us during posted office hours All information can be found on our website: www.dal.ca/sfs
Writing Centre	Meet with coach/tutor to discuss writing assignments (e.g., lab report, research paper, thesis, poster) <ul style="list-style-type: none"> - Learn to integrate source material into your own work appropriately - Learn about disciplinary writing from a peer or staff member in your field 	Killam Library Ground floor Learning Commons & Rm G25	To make an appointment: <ul style="list-style-type: none"> - Visit the Centre (Rm G25) and book an appointment - Call (902) 494-1963 - email writingcentre@dal.ca - Book online through MyDal We are open six days a week See our website: writingcentre.dal.ca

Faculty of Science Course Syllabus (Section B)
BIOL 3046
Molecular Evolution
Fall 2018

University Policies and Statements

This course is governed by the academic rules and regulations set forth in the University Calendar and by Senate

Academic Integrity

At Dalhousie University, we are guided in all of our work by the values of academic integrity: honesty, trust, fairness, responsibility and respect (The Center for Academic Integrity, Duke University, 1999). As a student, you are required to demonstrate these values in all of the work you do. The University provides policies and procedures that every member of the university community is required to follow to ensure academic integrity.

Information: https://www.dal.ca/dept/university_secretariat/academic-integrity.html

Accessibility

The Advising and Access Services Centre is Dalhousie's centre of expertise for student accessibility and accommodation. The advising team works with students who request accommodation as a result of a disability, religious obligation, or any barrier related to any other characteristic protected under Human Rights legislation (Canada and Nova Scotia).

Information: https://www.dal.ca/campus_life/academic-support/accessibility.html

Student Code of Conduct

Everyone at Dalhousie is expected to treat others with dignity and respect. The Code of Student Conduct allows Dalhousie to take disciplinary action if students don't follow this community expectation. When appropriate, violations of the code can be resolved in a reasonable and informal manner—perhaps through a restorative justice process. If an informal resolution can't be reached, or would be inappropriate, procedures exist for formal dispute resolution.

Code: https://www.dal.ca/dept/university_secretariat/policies/student-life/code-of-student-conduct.html

Diversity and Inclusion – Culture of Respect

Every person at Dalhousie has a right to be respected and safe. We believe inclusiveness is fundamental to education. We stand for equality. Dalhousie is strengthened in our diversity. We are a respectful and inclusive community. We are committed to being a place where everyone feels welcome and supported, which is why our Strategic Direction prioritizes fostering a culture of diversity and inclusiveness

Statement: <http://www.dal.ca/cultureofrespect.html>

Recognition of Mi'kmaq Territory

Dalhousie University would like to acknowledge that the University is on Traditional Mi'kmaq Territory. The Elders in Residence program provides students with access to First Nations elders for guidance, counsel and support. Visit or e-mail the Indigenous Student Centre (1321 Edward St) (elders@dal.ca).

Information: https://www.dal.ca/campus_life/communities/indigenous.html

Important Dates in the Academic Year (including add/drop dates)

https://www.dal.ca/academics/important_dates.html

University Grading Practices

https://www.dal.ca/dept/university_secretariat/policies/academic/grading-practices-policy.html

Missed or Late Academic Requirements due to Student Absence (policy)

https://www.dal.ca/dept/university_secretariat/policies/academic/missed-or-late-academic-requirements-due-to-student-absence.html

Student Resources and Support

Advising

General Advising https://www.dal.ca/campus_life/academic-support/advising.html

Science Program Advisors: <https://www.dal.ca/faculty/science/current-students/academic-advising.html>

Indigenous Student Centre: https://www.dal.ca/campus_life/communities/indigenous.html

Black Students Advising Centre: https://www.dal.ca/campus_life/communities/black-student-advising.html

International Centre: https://www.dal.ca/campus_life/international-centre/current-students.html

Academic supports

Library: <https://libraries.dal.ca/>

Writing Centre: https://www.dal.ca/campus_life/academic-support/writing-and-study-skills.html

Studying for Success: https://www.dal.ca/campus_life/academic-support/study-skills-and-tutoring.html

Copyright Office: <https://libraries.dal.ca/services/copyright-office.html>

Fair Dealing Guidelines <https://libraries.dal.ca/services/copyright-office/fair-dealing.html>

Other supports and services

Student Health & Wellness Centre: https://www.dal.ca/campus_life/health-and-wellness/services-support/student-health-and-wellness.html

Student Advocacy: <https://dsu.ca/dsas>

Ombudsperson: https://www.dal.ca/campus_life/safety-respect/student-rights-and-responsibilities/where-to-get-help/ombudsperson.html

Safety

Biosafety: <https://www.dal.ca/dept/safety/programs-services/biosafety.html>

Chemical Safety: <https://www.dal.ca/dept/safety/programs-services/chemical-safety.html>

Radiation Safety: <https://www.dal.ca/dept/safety/programs-services/radiation-safety.html>

Scent-Free Program: <https://www.dal.ca/dept/safety/programs-services/occupational-safety/scent-free.html>