

# BIOL 440

## Speciation and Macroevolution

Autumn Term (2024-25)

**CALENDAR DESCRIPTION:** An exploration of higher-level processes in evolution spanning considerations of mechanisms of speciation, extinction, adaptive radiation, and phylogenetics.

PREREQUISITE (BIOL 300/3.0 or BIOL 302/3.0 or BIOL 303/3.0) and a minimum GPA of 2.0 in the Biological Foundations List.

Biological Foundations List

BIOL 102/3.0; BIOL 103/3.0; BIOL 200/3.0; BIOL 201/3.0; BIOL 202/3.0; BIOL 205/3.0; BIOL 206/3.0; BIOL 212/3.0; BIOL 300/3.0; BIOL 330/3.0; BIOL 334/3.0; BIOL 339/3.0; BIOL 341/3.0; BIOL 302/3.0; BIOL 303/3.0

**Instructor:** See onQ

**Instructor Contact:** See onQ

**Office Hours:** By appointment. We will set up some regular sessions during the term.

**TAs:** See onQ

**TA Contact Information:**

**Teaching Modality:** In class

**Important University Dates:**

- *Tuesday September 3, 2024:* Fall term classes begin
- *Monday September 16, 2024:* Last date to drop Fall Term and multi-term classes without financial penalty
- *Monday September 30, 2024:* National Day of Truth and Reconciliation (classes cancelled)
- *Monday October 14, 2024:* Thanksgiving Day (no classes)
- *Tuesday October 15, 2024 to Friday October 18, 2024:* Fall mid-term break
- *Tuesday October 15, 2024:* Last date to apply in SOLUS to graduate in Fall 2023.
- *Monday October 28, 2024:* Last date to drop Fall Term classes without academic penalty
- *Monday November 11, 2024:* Remembrance Day observance Classes cancelled 10:30-11:30
- *Sunday December 1, 2024:* First date to apply in SOLUS to graduate in Spring 2024
- *Tuesday December 3, 2024:* Fall term classes end

**Welcome Message:** Welcome to Biology 440 an in-depth exploration of mechanisms and genetics of speciation, but also of deep time evolution and the history of life on earth. The course we will create together emphasizes curiosity-driven research and exploration of the literature, peer engagement and collaboration, and hands-on work in the field of phylogenetics through a mixture of lectures, tutorials, and a final term essay where you will undertake focused research on a specific issue or phenomenon. We will use an OnQ portal for much of the material and indeed most of what we see here in the Syllabus is iterated there. We also emphasize peer review and you will be asked to grade your fellow students

assignments (assessing the work of others often helps you hone your own skills). The TAs and I are excited to offer this year's incarnation of BIOL440.

**Equity, Diversity, and Inclusivity Statement:** Queen's is committed to counteracting discrimination in this institution and developing a climate of educational equity that recognizes and respects the equal dignity and worth of all who seek to participate in the life, work, and mission of the University. Such a climate is created and maintained by developing a university-wide commitment to and understanding of educational equity, supported by policies, programs, curricula, practices, and traditions that facilitate individuals - and equity-seeking groups- free, safe, and full participation.

**Land Acknowledgement:** I understand that the territory upon which Queen's University lies is included in the *Dish With One Spoon Wampum Belt Covenant*, an agreement between the Iroquois Confederacy and the Confederacy of the Ojibwe and Allied Nations to peaceably share and care for the resources around the Great Lakes. The Kingston Indigenous community continues to reflect the area's Anishinaabek and Haudenosaunee roots. There is also a significant Métis community as well as First Peoples from other Nations across Turtle Island present here today."

**Expectations:** This is a fourth-year class and presumably you have chosen it because you have at least a molecule of interest in evolution and understanding where diversity comes from. As I am passionate about evolutionary biology and natural history, I can promise enthusiasm and dedicate to the course material. I encourage open discussion and ask (expect) interactions and constructive discussions in class and tutorial. Throughout this course, there will be opportunities for you to interact with me, your TAs, and your classmates. Students will interact with their peers particularly during tutorial sessions. We expect you to behave with integrity always, both in in-person interactions and when engaging with each other online. See the Netiquette guidelines below which I expect each of us to adhere to when interacting with one another whether in person or online.

**Course Overview:** This course explores evolutionary processes and the patterns that they produce at and above the species level. We'll begin with a brief reprise of microevolution and the purported distinction between it and macroevolution, if indeed such demarcation can be sharply drawn and is useful. This is followed by detailed considerations of theoretical underpinnings and empirical examinations of models and genomics of speciation (contrasting different mechanisms), adaptive radiation, evo/devo, cladogenesis, and origins of higher-order taxa, and reconstructions of evolutionary history of focal groups of species. Later in the course we explore deep-time evolution including such things as the causes, rates, and consequences of mass extinction. Of particular emphasis will be the vastness of time over which life on earth has evolved and the different eons, periods and epochs of geological/evolutionary time and the hallmark events that demarcate them.

**Learning Objectives:** Biology 440 explores evolutionary processes and the patterns that they produce at and above the species level. The course also aims to promote critical thinking and improve students' scientific literacy and writing skills. To these ends the course uses a mixture of lectures, interactive tutorials, group research projects, and individual research essays. Students will explore papers from the primary scientific literature, as well as using reviews and texts. After taking this course, the student should have:

- A strong understanding of evolutionary principles and main genetic mechanisms.
- An appreciation of evolutionary time scales and major events in the fossil record.
- Opinions about the relationship between micro- and macroevolution.
- An understanding of theory underlying speciation and extinction and knowledge of salient examples.
- An appreciation of the diversity of research and analytical approaches used to study evolutionary processes.
- Improved writing and presentation skills.

**Assignment 1** students will provide a better understanding of the diversity within the current cadre of practicing academic evolutionary biologists.

**Assignment 2** students will provide opportunities for students to interpret, synthesize, and present the evolutionary and natural history of one species and its relatives.

**Assignment 3** will provide students with an opportunity to learn how to manipulate, align, and analyze DNA sequences to generate phylogenies, and use these phylogenies to address major evolutionary hypotheses.

Through the **term paper** students will gain skills in critically reviewing the primary, peer-reviewed literature and exploring current controversies on a major theme in speciation and deep-time evolution.

**Approximate Learning Hours**

| <i>Teaching method</i> |                        | <i>Average hours/wk</i> | <i>Number of weeks</i> | <i>Total hours</i> |
|------------------------|------------------------|-------------------------|------------------------|--------------------|
| In-class hours         | Lecture                | 2                       | 12                     | 24                 |
|                        | Seminar                |                         |                        |                    |
|                        | Laboratory             |                         |                        |                    |
|                        | Tutorial               | 2.5                     | 10                     | 25                 |
|                        | Practicum              |                         |                        |                    |
|                        | Group learning         | 4                       | 5                      | 20                 |
| Other                  | Individual instruction |                         |                        |                    |
|                        | Online activity        | 1.25                    | 12                     | 15                 |
|                        | Off-campus activity    |                         |                        |                    |
|                        | Private study          | 3                       | 12                     | 36                 |
| Total hours on task    |                        |                         |                        | <b>120</b>         |

**Course Outline: Main Topics**

- Review of microevolutionary principles and distinct features of macroevolution
- Species concepts
- Ecological versus geographical models of speciation
- Sexual selection, sexual conflict and speciation
- Phylogenetics and phylogenomics
- Introduction to biogeography
- The genomics of speciation
- Coevolution & co-speciation
- Palaeontology and the fossil record
- Evolutionary developmental biology (EVO/DEVO)
- Causes and patterns of extinction

**Textbooks/Readings**

There is no comprehensive textbook on both speciation and macroevolution. Assigned and recommended readings vary from year to year and are available on the course OnQ site.

**Grading Scheme (considered final after first week)**

| Component  | Weight | Date                 |
|--|--------|----------------------|
| Weekly Quizzes (12 X 2%)   | 24%    | Throughout the term  |
| Introductory survey – 1% for completing                              | 1%     | September            |
| Exit survey – 1% for completing                                      | 1%     | November             |
| Assignment 1 (biographies of evolutionary biologists - written bio)  | 8%     | September            |
| Assignment 1 (biographies of evolutionary biologists - presentation) | 4%     | September            |
| Assignment 2 (evolutionary & natural history of local taxon)         | 12%    | October              |
| Assignment 3 (group phylogenetic project)                            | 20%    | November             |
| Term paper - critical review   | 30%    | Second week December |

***There is no final exam***

**BIOL440 Class Schedule 2024**

| WEEK & DATES                     | MATERIAL  | ASSIGNMENTS & ACTIVITIES  |
|----------------------------------|---|---|
| <b>Week 1:</b> Sept. 3-6         | Lecture 1   | Read the course Syllabus and review the structure and content of the course including assignments.<br><br><i>No tutorials</i><br><br>Quiz for Week 1<br><br><ul style="list-style-type: none"> <li>• Opens Tuesday Sept. 3<sup>rd</sup> at 6:00 am</li> <li>• Closes Sunday Sept. 8<sup>th</sup> at 11:59 pm</li> </ul>   |
| <b>Week 2:</b> Sept. 9-13        | Lectures 2 & 3                                      | Introduction to the tutorials & organization<br><br>Quiz for Week 2<br><br><ul style="list-style-type: none"> <li>• Opens Monday September 9<sup>th</sup> 6:00 am</li> <li>• Closes Sunday September 15<sup>th</sup> 11:59 pm</li> </ul>  |
| <b>Week 3:</b> Sept. 16-20       | Lectures 4 & guest lecture from Dr. Dilini Abeyrama | <i>Tutorials:</i> Work session for Assignment 1<br><br>Quiz for Week 3<br><br><ul style="list-style-type: none"> <li>• Opens Monday September 16<sup>th</sup> 6:00 am</li> <li>• Closes Sunday September 22<sup>nd</sup> 11:59 pm</li> </ul> <p><b>Sunday Sept. 22<sup>nd</sup> midnight</b> Submission to your respective tutorial sessions - Assignment 1 presentation slides in PDF format</p> |
| <b>Week 4:</b> Sept. 23-Sept. 27 | Lectures 5 & 6                                      | <i>Tutorials:</i> Assignment 1 presentations (in your respective sections).<br><br>Quiz for Week 4<br><br><ul style="list-style-type: none"> <li>• Opens Monday September 23<sup>rd</sup> 6:00 am</li> <li>• Closes Sunday September 29<sup>th</sup> 11:59 pm</li> </ul>  |
| <b>Week 5:</b> Oct. 1-Oct. 4     | Lectures 7 & 8                                      | <i>Tutorials:</i> Assignment 1 presentations (in your respective sections).<br>Brief introduction to Assignment 2   |

|  |                  |  |
|--|------------------|--|
|  |                  | <p>Quiz for Week 5</p> <ul style="list-style-type: none"> <li>• Opens Monday October 1<sup>st</sup> 6:00 am</li> <li>• Closes Sunday October 6<sup>th</sup> 11:59 pm</li> </ul> <p>All grades for Assignment 1 presentations to have been completed by Friday October 4<sup>th</sup> at midnight.</p> <p><b>Sunday October 6<sup>th</sup> at midnight:</b> Submit written biographies to FeedBack Fruits</p> |
| <b>Week 6:</b> Oct. 7- Oct. 11         | Lectures 9 & 10  | <p><i>Tutorial:</i> Work session for species presentations</p> <p>Quiz for Week 6</p> <ul style="list-style-type: none"> <li>• Opens Monday October 7<sup>th</sup> 6:00 am</li> <li>• Closes Sunday October 13<sup>th</sup> 11:59 pm</li> </ul> <p><b>Sunday Oct. 13<sup>rd</sup> midnight:</b> Submit grades for three peers via FeedBack Fruits</p>  |
| <b>Reading Week:</b> Oct. 14 – Oct. 18 | na               | <b>Deadlines.</b> Sunday October 20 <sup>th</sup> midnight. Submit your species presentation slides by midnight in PDF format.   |
| <b>Week 7:</b> Oct. 21- Oct. 25        | Lectures 11 & 12 | <p><i>Tutorials:</i> Assignment 2 presentations (in your respective sections).</p> <p>Quiz for Week 7</p> <ul style="list-style-type: none"> <li>• Opens Monday October 21<sup>st</sup> 6:00 am</li> <li>• Closes Sunday October 27<sup>th</sup> 11:59 pm</li> </ul>   |
| <b>Week 8:</b> Oct. 28 – Nov. 1        | Lectures 13 & 14 | <p><i>Tutorials:</i> Assignment 2 presentations (in your respective sections)</p> <p>Quiz for Week 8</p> <ul style="list-style-type: none"> <li>• Opens Monday October 28<sup>th</sup> 6:00 am</li> <li>• Closes Sunday November 3<sup>rd</sup> 11:59 pm</li> </ul> <p><b>Sunday Nov. 3<sup>rd</sup> midnight:</b> Submit grades for species presentations via FeedBack Fruits</p>                           |
| <b>Week 9:</b> Nov. 4 - Nov. 8         | Lectures 15 & 16 | <p><i>Tutorials:</i> Phylogenetics practicum. Sierra finches.</p> <p>Quiz for Week 9</p> <ul style="list-style-type: none"> <li>• Opens Monday November 4<sup>th</sup> 6:00 am</li> <li>• Closes Sunday November 10<sup>th</sup> 11:59 pm</li> </ul>   |
| <b>Week 10:</b> Nov. 11 - Nov. 15      | Lectures 17 & 18 | <p><i>Tutorials:</i> Phylogenetics work session</p> <p>Quiz for Week 10</p> <ul style="list-style-type: none"> <li>• Opens Monday November 11<sup>th</sup> 6:00 am</li> <li>• Closes Sunday November 17<sup>th</sup> 11:59 pm</li> </ul> <p><b>Sunday November 17<sup>th</sup> midnight:</b> Submit slides for Assignment 3</p>  |
| <b>Week 11:</b> Nov. 18 - 22           | Lectures 19 & 20 | <p><i>Tutorials:</i> Group phylogenetics presentations in your respective tutorial sections</p> <p>Quiz for Week 10</p>  |

|                                   |                  |  |
|-----------------------------------|------------------|--|
|                                   |                  | <ul style="list-style-type: none"> <li>• Opens Monday November 18<sup>th</sup> 6:00 am</li> <li>• Closes Sunday November 24<sup>th</sup> 11:59 pm</li> </ul>   |
| <b>Week 12:</b> Nov. 25 - Nov. 29 | Lectures 21 & 22 | <p><i>Tutorial:</i> Group phylogenetics presentations in your respective tutorial sections</p> <p>Quiz for Week 11</p> <ul style="list-style-type: none"> <li>• Opens Monday November 25<sup>th</sup> 12:01 am</li> <li>• Closes Sunday December 1<sup>st</sup> 11:59 pm</li> </ul> <p><b>Tuesday December 3<sup>rd</sup> midnight:</b> Submit peer evaluations for phylogenetics projects</p> |

*Your critical review term paper is due Monday December 16<sup>th</sup> 2024 at 11:59 pm You must start your essay well before the end of term as we cannot allow extensions and still have sufficient time to grade your papers.*

**Grading Method**

In this course, all components will be graded using numerical percentage marks. When letter grades are employed, the following scale will be used for calculating your course average:

**Arts & Science Letter Grade Input Scheme**

| Assignment mark | Numerical value for calculation of final mark |
|-----------------|---|
| A+              | 93  |
| A               | 87  |
| A-              | 82  |
| B+              | 78  |
| B               | 75  |
| B-              | 72  |
| C+              | 68  |
| C               | 65  |
| C-              | 62  |
| D+              | 58  |
| D               | 55  |
| D-              | 52  |
| F48 (F+)        | 48  |
| F24 (F)         | 24  |
| F0 (0)          | 0   |

Your course average will then be converted to a final letter grade according to Queen’s Official Grade Conversion Scale:

**Queen’s Official Grade Conversion Scale**

| Grade | Numerical Course Average (Range) |
|-------|----------------------------------|
| A+    | 90-100                           |

|    |              |
|----|--------------|
| A  | 85-89        |
| A- | 80-84        |
| B+ | 77-79        |
| B  | 73-76        |
| B- | 70-72        |
| C+ | 67-69        |
| C  | 63-66        |
| C- | 60-62        |
| D+ | 57-59        |
| D  | 53-56        |
| D- | 50-52        |
| F  | 49 and below |

### **Academic Integrity**

Queen's students, faculty, administrators and staff all have responsibilities to uphold the fundamental values of academic integrity; honesty, trust, fairness, respect, responsibility and courage. These values are central to building, nurturing, and sustaining an academic community in which all members of the community will thrive. Adherence to the values expressed through academic integrity forms a foundation for the "freedom of inquiry and exchange of ideas" essential to the intellectual life of the University (see the Senate Report on Principles and Priorities).

Students are responsible for familiarizing themselves with the regulations concerning academic integrity and for ensuring that their assignments and their behaviour conform to the principles of academic integrity. Information on academic integrity is available in the Arts and Science Calendar (see [Academic Regulation 1](#)), on the [Arts and Science website](#), and from the instructor of this course. Departures from academic integrity include plagiarism, use of unauthorized materials, facilitation, forgery, use of forged materials, contract cheating, unauthorized use of intellectual property, unauthorized collaboration, failure to abide by academic rules, departure from the core values of academic integrity, and falsification, and are antithetical to the development of an academic community at Queen's. Given the seriousness of these matters, actions which contravene the regulation on academic integrity carry sanctions appropriate to the severity of the departure that can range from a warning or the loss of grades on an assignment to the failure of a course to a requirement to withdraw from the university.

### ***Plagiarism***

Please note that we have had issues in the past with unintended plagiarism in this course, particularly in the final essay. Regardless of how and where you retrieve information, the principles of academic integrity apply. Please visit these helpful websites to help you to write things in your own words:

- <https://www.queensu.ca/academicintegrity/students/avoiding-plagiarismcheating>
- <https://integrity.mit.edu/handbook/academic-writing/avoiding-plagiarism-paraphrasing>
- [http://writing.wisc.edu/Handbook/QPA\\_paraphrase.html](http://writing.wisc.edu/Handbook/QPA_paraphrase.html)

### ***Group Work***

- You are encouraged to consult with your peers on course work, but individual assignments are to be your own work. Assignment 3 is expressly designed as a collaborative project among small groups of students – you are asked here expressly to collaborate and present together.
- We all share in maintaining a culture of integrity, if you become aware of anyone trying to share, or solicit, answers to quizzes, please remind them that this is against the rules and inform your TA or instructor immediately.

### **Copyright**

Course materials created by me or TAs, including all slides, presentations, handouts, tests, exams, and other similar course materials, are our intellectual property. It is a departure from academic integrity to distribute, publicly post, sell or otherwise disseminate an instructor's course materials or to provide an instructor's course materials to anyone else for distribution (including note sharing sites), posting, sale or other means of dissemination without the instructor's express consent. A student who engages in such conduct may be subject to penalty for a departure from academic integrity and may also face adverse legal consequences for infringement of intellectual property rights.

### **Netiquette**

In any course you often communicate with your peers and teaching team through electronic communication. You are expected to use the utmost respect in your dealings with your peers.

Here is a list of netiquette guidelines. Please read them carefully and use them to guide your communication in this course and beyond.

- Make a personal commitment to learn about, understand, and support your peers.
- Assume the best of others and expect the best of them.
- Acknowledge the impact of oppression on the lives of other people and make sure your writing is respectful and inclusive.
- Recognize and value the experiences, abilities, and knowledge each person brings.
- Pay close attention to what your peers write before you respond. Think through and re-read your writings before you post or send them to others.
- It's ok to disagree with ideas, but do not make personal attacks. Be generous in your discourse.
- Be open to being challenged or confronted on your ideas and to challenging others with the intent of facilitating growth. Never demean or embarrass others.
- Encourage others to develop and share their ideas.

### **Course Technology**

In this course we may use the following additional technology/software:

- Feedback Fruits (yah I didn't name it ... It is to enable peer review)
- MEGA
- Clustal
- BLAST
- MrBayes
- BEAUTI & BEAST

**Late Policy:** Because assignments involve peer assessment and in-class presentations deadlines for tutorial assignments cannot be altered. If you anticipate issues or become ill we will of course work to accommodate you. For your term essay, you will lose 10% for each day past the deadline. Please approach Dr. Lougheed in advance should this be an issue.

**Attendance:** It is easy to blow off in class lectures. Please note that quizzes are based on material that I present in lecture – and this is not always readily decipherable from PDFs (relevant to quizzes). Note too that if you are seeking to get something out of the course class engagement and discussion are indispensable.