Biology 488/588
Evolutionary Processes
Fall 2023

Instructor: Matt Streisfeld
Office hours: Tuesday, 3:00 – 4:30, or by appointment
Office location: Onyx Bridge 267A
email: mstreis@uoregon.edu (include BI 488/588 in the subject line of all emails)

Meeting Times: T/Th 10:00-11:20
Location: Tykeson 240

Course Description: A major goal of evolutionary biology is to understand the processes that generate and maintain patterns of variation in nature. In addition, it is well-known that organisms routinely show a remarkable fit with their environments, suggesting that these phenotypes are adaptive. However, there are several ecological and evolutionary processes that can operate to produce similar patterns of phenotypic variation in nature. So what are the tools that we - as evolutionary biologists - use to determine whether a phenotypic trait is adaptive in nature? The main goal of this course is to learn how evolutionary biologists experimentally study adaptation and speciation. Such a course is interdisciplinary, in that it unites several areas of biology, including ecology, genetics, statistics, molecular biology, and genomics. By the end of the term, you will have an appreciation for the different techniques and skills that are required to understand the evolutionary process.

Learning outcomes:

- Demonstrate how the evolutionary process is used to understand the process of adaptation
- Become proficient in critical thinking based on evaluation of data from the primary literature
- Analyze data from the primary literature using statistical and population genetic approaches
- Develop verbal and written communication skills through in-class discussion and assignments

Prerequisite: BI 380, Evolution; or Instructor approval

Details: This is an advanced, upper-level biology course. It should be challenging, but fun. Our meetings will be a mix of discussion and lecture. **I expect that you will come prepared to each class for a lively discussion.** This is an advanced course in evolutionary biology. As such, I expect that you are comfortable with basic evolutionary theory, such as population genetics. To make sure that we are on the same page, during the first week, I will provide you with an overview of the basic concepts that are necessary for you to be successful in this class. However, if these topics are not familiar to you, or if you would like a better foundation in basic evolutionary theory, I strongly recommend that you do some additional background reading. If you would like information on appropriate reading, please see me.

Because the statistics, techniques, and advances in this area are ever-changing, there is no textbook that covers all of the relevant topics. Therefore, we will use the primary literature as our guide to the approaches that currently are being used in the field. Some days will be entirely lectures from me that introduce a new topic to you. Other days will be discussion only - you will read a paper related to the topic and we will discuss it. Finally, other days will include both lectures and discussions of papers. The plan here is for me to introduce a new topic to you at the end of the previous meeting. You will then read a paper from the primary literature related to this topic and we will discuss it during the next class period. This will allow you to have the necessary background from my lectures to allow you to understand the details in the papers.

Readings: Papers from the primary literature constitute all of the reading for the course. All papers are available on Canvas as pdfs for download. Readings must be completed by the time of the class meeting in which they will be discussed. **Class participation is essential to an intellectually lively course; it will also contribute to your grade.**

I have chosen these papers because they are either technical descriptions of a relevant approach in the field or because they represent exemplar cases that experimentally use these approaches. Many of the papers will contain lots of technical information. It is OK if you don't understand everything when you read the paper. The purpose of the discussion is for the entire class to work through the papers to gain a better understanding of the material. **You should come to class prepared with questions about what you didn't understand.** Some questions to ask yourself when you read each paper:

- What is the purpose of this paper?
- What is the main question that the authors ask?
- What are the main findings? Can I explain what each figure represents?
- Do the findings support the conclusions that the authors draw?

Assessment:

Homework: There will be three homework problem sets that you will need to complete. They will be administered via Canvas. I will provide you with a data-set or set up an experimental situation, and you will be required to analyze and interpret the data using methods that we learn about in class. These will be due in weeks 3, 6, and 9. You are expected to work on these by yourself.

Annotated Bibliography: Over the course of the term, you will be reading 12 important papers in evolutionary biology. In order to help you develop the skills needed to become better at reading scientific papers, you will generate an annotated bibliography of these papers throughout the term. Each day that we read a new paper (see schedule below), you will write a 3-4 sentence summary of the paper. By the end of the term, this will give you an excellent reference of some of the most important works in this field. In writing your summary, I want you to focus on: 1) the main question being asked, and 2) the major conclusion(s) of the study. In addition, by summarizing these findings, you will be prepared for the day's discussion. You will be graded on the quality of the writing (0.5 points) and its content (1 point). These will be due by the beginning of our class period (on the days we discuss papers). Due dates are included on the Canvas assignment. When there are two papers assigned for a particular day, you will write a summary (and will be graded) separately on both papers. Late assignments do not receive credit. In total, this is worth 18% of your grade.

You will complete these assignments by submitting your entry in a Canvas text box for each day that a paper is assigned.

Presentations: In the last week of the term, we will switch from my instruction of content to student group presentations of case studies on adaptation. The goal of this assignment will be for the students in the class to show each other (and me) what they have learned throughout the class by comprehensively reviewing and synthesizing a case study on adaptation. Students will form groups (2-3 people per group) and critically examine one of the case studies of adaptive evolution provided below. Currently, these are recognized as some of the most complete studies of adaptive evolution. <u>It is your job to determine how well the investigators have done characterizing the different aspects of the evolutionary process</u>.

Groups will sign up for a presentation slot in Week 3. The length of the presentations will be based on how many students are enrolled in the class and how many groups there are. I will provide more specifics on the length of presentations when you sign up. Groups will present their findings to the class in a roughly 20-minute Powerpoint (or similar) presentation (18 minute presentation and 2 minutes for questions). Again, this length is subject to change.

There should be three parts to the presentation that are integrated into a comprehensive oral argument: 1) an introduction that defines adaptation, how you test for it, and what are the challenges of testing/studying it; 2) a literature review of the relevant studies from your case study, which includes an introduction to the important details of the organisms, their habitat, etc; and 3) your assessment of whether the authors have convincingly identified adaptation (ie., a conclusion). This final area requires that you defend your point using specific examples. Typically, the study of adaptive evolution is a long-term research objective. Therefore, you should not expect to find all of the relevant information in a single paper. Instead, I expect that you will read the literature thoroughly and present a <u>summary</u> of the background literature on the study system, and then critically interpret the significance of these results for the study of adaptation. Your presentations should be visually appealing and include not only text, but also images and relevant figures that support your perspective.

Your grade will be determined using the following rubric, scored on a 1-4 scale for each item:

1) Content - have you reviewed the relevant literature and presented it accurately? (50%)
2) Clarity - flow, style, is it visually appealing? have you practiced? (25%)
3) Is there a clear and convincing argument made? Are the conclusions supported by the evidence presented? (25%)

Some notes on this assignment: I do not want you to simply restate the results from these studies. Rather, I am looking for you to synthesize the findings related to potential adaptation. Then, I want you to use what you have learned throughout the class to make a **coherent and evidence-based argument** about the various components of the adaptive process in the system you choose. There is no right or wrong answer to this … what I want is to see you critically think about the topic and clearly describe your perspective of the case study you have chosen.

To search for papers, I would recommend using Google Scholar. In addition, PubMed Central (http://www.ncbi.nlm.nih.gov/pubmed) and ISI Web of Science (http://www.isiknowledge.com) may be useful. Google Scholar and Pubmed can be accessed from any computer; web of science requires a UO IP address. To be able to download many of the papers, however, you also will need a UO IP address. Alternatively, if you are off campus, you can download the UO VPN to connect to the UO servers and access the online articles through the UO library. Details can be found here (https://service.uoregon.edu/TDClient/2030/Portal/KB/ArticleDet?ID=31471).

Case Studies

1) Coat color variation in *Peromyscus* deer mice (Nebraska sand hills). Be sure that you are examining the correct system, as there are two sets of populations studied for coat coloration in *Peromyscus*.
   Lead author: Hopi Hoekstra.

2) Speciation due to wing patterning in South American *Heliconius* butterflies.
   Lead authors: Chris Jiggins, W. Owen McMillan, James Mallet

3) The Long Term Evolution Experiment (LTEE) in *E. coli*.
   Lead author: Rich Lenski.

4) Adaptive radiation and speciation in African cichlid fish.
   Lead authors: Axel Meyer, Walter Salzburger, Ole Seehausen

5) Adaptation to drought/flowering time/life history in *Mimulus guttatus*.
   Lead authors: John Willis, David Lowry, Jannice Friedman.

6) Ecological speciation in monkeyflowers (*Mimulus cardinalis* and *M. lewisii*).
   Lead authors: Doug Schemske, HD Bradshaw, Jr., Amy Angert, Lila Fishman

Evaluation: Your final grade will be determined as follows:

	Percent of Final Grade:
Presentation	30%
Problem sets (3)	45% (15% each)
Annotated Bibliography	18%
Participation	7%

Please note that late assignments will incur a 5% penalty per day and will not be accepted after the assignment closes on Canvas (and/or the answer key is posted). Bibliographies will not be accepted after the beginning of class on the day that paper is discussed.

A final score of 68% is required to receive a passing grade (P/C-).

Academic Integrity: I have a zero tolerance policy for cheating, plagiarism, or any other form of academic dishonesty. For this course, that means your paper and assignments must be your work, and all references to others' scholarship should be properly cited. All persons involved in academic dishonesty will be disciplined in accordance with University regulations and procedures.

Students with Disabilities: The University of Oregon is working to create inclusive learning environments. Please notify me if there are aspects of the instruction or design of this course that result in disability-related barriers to your participation. You are also encouraged to contact the Accessible Education Center in 164 Oregon Hall at 541-346-1155 or *uoaec@uoregon.edu*.

Date	Discussion Topic (I will present lectures on each discussion topic in the class period before they are discussed)	Readings (Bibliography due this day of class)
26-Sept	Course introduction, review of genetic and evolution terms	None
28-Sept	Population genetics: review; selection vs. drift	Schemske and Bierzychudek 2001
3-Oct	Quantitative genetics: introduction	Conner 2002
5-Oct	Quantitative genetics and recombination: continued First discussion: What is (and is not) adaptation?	Gould and Lewontin 1979 Barrett and Hoekstra 2011
10-Oct	Phenotypic selection: direct vs indirect; univariate/ multivariate	--
12-Oct	Phenotypic selection: direct vs indirect; univariate/ multivariate (discussion) **1st Homework Due**	--
17-Oct	Phenotypic selection: direct vs indirect; univariate/ multivariate (discussion)	Grant and Grant 1993, 1995
19-Oct	Population differentiation – Fst	Lowry et al. 2008
24-Oct	Population differentiation - Structure	--
26-Oct	Molecular population genetics – introduction	Sabeti et al. 2006
31-Oct	Molecular population genetics – single genes	Wang et al. 1999
2-Nov	Population genomic scans for selection **2nd Homework Due**	Hohenlohe et al 2010
7-Nov	Speciation genomics – introduction	--
9-Nov	Speciation genomics - discussion	Ellegren et al. 2012
14-Nov	Finding the genes – QTL mapping (lecture)	--
16-Nov	Finding the genes – QTL mapping (discussion)	Steiner et al. 2007
21-Nov	Catch-up and conclusions **3rd Homework Due**	TBD
23-Nov	*Thanksgiving – No Class*	--
28-Nov	**Student Presentations 1**	--
30-Nov	**Student Presentations 2**	--