Molecular Ecology (Biology 327)

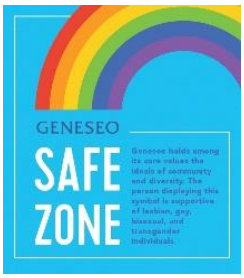
Spring 2024

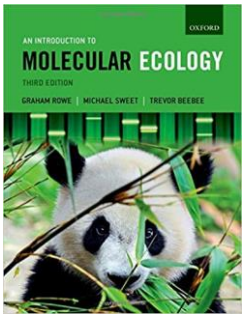
(T R 9:30 – 10:45 am ISC 137)

Course overview

Molecular ecology is a young and exciting field that is taking advantage of the rapid development of new techniques in molecular genetics as well as advances in the theoretical and statistical approaches to interpreting the wealth of molecular data now available. These new techniques permit ecologists and evolutionary biologists to address questions in a wide variety of research areas, including phylogeography, population genetics, conservation genetics, behavioral ecology, microbial ecology, adaptation, ecological genetics, hybridization, and speciation. By providing new tools for testing hypotheses, the employment of molecular markers has revolutionized many of these research areas. While molecular ecology is a technologically rich discipline, its roots, and indeed its relevance, lie in one of the oldest scientific pursuits—natural history. Observations of the natural variation within and between organisms inspire the research questions pursued by molecular ecologists. These research efforts utilizing molecular approaches often help provide answers relevant to another long-lived scientific pursuit—the study of evolutionary processes and patterns. Through this course, I hope that in addition to appreciating the tools that molecular ecology employs, you will also marvel at the fascinating stories of natural history, evolution, and diversity that molecular ecology can tell.

Course details





Instructor: Dr. Jennifer L. Apple (*she/her/hers*) Office: ISC 258 Lab: ISC 340
e-mail: applej@geneseo.edu Phone: 245-5442

Office hours: To be determined

Course description from Bulletin: This course explores how molecular methods are used to address research questions in ecology. The techniques for generating molecular marker data as well as the properties and applications of different types of molecular data will be examined. Topics will include phylogeography, population genetics, conservation genetics, behavioral ecology, adaptation, ecological genetics, speciation, hybridization, and microbial ecology.

Prerequisites: Biol 203 and Biol 222

What you will need: Internet access, computer with Microsoft Word, Microsoft Excel, R, and RStudio installed

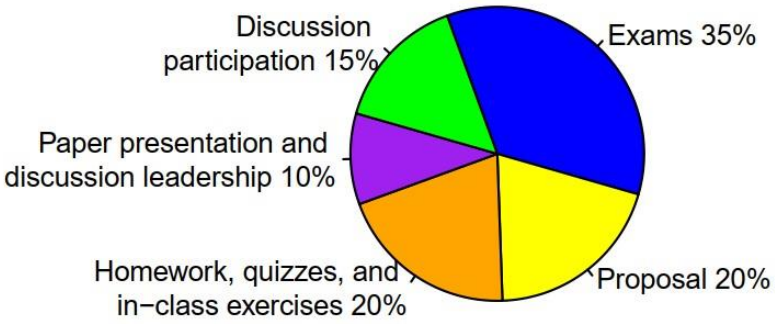
Required text: *Introduction to Molecular Ecology* (3rd ed, 2017) by Graham Rowe, Michael Sweet, and Trevor Beebee (ISBN:978-0198716990).

Learning outcomes

Upon completion of this course, successful students will be able to:

- identify and describe the common contemporary molecular methods and analyses used to address ecological questions
- describe the wide range of research directions that comprise the field of molecular ecology and the common molecular approaches to these research questions
- interpret data from common analyses employed in molecular ecological studies
- effectively communicate the interpretation and significance of research findings
- thoughtfully discuss and evaluate the conclusions reached in scientific papers based on the presented results and proposed hypotheses
- explore, interpret, and synthesize the primary literature to develop a written proposal for addressing an original ecological or evolutionary research question using molecular tools

How is your grade determined?



Exams (35% of grade)

Both exams for this course (a mid-term and final) will be take-home exams. You will be given each exam at least one week in advance of its due date. The exams will include a combination of essay questions, problem-solving exercises, data analysis using population genetics computer programs, and interpretation of data. You may use your textbook, notes, and other materials to answer these questions, but you may not discuss the exam with classmates or seek help from anyone in responding to the questions. (You may ask questions of me for clarification, if necessary.) You must cite information from all sources and observe the policy on plagiarism described below.

Paper presentation and discussion leadership (10% of grade)

You will work with a partner to present and guide discussion on a primary research paper. Your presentation should be a brief (≈15 minutes) but well-organized introduction to the paper which provides relevant background about the study system and research question(s) including reference to previous work from other studies. It should also provide a brief overview of the methods and include effective visual aids to enhance our understanding of the study system and approach. You and your partner will facilitate participation of all class members in the discussion of the paper by preparing engaging discussion questions. See Brightspace for more details.

Participation in class discussions (15% of grade)

We will be exploring the primary literature in molecular ecology through in-class discussion of original research papers. Everyone should read the papers carefully and critically in preparation for these discussions. Verbal participation in these discussions is expected and will be 60% of your participation grade. On the day of the discussion, you must hand in four thoughtful questions or comments (a typed, hard copy) for *each* paper being discussed that day; these questions/comments will not be accepted late since their purpose is to prepare you to discuss the paper in class. You will also be given a short in-class quiz on the reading (based on questions posted in advance). Scores on this quiz and your written questions/comments will make up 40% of your participation grade.

Written proposal (20% of grade)

You will develop and write a proposal (8-12 pages) for a study that employs molecular tools to address a particular ecological or evolutionary question. The project you propose must be *original* and *feasible*. Detailed guidelines for this assignment are provided on Brightspace.

Homework, quizzes, and in-class exercises (20% of grade)

Throughout the course, we will have in-class activities or homework assignments that reinforce the concepts we are studying. Some of these exercises will require your laptop computers, as we work with software commonly used by molecular ecologists. Some in-class activities may require additional work outside of class that you will turn in as homework. Intermediate assignments related to your proposal will count toward your homework grade. In addition to the frequent "mini-quizzes" on daily reading, you will have three longer in-class quizzes on the course material. These will consist of multiple-choice, true/false, fill-in-the-blank, or short answer questions. You will be given a study guide for each quiz.

Grading scale

A 93-100%	B 83-86.9%	C 73-76.9%
A- 90-92.9%	B- 80-82.9%	C- 70-72.9%
B+ 87-89.9%	C+ 77-79.9%	D 60-69.9%

I follow conventional rounding procedures, so a 92.94% would represent an A- (rounded down to 92.9%), while a 92.95% would be rounded up to 93.0% and an A.

How to be successful in this course

Come prepared to class sessions

In addition to learning course material beyond what is presented in the textbook, class sessions often consist of activities that reinforce course content and practice skills that you will need to demonstrate on exams. You will get more out of the class and each class session if you read the textbook and any supplementary reading by the date indicated on the syllabus. On most days you will be given a graded mini-quiz (1-2 questions) about the day's reading. These mini-quiz questions will be selected from

study questions that I will post via a Google Doc for each day's reading. I will update reading assignments in class as adjustments in our schedule require; additional supplementary readings may be posted on Brightspace. On some days I might ask you to bring in your laptops so that we can practice data analysis using freely available software; make sure your computer battery is charged and install any necessary software as instructed for these activities. It is your responsibility to check Brightspace and your e-mail frequently for course-related announcements. Make sure you set your notifications in Brightspace to keep up to date with course activities.

Take advantage of course resources and study aids

I continually update a Google doc with study questions that you can use to help guide your review of course material and prepare for mini-quizzes and reading quizzes on the primary literature papers (available in a Google drive folder; you might want to make your own copy to create a version you can edit). PDFs of the lecture slides are also posted in a Google drive folder.

Participate in discussions

Sixty percent of your participation grade is based on your contributions to class discussions of primary literature. While you might find it intimidating to speak up in class, if you have read the papers and developed some questions and comments about what you read (as you are required to do before each discussion), you already will be prepared with something thoughtful to say. Discussions are more interesting when everyone participates – please do not think you can't make a valuable contribution!

Come see me if you need help!

Office hours. I am available for in-person office hours. If any of the posted times do not suit you, you can email me to set up another appointment for an in-person meeting or video conference via Teams. When doing so, please suggest some possible times that you are available to meet in your email to make our correspondence more efficient.

Email communication. I can often answer your questions by email as well. I will try to respond during the same day for emails sent M-F by 6 pm (if I see the message – I do not constantly monitor email). Otherwise please expect a response by the end of the next *business* day. If you have not heard from me by then, feel free to send me a reminder email.

Back up your work

Do yourself a favor to avoid last-minute computer calamities and stress by saving your work frequently and backing up your files using some kind of cloud storage system like Google Drive, OneDrive, Dropbox, or some other service. Also, don't wait until the day before a deadline to get started!

Respect our learning environment

Please help promote an effective learning environment by avoiding distractions and disruptions to others. Silence your cell phone and refrain from texting/browsing while in class. I will permit the use of

laptops for taking notes (and of course in-class activities that require them) but will ask you to turn them off if I see they are not being used for classroom activities and/or are distracting to others. Please be courteous to me and your classmates by arriving on time.

Attendance guidelines, public health, and your well-being and mental health

Guidelines for attendance and public health considerations

SUNY Geneseo is a residential liberal arts college where we all learn together in a shared space. Our classroom community is vital for engaging in discussions, solving problems, and answering questions together. I strive to create an interactive and collaborative laboratory space, and in return I expect you to attend and engage in the activities.

We know that COVID is shifting from a pandemic to endemic stage, and it's possible that some of you may get infected over the course of the semester. Because we want you to be successful and because we value your contribution to the course, we expect you to prioritize consistent attendance. If you are experiencing symptoms associated with COVID on a day we have class, please take a COVID test. Testing is available through the Health Center or you may take a self-test if you have one. If you test negative and feel well enough to attend, put on a well-fitting mask, come to class, and maintain physical distance as much as possible. If your symptoms do not allow you to attend class, stay home (except to go to the Health Center), rest, and take care of yourself. I can support you to keep up with class if you are out for COVID or other health-related reasons, but I need you to be proactive in letting me know when you will be absent and why. Although I can work with you on keeping up, you may miss some course content and extended absences may impact your ability to realize your full potential in this class. For extended absences (i.e., more than a couple of days of classes), you should contact the Dean of Students (585-245-5706, http://www.geneseo.edu/dean_students) who can assist with reaching out to all of your professors about challenges you face and accommodations you may require. I want you to succeed and learn in this class, and I want to protect our community from COVID as best as I can.

Student well-being and mental health

Prioritizing well-being can support the achievement of academic goals and alleviate stress. Eating nutritious foods, getting enough sleep, exercising, avoiding drugs and alcohol, maintaining healthy relationships, and building in time to relax all help promote a healthy lifestyle and general well-being.

As a student, you may experience a range of challenges that can impact your mental health and thus impact your learning; common examples include increased anxiety, shifts in mood, strained relationships, difficulties related to substance use, trouble concentrating, and lack of motivation, among many others. These experiences may reduce your ability to participate fully in daily activities and affect your academic performance. Students are strongly encouraged to communicate their needs to faculty and staff and seek support if they are experiencing unmanageable stress or are having difficulties with daily functioning. The Dean of Students can assist and provide direction to appropriate campus resources.

SUNY Geneseo offers free, confidential counseling for students at the Lauderdale Center for Student Health and Counseling; seeking support for your mental health can be key to your success at college. You can learn more about the various mental health services available on campus at geneseo.edu/health. To request a counseling appointment, please complete the online form through myhealth.geneseo.edu. Getting help is a smart and courageous thing to do -- for yourself and for those who care about you.

See the "Course orientation" module (Well-being and mental health page) on Brightspace for more resources available to students facing food insecurity or short-term financial crisis.

Other course policies

Late work

Completion of the assignments in a timely manner is important for understanding and applying course content. Graded assignments will be penalized by a loss of 5% of the total assignment's points possible per day. But if you think you must turn in something late because of extenuating circumstances, feel free to discuss the situation with me (**before** the deadline) and we can negotiate terms to reduce the late penalty and/or adjust deadlines.

Plagiarism and academic dishonesty

Plagiarism and other forms of academic dishonesty (cheating, turning in another student's work as your own) will not be tolerated. Evidence of academic dishonesty is grounds for a score of zero on any assignment and further action including notifying the department chair, Dean of Academic Planning and Advising, Dean of Students, and Student Conduct Board, which can result a report filed with the Dean of Students.

According to SUNY Geneseo's Academic Dishonesty and Plagiarism Policy (https://www.geneseo.edu/dean_office/dishonesty), plagiarism includes the following:

1. direct quotation without identifying punctuation and citation of source;
2. paraphrase of expression or thought without proper attribution;
3. unacknowledged dependence upon a source in plan, organization, or argument.

In SUNY Geneseo's policy, "Plagiarism is the representation of someone else's words or ideas as one's own or the arrangement of someone else's material(s) as one's own." Take care to properly cite sources of ideas, figures, data, etc. (including internet sources) in your writing and presentations. Even if you properly cite your source, when you borrow wording and sentence structure from the original source and pass it off as your own (i.e., by not using quotation marks), you are guilty of plagiarism. Learn how to paraphrase in your own words information from the original source.

Use of AI tools. All work on written assignments should be in your own words and represent your own thoughts and opinions (or those of your group members in the case of group assignments). You may

not use generative artificial intelligence (AI), such as OpenAI's ChatGPT, to edit or generate text because it is not guaranteed to be free from using the intellectual products of others.

Copyright statement

Many of the materials that are provided to students in this course have been created by me or other faculty (lecture slides, assignments, instructional documents, etc.). Students would be best to assume that all course materials are protected by legal copyright. Copyright will be indicated by a "© DATE AUTHOR" on the document. Copyright protection means that reproduction of this material is prohibited without the author's consent. Thus, students are prohibited sharing or posting copyrighted material to any websites outside our course Brightspace site. Students are also prohibited from reproducing material to be shared with other more limited groups (e,g., sorority/fraternity test bank).

Religious observation and class attendance

New York State Education Law 224-a stipulates that "any student in an institution of higher education who is unable, because of [their] religious beliefs, to attend classes on a particular day or days shall, because of such absence on the particular day or days, be excused from any examination or any study or work requirements" (see https://www.geneseo.edu/apca/classroom-policies). SUNY Geneseo has a commitment to inclusion and belonging, and I want to stress my respect for the diverse identities and faith traditions of students in my class. If you anticipate an absence due to religious observations, please contact me as soon as possible in advance to discuss your needs and arrange make up plans.

Military obligations and class attendance

Federal and New York State law requires institutions of higher education to provide an excused leave of absence from classes without penalty to students enrolled in the National Guard or armed forces reserves who are called to active duty. If you are called to active military duty and need to miss classes, please let me know and consult as soon as possible with the Dean of Students.

Diversity and inclusion

The Department of Biology has pledged to develop more inclusive pedagogical practices and work to promote diversity in our curriculum while confronting racism, particularly ways in which science has been used to sustain it (Biology Department's Statement in Support of Racial Justice, also available on Department of Biology website). I hope to create an inclusive and supporting learning environment in which anyone can succeed, regardless of your identity (race, gender, ethnicity, sexual orientation, age, socioeconomic status, religion, and ability). I want to provide for students' growth as scientists and learners and promote a sense of belonging.

Land acknowledgment

Land acknowledgements are expressions of sorrow and remembrance to those whose historic territory one resides on. Geneseo resides on the historic homelands of the Seneca Nation of Indians and

Tonawanda Seneca Nation. As stated in the Community Commitment to Diversity, Equity, and Inclusion, "we at SUNY Geneseo have an obligation to recognize all who, through history or identity, have been marginalized or oppressed, made invisible or silenced." I encourage you to learn more about these original occupants and those indigenous to other places you have lived. You may consider using the Native Land app and/or websites such as sni.org to learn more about the community of more than 7,000 enrolled Indigenous Peoples.

Student success resources at SUNY Geneseo

Accessibility and accommodations

SUNY Geneseo is dedicated to providing an equitable and inclusive educational experience for all students. The Office of Accessibility will coordinate reasonable accommodations for persons with documented physical, emotional, or cognitive disabilities to ensure equal access to academic programs, activities, and services at Geneseo. Students with approved accommodations may submit a semester request to renew their academic accommodations. Please visit the OAS website for information on the process for requesting academic accommodations. Please contact the Office of Accessibility Services for questions related to access and accommodations: access@geneseo.edu, 585-245-5112, www.geneseo.edu/accessibility-office.

Reporting bias-related incidents

Here at SUNY Geneseo, we want to provide a space where everyone feels welcome to learn and grow in their identities as well as in their role as students, faculty, and staff. If in the unfortunate instance you experience an incident of bias, we encourage you to reach out to the we encourage you to reach out to the Chief Diversity Officer (routenberg@geneseo.edu), Director of Multicultural Affairs (charcum@geneseo.edu), and/or our University Police Department. In trying to create an environment that facilitates growth through diverse thoughts and ideas, reporting incidents of bias - including threats, vandalism, and microaggressive behaviors - can help bring a better understanding of our campus climate as well as provide opportunities for learning and restoring harm.

Other resources

Additional resources are available to support your academic success and well-being, including academic support services like tutoring or peer mentors, library research help, computer and technology support, food security support, and emergency funding. See the "Student success resources" and "Well-being and mental health" pages in the Brightspace course orientation module for more information about these services.

Molecular Ecology – Spring 2024

Course Schedule

Date		**Topic/activity** (module indicated in blue)	**Reading** *	**Major assignments**
T	1-23	Introduction to molecular ecology		
Th	1-25	Molecular markers & methods: molecular biology/genetics background	**1:** 1-25, **2**:26-35, 43-59	
T	1-30	Molecular markers & methods	**2:** 36-43; **3:** 64-90	
Th	2-1	Molecular markers & methods	**4:** 91-122	
T	2-6	*Simulating evolutionary processes***	**5:** 123-138	
Th	2-8	Literature research methods**; Population genetics: genetic diversity	**7:** 206-214	
T	2-13	Population genetics: HWE; effective population size, bottlenecks	**7**: 214-220	Quiz #1 – molecular markers & methods
Th	2-15	Population genetics: population subdivision	**7:** 221-230	
T	2-20	Population genetics: gene flow, landscape genetics	**7:** 231-242	Proposal topic with 3 primary sources due **Friday, Feb 23**
Th	2-22	Population genetics: *data analysis***		
T	2-27	*DIVERSITY SUMMIT – NO CLASS*		
Th	2-29	*Discussion*: instructor-led; Behavioral ecology: parentage	See list; **6**: 165-175	**Revised proposal topic due Friday, Mar 1**
T	3-5	Behavioral ecology: relatedness, mating systems, cooperative behavior	**6:** 175-205	Quiz #2 – population genetics
R	3-7	*Discussion:* Population genetics	See list	
		SPRING BREAK March 11 – 15		
T	3-19	Behavioral ecology: trophic interactions; *behavioral ecology data analysis***	**5:** 139-164	
Th	3-21	Adaptive genetic variation: defining neutral vs. adaptive variation; measuring gene expression	**8:** 243-260; **4**: 111-115	Midterm exam due **Friday, Mar 22**
T	3-26	Adaptive genetic variation: genomic approaches	See list	
Th	3-28	*Discussion*: Behavioral ecology	**8:** 261-277	Outline & annotated bibliography due **Fri, Mar 29**

Date		Topic/activity (module indicated in blue)	Reading *	Major assignments
Th	4-2	Adaptive genetic variation: special guest	See list	
Th	4-4	Phylogeography: generating genealogical data	**9**:278-295	
T	4-9	Phylogeography: interpreting trees, networks	**9**: 295-321	
R	4-11	*Discussion:* Adaptive genetic variation	See list	Proposal draft due **Friday, Apr 12**
T	4-16	Conservation genetics: genetic diversity, inbreeding	**10**: 322-338	
Th	4-18	Peer review panels: *discuss proposal drafts***		Peer reviews due
T	4-23	Conservation genetics: conservation strategies; Microbial ecology & metagenomics	**11**: 355-382	
Th	4-25	*Discussion*: Phylogeography	See list	
T	4-30	Microbial ecology & metagenomics: eDNA	**TBA**	
Th	5-2	*Discussion*: Conservation genetics; metagenomics	See list	
T	5-7	Emerging topics in molecular ecology**	**TBA**	Quiz #3 – adaptive genetic variation, phylogeography, conservation genetics
W	5-8	Study Day		Proposal due **Wednesday, May 8**
W	5-15	Final exam period, 12 – 2:30 pm: short proposal presentations		Final exam due **Thursday, May 16**

* Chapters refer to the textbook, *An Introduction to Molecular Ecology,* 3rd edition, by Rowe et al. Readings for discussions are available on the course webpage on Brightspace. Additional readings from other sources may also be assigned and will be posted on Brightspace.

** Bring laptop computer to class on these days

Minor assignments like homework worksheets and mini-quizzes or reading quizzes are not indicated on this schedule.