

Evolutionary Genetics
Parul Johri, Ph.D.
BIOL 454-001
Office hours: On request.

Text (optional):

Elements of Evolutionary Genetics by Brian Charlesworth & Deborah Charlesworth

Course description: The roles of mutation, genetic drift, population history, and natural selection in the evolution of the genotype. Basic principles are applied to biological studies. Three lecture hours a week.

Requisites: Prerequisites, BIOL 201 and BIOL 202; or BIOL 103 and BIOL 104; or permission of the instructor for students lacking the prerequisites.

Course Goals: The aim of the course is to provide an overview of the evolutionary processes that shape genomic variation. The course will have a heavy quantitative emphasis and **you will be challenged to understand derivations, experiments, conclusions, and primary literature.**

Set up in canvas

CLASS HOURS AND VENUE

Fall 2024

M: Monday, W: Wednesday, F: Friday.

11:15 am - 12:05 pm

Genome Sciences Building, Room 1374

SYLLABUS

MODULE 1. Basic evolutionary processes

Week 1: Genetic variation [Aug 19 – 23]

M: Discussion of the syllabus + Introduction to population genetics (lecture)

W: Genetic variation + Basic probability + Hardy Weinberg Equilibrium (lecture)

F: Problem Set #1

Week 2: Mutation and Genetic drift I [Aug 26 – Aug 30]

M: Genetic Drift (Lecture)

W: Mutation (Lecture)

F: Problem Set #2

Week 3: Mutation and Genetic drift II [Sep 2 – Sep 6]

M: No class (Labor Day)

W: Paper presentation #1 (Gould and Lewontin 1979)

F: Paper presentation #2 (Chen et al., 2018)

Week 4: Selection [Sep 9 -13]

M: Selection at single sites (lecture)

W: Problem Set #3

F: Paper presentation #3 (Lenski and Travisano 1994)

Week 5: Recombination [Sep 16-20]

M: Linkage disequilibrium (Lecture)

W: Problem Set #4

F: Paper presentation #4 (Coop et al., 2008)

Week 6: Review + Midterm [Sep 23- 27]

M: No class (Wellness Day)

W: Class open to questions

F: MIDTERM #1

MODULE 2. Complex evolutionary processes

Week 7: Coalescence Theory [Sep 30 – Oct 4]

M: Coalescence Theory (Lecture)

W: Problem Set #5

E: Paper presentation #5 [Chapter 1, Coalescent Theory by John Wakeley]

Week 8: Population structure [Oct 7 – 11]

M: FST, Island model, Extinction recolonization models (Lecture)

W: Problem set #6

E: No class (University Day)

Week 9: Demographic history [Oct 14- 18]

M: Effect of population size changes on the coalescent (Lecture)

W: Paper presentation #6 (Novembre et al., 2008)

E: No class (Fall Break)

Module 3: EMPIRICAL APPLICATIONS/ ADVANCED CONCEPTS

Week 10: Midterm + Heterogeneity in mutation and recombination rates [Oct 21-25]

M: MIDTERM #2 (material from Module 2)

W: Group Reading #1 (Stapley et al., 2017)

E: Paper presentation #7 (Chintapali and Moorjani 2020)

Week 11: The distribution of fitness effects of new mutations [Oct 28 – Nov 1]

M: Estimation of the distribution of fitness effects + Fisher's Geometric Model (Lecture)

W: Group Reading #2 (Orr 2005)

F: Paper presentation #8 (Keightley and Eyre-Walker 2007)

Week 12: Effects of selection on linked sites [Nov 4 – 8]

M: Hill-Robertson Effects: Background selection + selective sweeps + AOD + Muller's ratchet (Lecture)

W: Group Reading #3 (Charlesworth et al., 1993)

F: Paper presentation #9 (Teshima et al., 2006)

Week 13: Sequencing and genotyping errors [Nov 11 – 15]

M: Genotyping errors and effects on summary statistics (Lecture)

W: Group Reading #4 (Han et al., 2014)

F: Paper presentation #10 (Bergeron et al., 2022)

Week 14: Genome Evolution [Nov 18 – Nov 22]

M: Evolution of transposable elements and gene duplications (Lecture)

W: Group Reading #6 (Gozashti et al., 2022)

F: Paper presentation #11 (Lynch and Conery 2003)

Week 14: Detecting selection in the genome [Nov 25-29]

M: Detection selection using polymorphism and divergence (Lecture)

W: No Class (Thanksgiving Break)

F: No Class (Thanksgiving Break)

Week 16: Last lecture and review [Dec 2, 4]

M: Open questions or debates in population genetics: Neutral theory vs Genetic Draft (Lecture)

W: Class open to questions

FINAL EXAM

F: Final Exam (4:00 pm in GSB 1374)

COURSE ASSIGNMENTS & ASSESSMENTS

Grading Scale:

Numeric Grade (%)	Letter Grade
92.5 and above	A
89.5 – 92.4	A-
86.5 – 89.4	B+
82.5 – 86.4	B
79.5 – 82.4	B-
76.5 – 79.4	C+
72.5 – 76.4	C
69.5 – 72.4	C-
66.5 – 69.4	D+
59.5 – 66.4	D
59.4 and below	F

Grading

Problem Set/Group Readings: 10% (participation) + 10% (speaking or presenting)

Paper questionnaire: 20%

Paper presentation: 20%

Midterm exam #1: 10%

Midterm exam #2: 10%

Final Exam: 20%

GRADES

Participation in Problem Set/Group Reading:

On Wednesdays, we will be performing two types of group activities – (1) solving Problem Sets or (2) discussing Group Readings. After the discussion within groups, each group will present what they discussed. You must make sure that you present at least once during the semester.

The problem sets will be released during class.

For group reading, you must read the assigned reading before coming to class.

Paper Presentations:

Each week (usually on Fridays) a group of 2-3 students will present and lead the discussion of a weekly paper (posted on canvas). Each student must sign up to present

one paper. Sign up for the papers at:

https://docs.google.com/spreadsheets/d/1TWF_wUMoKPRw6EyWnlNyvGgyevJZt2dyfbSrKDe_p7OU/edit?usp=sharing

The presenters are also responsible for leading the discussion of the paper.

Guidelines to make paper presentations: If the manuscript is a research article, structure your presentation so that it has the following four sections in this order:

Introduction (what is the study trying to do?)

Methods (how did they do it?)

Results (what did they find?)

Discussion and Conclusions (what is your and their interpretation of the results?)

If the paper is a review/perspective/opinion piece, follow the structure of the manuscript as is, using the same headings.

Each student should present for at least 6 minutes. Both powerpoint presentations and chalk talks are allowed.

Whenever you have your final presentation ready, you can share it with me (parul.johri@gmail.com) on google drive, or send it to me by email (pjohri@unc.edu). I will upload it on Canvas.

Following is the rubric on which you will be assessed during your presentation:

	Excellent(5)	Great(4)	Good(3)	Okay(2)	Less than okay (0)
Time	Presentation is at least 6 minutes long	Presentation is at least 5 minutes long	Presentation is at least 4 minutes long	Presentation is at least 3 minutes long	Presentation is less than 3 minutes
Understanding	Shows a full understanding of the topic and concepts.	Shows a good understanding of the topic and concepts.	Shows a good understanding of some concepts and parts of topic.	Has tried but does not understand the topic well.	Has put no effort in understanding the topic and content.
Content (group score)	Covered all sections (see above) of the paper.	Covered 80% of the paper.	Covered 70% of the paper.	Covered 50% of the paper.	Covered less than 50% of the paper.
Effort	Has made a lot of effort	Has made a good	Has made a partial effort	Has made slight effort	Has made no effort into

	into understanding and explaining the material.	amount of effort into understanding and explaining the material.	into understanding and explaining the material.	into understanding and explaining the material.	understanding and explaining the material.
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Paper questionnaire

For each paper presentation (usually held on Fridays), each student must submit a questionnaire on Canvas. The reading questionnaire is due on Friday before class. You are allowed to discuss the paper with other students (if you like), but please fill out the questionnaire on your own. If your answers are similar to another student's, then you will only get half of the total points for that question.

Midterm exams

There will be two midterm exams.

Midterm 1 will include material only from Module 1.

Midterm 2 will include material only from Module 2.

Final exam:

Final Exam will include material from the whole semester.

Grade Complaints: Re-grade requests are allowed. Such requests must be made within one week of receiving a grade and they must be made in written form. I will consider it and make the final decision.

No requests for extra credit will be entertained.

No requests for rounding your final grade will be considered.

TECHNOLOGY USE

- Use of computers is allowed but only for taking notes, solving problem sets, and giving midterms/exams. The use of facebook, twitter, youtube or any other social media during class is prohibited.
- Recording and distributions of lectures is prohibited.
- Use of cell phones and similar devices is prohibited.

ACADEMIC POLICIES

Attendance Policy

University Policy: As stated in the University's [Class Attendance Policy](#), no right or privilege exists that permits a student to be absent from any class meetings, except for these University Approved Absences:

1. Authorized University activities: [University Approved Absence Office \(UAAO\) website](#) provides information and [FAQs for students](#) and [FAQs for faculty](#) related to University Approved Absences
2. Disability/religious observance/pregnancy, as required by law and approved by [Accessibility Resources and Service](#) and/or the [Equal Opportunity and Compliance Office](#) (EOC)
3. Significant health condition and/or personal/family emergency as approved by the [Office of the Dean of Students](#), [Gender Violence Service Coordinators](#), and/or the [Equal Opportunity and Compliance Office](#) (EOC).

Honor Code

All students are expected to follow the guidelines of the UNC honor code. In particular, students are expected to refrain from "lying, cheating, or stealing" in the academic context. If you are unsure about which actions violate that honor code, please consult the [Student Conduct website](#).

Acceptable Use Policy

By attending the University of North Carolina at Chapel Hill, you agree to abide by the University of North Carolina at Chapel Hill policies related to the acceptable use of IT systems and services. The Acceptable Use Policy (AUP) sets the expectation that you will use the University's technology resources responsibly, consistent with the University's mission. In the context of a class, it's quite likely you will participate in online activities that could include personal information about you or your peers, and the AUP addresses your obligations to protect the privacy of class participants. In addition, the AUP addresses matters of others' intellectual property, including copyright. These are only a couple of typical examples, so you should consult the full [Information Technology Acceptable Use Policy](#), which covers topics related to using digital resources, such as privacy, confidentiality and intellectual property. Additionally, consult the [Safe Computing at UNC](#) website for information about data security policies, updates, and tips on keeping your identity, information, and devices safe.

Syllabus Changes

The instructor reserves the right to make changes to the syllabus including project due dates and test dates. These changes will be announced as early as possible.

Data Security & Privacy

UNC-Chapel Hill is committed to fulfilling its responsibilities of transparency as a state-sponsored institution of higher learning, protecting certain types of information, and using information Carolina collects only for appropriate purposes. Consult the [UNC-Chapel Hill Privacy Statement](#) for additional information.

Syllabus Guidelines for Generative AI

Generative AI is extremely useful; however, it has the following limitations:

- How output is arrived at is not clear as the internal processes used to produce a particular output within the generative AI cannot be determined.
- The output is based on existing data (often scraped from online sources) and may reflect biases that should be acknowledged; it may also be inaccurate or entirely fabricated, even if it appears reliable or factual.
- AI evokes a range of intellectual property concerns; sourcing and ownership of information is unclear, and the status of AI output raises numerous questions—e.g., is output equivalent to a published resource? What citational responsibilities are in place for various AI interactions?

The following sections provide the philosophy and specific guidelines for using these tools and features (increasingly, generative AI capabilities will be integrated with everyday applications). **Unless I provide other guidelines for an assignment or exam, you should follow these guidelines.**

Usage Philosophy

Use/disuse of generative AI in your coursework is based on the following principles:

1. **AI should help you think.** Not think for you.
Use these tools to give you ideas, perform research (in compliance with point 2 below), and analyze problems. Do not use them to do your work for you, e.g., do not enter an assignment question into ChatGPT and copy & paste the response as your answer.
2. **Engage with AI Responsibly and Ethically:** Engage with AI technologies responsibly, critically evaluating AI-generated outputs and considering potential biases, limitations, and ethical implications in your analysis and discussions. Utilize AI technologies ethically, respecting privacy, confidentiality, and intellectual property rights. Ensure that the data used for AI applications is obtained and shared responsibly and in compliance with relevant regulations.
3. **You are 100% responsible for your final product.**
You are the user. If the AI makes a mistake, and you use it, it's your mistake. If you don't know whether a statement about any item in the output is true, then your responsibility is to research it. If you cannot verify it as factual, you should delete it. You hold full responsibility for AI-generated content as if you had produced the materials yourself. This means ideas must be attributed, facts are true, and sources must be verified.

4. **These guidelines are in effect unless I give you specific guidelines for an assignment or exam.** It is your responsibility to ensure you are following the correct guidelines.
5. **Data that are confidential or personal should not be entered into generative AI tools.**
Putting confidential or personal data (e.g., your One Card details) into these tools exposes you and others to the loss of important information. Therefore, do not do so.

The following sections provide the philosophy and specific guidelines for using these tools and features (increasingly, generative AI capabilities will be integrated with everyday applications). **Unless I provide other guidelines for an assignment or exam, you should follow these guidelines.**

Guideline Specifics

Not following these guidelines may be a reportable violation to the UNC Honor Court.

Use of generative AI in your coursework is strongly discouraged unless specified otherwise. Note that you are 100% responsible for your final product. You hold full responsibility for AI-generated content as if you had produced the materials yourself.

Assignments

- Readings and Discussions: Do not generate responses to readings using AI.
- Written & Oral Exams: The utilization of AI tools is prohibited and could potentially constitute a reportable violation to the UNC Honor Court.

SERVICES & STUDENT SUPPORT POLICIES

Accessibility Resources and Service

[Accessibility Resources and Service](#) receives requests for accommodations, and through the Student and Applicant Accommodations Policy determines eligibility and identifies reasonable accommodations for students with disabilities and/or chronic medical conditions to mitigate or remove the barriers experienced in accessing University courses, programs and activities. ARS also offers its Testing Center resources to students and instructors to facilitate the implementation of testing accommodations.

Counseling and Psychological Services

UNC-Chapel Hill is strongly committed to addressing the mental health needs of a diverse student body. The [Heels Care Network](#) website is a place to access the many

mental health resources at Carolina. CAPS is the primary mental health provider for students, offering timely access to consultation and connection to clinically appropriate services. Go to the [CAPS website](#) or visit their facilities on the third floor of the Campus Health building for an initial evaluation to learn more. Students can also call CAPS 24/7 at 919-966-3658 for immediate assistance.

Title IX and Related Resources

Any student who is impacted by discrimination, harassment, interpersonal (relationship) violence, sexual violence, sexual exploitation, or stalking is encouraged to seek resources on campus or in the community. Reports can be made [online to the EOC](#) or by contacting the University's Title IX Coordinator ([Elizabeth Hall](#)) or the [Report and Response Coordinators](#) in the Equal Opportunity and Compliance Office. Confidential resources include Counseling and Psychological Services and the [Gender Violence Services Coordinators](#). Additional resources are available at [Safe at UNC](#).

Policy on Non-Discrimination

The University is committed to providing an inclusive and welcoming environment for all members of our community and to ensuring that educational and employment decisions are based on individuals' abilities and qualifications. Consistent with this principle and applicable laws, the University's [Policy Statement on Non-Discrimination](#) offers access to its educational programs and activities as well as employment terms and conditions without respect to race, color, gender, national origin, age, religion, genetic information, disability, veteran's status, sexual orientation, gender identity or gender expression. Such a policy ensures that only relevant factors are considered, and that equitable and consistent standards of conduct and performance are applied. If you are experiencing harassment or discrimination, you can seek assistance and file a report through the Report and Response Coordinators (email the [Report and Response Coordinators](#) or see additional contact info at [Safe at UNC](#)) or the [Equal Opportunity and Compliance Office](#).

Undergraduate Testing Center

The College of Arts and Sciences provides a secure, proctored environment in which exams can be taken. The [Undergraduate Testing Center](#) works with instructors to proctor exams for their undergraduate students who are not registered with ARS and who do not need testing accommodations as provided by ARS. In other words, the Center provides a proctored testing environment for students who are unable to take an exam at the normally scheduled time (with pre-arrangement by your instructor).

Learning Center

Want to get the most out of this course or others this semester? Visit UNC's [Learning Center](#) to make an appointment or register for an event. Their free, popular programs will help you optimize your academic performance. Try academic coaching, peer tutoring, STEM support, ADHD/LD services, workshops and study camps, or review tips and tools available on the website.

Writing Center

For free feedback on any course writing projects, check out UNC's [Writing Center](#). Writing Center coaches can assist with any writing project, including multimedia projects and application essays, at any stage of the writing process. You don't even need a draft to come visit. To schedule a 45-minute appointment, review quick tips, or request written feedback online, visit the [Writing Center's website](#).