BIOL 5591: Advanced Genomics **Instructor: Jamie Henzy** **Fall 2025**

Welcome to Advanced Genomics! The role of genomic data in science, medicine, and society is growing in leaps and bounds. In this course, you'll learn how researchers generate, analyze, and interpret these data in ways that connect directly to important biological questions regarding disease, evolution, and basic biological mechanisms. Among the topics you'll encounter are genome sequencing and assembly, assessment and analysis of variation, transcriptome analysis, phylogenetics, and structure prediction. By the end of the course, you'll be able to converse with confidence about key questions and discoveries in genomics, understand why big data is so important to the field, and think critically about new research findings you encounter in the news or in scientific journals.

Course objectives: Generally, become familiar with the approaches, techniques, and tools of analysis that genomicists use and the types of research questions they pursue, for example:

- Describe various techniques used in sequencing, assembling, and annotating genomes.
- Explain techniques used to determine, analyze, and visualize transcriptional information.
- Demonstrate understanding of the concepts underlying phylogenetic analysis.
- Interpret data and findings from research articles.
- Describe how structure prediction is performed.

Course format: Please note that this is a fully in-person course. Class sessions will include a mix of lecture, discussion of papers, student presentations, and exercises. ***If you are absent****, there is no need to email me. It is your responsibility to obtain notes on missed material from a classmate.*

Device policy: No cell phone use, please. Laptops: Will be required for in-class work, but I encourage you to use it only for that purpose, and not for general notetaking. If you are in a situation that requires you to take a text or call during class, please see me ahead of time to arrange to step out of the classroom when needed. The purpose of this policy is to reduce distractions and screen time and promote engagement during our sessions.

Course materials:

1. **Readings.** A mix of research papers, reviews, and summaries available through PubMed and online sites.
2. **Pocket folder, notebook paper, and pen or pencil.**
3. **Laptops**. Often we will do exercises that require access to online genomics tools such as the UC Genome Browser. So please bring a laptop but use it only for exercises.

Grading:	3 exams (incl. final) x 28%	84%
	Notebook: 3 x 3.33%	10%
	Mini-modules 2 x 3%	6%

Exams: There will be two unit exams and one partially comprehensive final. All are in-class, on paper. Please note the dates on your calendar **in bold**. There are no makeups. If you have an unavoidable, documented emergency, the score on the final will count double.

Notebook: Research has shown that people process information better when writing and drawing figures by hand. You'll be given various exercises throughout the term -- both in-class and take-home -- designed to prepare you for mastering the material. Before each exam, you'll submit your notebook (the pocket folder) with the exercises for points constituting 10% of your grade. **To receive points, all work must be handwritten and not photocopied.**

Mini-modules: There's no better way to learn material than to teach it! You and a partner will give two 5-min presentations on selected topics from the course content, introducing the material as if you are teaching it. Please see the Canvas signup sheet (coming soon) to choose a date and topic.

Grading scale:
A: 90 - 100% B: 80 - 89% C: 70 - 79% D: 60 - 69% F: 59% or less

Pluses and minuses will distinguish between higher or lower performance within each letter range. To ensure fairness, everyone will be graded according to the same standards. If you identify a calculation error in any score, please let me know. However, requests for special consideration in terms of extra credit, more generous rounding, or any other type of "grade bump" are inappropriate, unprofessional, and have zero chance of being granted.

Getting help:

- Canvas discussion "Help!" thread: For all questions about anything course related. Visit the thread often to pick up tips or info, or to chime in and answer a question!
- Office hours: For additional help, if needed, use the link above the syllabus to sign up for a 15-min slot.
- Claude, or any other AI: Feel free to use Claude to help clarify concepts, understand figures, or quiz yourself on learning objectives to test your understanding. **Use it to make yourself smarter and not dumber!**

Email: For personal issues only. All questions that could possibly be of interest to even one other student must be posted on the Canvas "Help!" thread to receive an answer.

Expanding the field: Science and the society it serves is greatly enriched by the participation of people from diverse backgrounds, who can bring fresh views and priorities, driving new lines of inquiry and application. Science is hard, and students from groups who have traditionally been under-represented sometimes feel insecure in their ability to participate and express their views. Please let me know if you have any concerns of this nature. And here's a secret: anyone who has curiosity and wants to use data to solve a mystery is a scientist at heart!

Cheating policy: Honesty, integrity, and ethical behavior are of utmost importance in science, and can make or break a scientific or medical career. Anyone caught cheating (for example, copying from the work of other students, or collaborating during exams) will receive a zero and be referred to the Office of Student Conduct and Conflict Resolution. Please make sure you have read and understand the student code of conduct: http://www.northeastern.edu/osccr/code-of-student-conduct/

Schedule of topics (all exam dates are final, but some content may change, based on student interest):

#	Date	Pre-readings and prep	Topics
1	Fri Sep 5	Syllabus	Introduction; the ABCs of genomic information; GenBank
2	Tue Sep 9	RNA world; Mitochondria	mtDNA; RNA; BLAST
3	Fri Sep 12	Human genome data	Genomes and their contents
4	Tue Sep 16	Burian review	Sanger as foundation for sequencing methods; NGS
5	Fri Sep 19	Burian, continued	Assembly, annotation; coverage depth; N50

#	Date	Pre-readings and prep	Topics
6	Tue Sep 23	Genotyping protocols	Variation and its assessment; linkage and haplotypes
7	Fri Sep 26	Ten_things_TEs.pdf	Transposable elements
8	Tue Sep 30	Ten_things, continued	UCSC genome browser
9	Fri Oct 3	Spillover	Mop up loose ends!
10	**Tue Oct 7**	**Exam 1**	
11	Fri Oct 10	Lowe.pdf	Transcriptomics
12	Tue Oct 14	Lowe, continued	Methods in transcriptomics
13	Fri Oct 17	Haque.pdf	Single-cell RNA-seq
14	Tue Oct 21	Haque, continued	Single-cell RNA-seq
15	Fri Oct 24	Working with the GEO database	Gene Expression Omnibus database
16	Tue Oct 28	Mishina.pdf	Analysis of differential gene expression
17	Fri Oct 31	Mishina, continued	Scatterplots, heatmaps
18	Tue Nov 4	Spillover	Mop up loose ends
19	**Fri Nov 7**	**Exam 2**	
20	**Tue Nov 11**		NO CLASS
21	Fri Nov 14	Nova: Carl Woese	Tree of life; phylogenomics
22	Tue Nov 18	Chaconas.pdf	Bacterial genomics
23	Fri Nov 21	Chaconas, continued	Bacterial genomics, continued
24	Tue Nov 25	Li.pdf	Ancient DNA
25	**Fri Nov 28**		NO CLASS
26	Tue Dec 2	Jaganathan.pdf	Machine learning applied to genomics
27	Fri Dec 5	Jaganathan, continued	ML, continued
28	**Thu Dec 11**	**Comprehensive final:** 3:30 - 5:30 pm	