

BIOL 5591

Advanced Genomics

Spring 2024

MR 5:15 - 6:55 pm | Behrakis 320

Professor: Jamie Henzy

Office: Mugar 205F

Office hours: by appt

Material: We'll read a mix of research papers and reviews. We'll also try out a few simple online genomics tools that you can perform on your own computer.

Prerequisite: BIOL 2301 Genetics and Molecular Biology

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, and exercises. Twice during the semester pairs of students will give presentations, followed by a class quiz.

Grading:	Paper summaries:	3 pts x 11	= 19% of grade
	In-class discussion:	3 pts x 11 (drop 2 lowest)	= 16% of grade
	Exercises:	5 pts x 10	= 30% of grade
	Presentation:	20 pts	= 12% of grade
	<u>In-class quizzes:</u>	<u>20 pts x 2</u>	<u>= 23% of grade</u>
			100

Grading scale:

A: 90 - 100% B: 80 - 89% C: 70 - 79% F: 69% or less

Pluses and minuses will distinguish between higher or lower performance within each letter range.

Paper summaries: A major component of the course is summary and discussion of papers. For each paper, you can earn 3 pts for submitting a summary by the due date (which is always the start of the class in which we'll discuss the paper). If you miss the due date, you can still submit a summary within the next 24 hours but you will not be able to earn the in-class discussion points for that paper.

In-class discussions: For each paper, you can earn 3 pts for **being present and prepared to discuss** the figures and other key elements addressed in your submitted summary. Because a discussion involves the submitted summaries, the 3 in-class discussion pts are only available if you have submitted your summary by the start of class. Since absence on a discussion day (see schedule below) will cost 3 pts, as a buffer against the various events (sickness, travel, "mental health" days) that might prevent you from attending class on any of these dates, the two lowest discussion-day scores will be dropped.

Exercises: There will be 10 exercises worth 5 pts each to introduce you to various genomics methods and techniques. You'll have a week to complete each, after which we'll go over the solutions in class. No submissions will be accepted after we have gone over solutions.

Presentation and in-class quizzes: Pairs of students will each give a 5-min presentation on selected topics from the papers we have discussed. Half the class will present on Feb 12 and half on Mar 18. Each

pair will also supply (to me) two multiple-choice questions and answers that anyone who has listened to their presentation should be able to answer. After all groups have presented, the class will take a quiz composed of the questions from each group along with questions drawn from the exercises. **The two dates for presentation/in-class quiz should be treated as exam days and cannot be made up. Please mark these on your calendars.**

Getting help: Please post any questions about course material or assignments -- questions that other students may also be interested in -- in the "Ask the prof" Discussion forum on Canvas. For more specific issues, please sign up for a Zoom office hours slot, using the link found on the Office Hours page.

Expanding the field: Although science is considered an "objective" endeavor, most research questions, discoveries, and applications have been influenced by the experiences of the scientists involved, who have been predominately white males. 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. A hurdle is that students who have traditionally been under-represented in science often feel insecure in their ability to participate and express their views. A secret: anyone who has curiosity and wants to use data to solve a mystery is a scientist at heart! Please let me know if you have any concerns of this nature.

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 quizzes) 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 *amenable to changes based on student interest or publication of new research papers.* Following the schedule is the list of readings. All readings are freely accessible through the Northeastern PubMed database or elsewhere online.

Date	Topic	Readings
M Jan 8	Introduction to genomics	Burian et al.
R Jan 11	Discussion + exercise 1	Burian et al.
M Jan 15	MLK DAY: NO CLASS	
R Jan 18	Follow-up + intro to next paper Helpful webpage	IHGSC
M Jan 22	Discussion + exercise 2	IHGSC
R Jan 25	Follow-up + intro to next paper	Palazzo & Gregory
M Jan 29	Discussion + exercise 3	Palazzo & Gregory
R Feb 1	Follow-up + intro to next paper	Hutchinson et al.
M Feb 5	Discussion + exercise 4	Hutchinson et al.
R Feb 8	Follow-up + intro to next paper	Mishina et al.
M Feb 12	PRESENTATIONS + QUIZ	
R Feb 15	Discussion + exercise 5	Mishina et al.

M Feb 19	PRESIDENTS' DAY: NO CLASS	
R Feb 22	Follow-up + intro to next paper	Casjens et al.
M Feb 26	Discussion + exercise 6	Casjens et al.
R Feb 29	Follow-up + intro to next paper	Lu et al.
Mar4 - Mar8	SPRING BREAK: ENJOY!	
M Mar 11	Discussion + exercise 7	Lu et al.
R Mar 14	Follow-up + intro to next paper	Klunk et al.
M Mar 18	PRESENTATIONS + QUIZ	
R Mar 21	Discussion + exercise 8	Klunk et al.
M Mar 25	Follow-up + intro to next paper	Gozashti et al.
R Mar 28	Discussion + exercise 9	Gozashti et al.
M Apr 1	Follow-up + intro to next paper	Yutín et al.
R Apr 4	Discussion + exercise 10	Yutín et al.
M Apr 8	Follow-up + intro to next paper	Bellas et al.
R Apr 11	Discussion + Jeopardy!	Bellas et al.

Reading list:

- Bellas, Christopher, Thomas Hackl, Marie-Sophie Plakolb, Anna Koslová, Matthias G. Fischer, and Ruben Sommaruga. "Large-Scale Invasion of Unicellular Eukaryotic Genomes by Integrating DNA Viruses." *PNAS* 120, no. 16 (April 18, 2023): e2300465120. <https://doi.org/10.1073/pnas.2300465120>.
- Burian AN, Zhao W, Lo TW, Thurtle-Schmidt DM. "Genome sequencing guide: An introductory toolbox to whole-genome analysis methods." *Biochem Mol Biol Educ*. 2021 Sep;49(5):815-825. doi: 10.1002/bmb.21561. Epub 2021 Aug 11. PMID: 34378845; PMCID: PMC9291972.
- Casjens, Sherwood R., Eddie B. Gilcrease, Marija Vujadinovic, Emmanuel F. Mongodin, Benjamin J. Luft, Steven E. Schutzer, Claire M. Fraser, and Wei-Gang Qiu. "Plasmid Diversity and Phylogenetic Consistency in the Lyme Disease Agent *Borrelia burgdorferi*." *BMC Genomics* 18 (February 15, 2017): 165. <https://doi.org/10.1186/s12864-017-3553-5>.
- Gozashti, Landen, Scott W. Roy, Bryan Thornlow, Alexander Kramer, Manuel Ares, and Russell Corbett-Detig. "Transposable Elements Drive Intron Gain in Diverse Eukaryotes." *PNAS* 119, no. 48 (n.d.): e2209766119. <https://doi.org/10.1073/pnas.2209766119>.
- Hutchison, Clyde A., Ray-Yuan Chuang, Vladimir N. Noskov, Nacyra Assad-Garcia, Thomas J. Deerinck, Mark H. Ellisman, John Gill, et al. "Design and Synthesis of a Minimal Bacterial Genome." *Science* 351, no. 6280 (March 25, 2016): aad6253. <https://doi.org/10.1126/science.aad6253>.
- International Human Genome Sequencing Consortium (IHGSC), Whitehead Institute for Biomedical Research, Center for Genome Research:, Eric S. Lander, Lauren M. Linton, Bruce Birren, Chad

- Nusbaum, Michael C. Zody, et al. "Initial Sequencing and Analysis of the Human Genome." *Nature* 409, no. 6822 (February 15, 2001): 860–921. <https://doi.org/10.1038/35057062>.
- Klunk, Jennifer, Tauras P. Vilgalys, Christian E. Demeure, Xiaoheng Cheng, Mari Shiratori, Julien Madej, Rémi Beau, et al. "Evolution of Immune Genes Is Associated with the Black Death." *Nature* 611, no. 7935 (2022): 312–19. <https://doi.org/10.1038/s41586-022-05349-x>.
- Lu, Roujian, Xiang Zhao, Juan Li, Peihua Niu, Bo Yang, Honglong Wu, Wenling Wang, et al. "Genomic Characterisation and Epidemiology of 2019 Novel Coronavirus: Implications for Virus Origins and Receptor Binding." *Lancet* 395, no. 10224 (2020): 565–74. [https://doi.org/10.1016/S0140-6736\(20\)30251-8](https://doi.org/10.1016/S0140-6736(20)30251-8).
- Mishina, Tappei, Ming-Chung Chiu, Yasuyuki Hashiguchi, Sayumi Oishi, Atsunari Sasaki, Ryuichi Okada, Hironobu Uchiyama, et al. "Massive Horizontal Gene Transfer and the Evolution of Nematomorph-Driven Behavioral Manipulation of Mantids." *Current Biology: CB* 33, no. 22 (November 20, 2023): 4988-4994.e5. <https://doi.org/10.1016/j.cub.2023.09.052>.
- Palazzo, Alexander F., and T. Ryan Gregory. "The Case for Junk DNA." *PLoS Genetics* 10, no. 5 (May 8, 2014): e1004351. <https://doi.org/10.1371/journal.pgen.1004351>.
- Yutin, Natalya, Maxim Y Wolf, Yuri I Wolf, and Eugene V Koonin. "The Origins of Phagocytosis and Eukaryogenesis." *Biology Direct* 4 (February 26, 2009): 9. <https://doi.org/10.1186/1745-6150-4-9>.