

BIOINFORMATICS

11:126:485/16:765:585

Fall 2025

Meeting Times/Locations

Lecture: Mondays, 5:40-7:00 PM, Foran Hall 124 (computer lab)

Lab: Thursdays, 5:40- 8:40 PM, Foran Hall 124 (computer lab)

Journal club (grad section only): TBD

Instructors

Dr. Alanna Cohen

Office: Foran Hall 280

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Dr. Anat Kreimer

Office: CABM 239

kreimer@cabm.rutgers.edu

Office hours: By appointment

Required text: No required text for lab or lecture

Suggested text: Applied Bioinformatics of Nucleic Acid Sequences by David A. Hendix

An Introduction to Applied Bioinformatics (IAB) by J Gregory. Caporaso

A Primer for Computational Biology by Shawn T. O'Neil

(All of the above are best for those new to programming/coding and include additional help and exercises. They are free, open access resources)

COURSE DESCRIPTION

Bioinformatics aims to build computational models of biological systems. This is accomplished primarily by the creating of algorithms, databases, and web applications to solve questions in biology. Bioinformatics implements computational advances such as dynamic computing, artificial intelligence, and cloud computing. These methods are required to deal with the huge amounts of data being produced by high-throughput sequencing and experimental techniques.

We live at a time where sequencing costs are lower than ever. As a result, there are massive amounts of DNA, RNA, and protein sequences that we are not sure how to make sense of. Bioinformatics attempts to sift through the data, identifying patterns, and addressing biological questions and providing statistical significance.

What this course is

This course is primarily for biologists, to introduce them to bioinformatics concepts and techniques. We will expand on previous courses that utilized web-based databases and tools and introduce command-line programming. This will allow you to perform more complex and computationally expensive analyses with larger datasets. We will also explore how to write our own code to extract specific information or results. I strongly believe that there are good programs available, it is not usually necessary to write your own code from scratch. However, you must understand when and how to use certain tools and how to optimize parameters to best fit the needs of your project or biological question.

All the work will be done in a live development environment, using Amarel, the high-performance computing cluster used by many labs at Rutgers. Working in this environment requires a basic knowledge of how to navigate a command-line environment and some basic programming/scripting. These concepts should have been covered in prerequisite courses but will be reviewed here as well. By the end of the course, students will be comfortable working with UNIX/LINUX systems, Python script development, and automating existing applications for large datasets.

Please sign up for an Amarel account prior to our first lab meeting. You may request access to the cluster at <https://oarc.rutgers.edu/amarel-cluster-access-request/>

COURSE OBJECTIVES

1. Introduce bioinformatic algorithms/concepts and their implementations
2. Introduce the basics of working in a Linux environment, SLURM environment job submissions for parallel computing, and python scripting
3. Teach how to approach a biological problem as one that can be answered/addressed with bioinformatics. Students will learn the skills necessary to select appropriate tools, install/use them, optimize them based on their particular data, and build pipelines from a combination of existing tools and *de novo* code
4. Prepare students for more advanced bioinformatic courses
5. Provide students with a bioinformatic skill set that includes knowledge of basic script development and the vocabulary to collaborate within a multi-disciplined research team

TENTATIVE COURSE SCHEDULE (subject to change)

Monday	Lecture	Thursday	Lab
1-Sep	No Class	4-Sep	Introduction to Bioinformatics (Lecture)
8-Sep	Online Tools and Databases	11-Sep	Intro to Linux/command line programming
15-Sep	Gene Finding	18-Sep	Python I: data structures
22-Sep	Pairwise Alignments	25-Sep	Python II: conditional statements and loops
29-Sep	BLOSUM and BLAST	2-Oct	BLAST/command line programs
6-Oct	Multiple Sequence Alignments	9-Oct	Python III: functions and scripts
13-Oct	Sequence Signatures and Motifs	16-Oct	Structural Bioinformatics (Lecture) and Review
20-Oct	Midterm	23-Oct	Office hours
27-Oct	Phylogenetics I: parsimony and UPGMA	30-Oct	Pfam, HMMER, and MUSCLE
3-Nov	Phylogenetics II: NJ, ML, and Bayes	6-Nov	IQ-Tree and Mr. Bayes
10-Nov	Metagenomics	13-Nov	USEARCH
17-Nov	Differential Expression	20-Nov	Tophat and Cufflinks
24-Nov	Disease Gene Prioritization	27-Nov	No class (Thanksgiving)
1-Dec	Variation and Molecular Level Selection	4-Dec	Ka/Ks
8-Dec	Final Review/Office hours		

GRADING POLICY

Each category of coursework will be weighted as follows:

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(Undergraduate)

Lab Homework/Quizzes 30%

Midterm 30%

Split evenly between in-class written exam and take-home coding project

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(Graduate)

Lab

Homework/Quizzes 25%

Midterm 25%

Split evenly between in-class written exam and take-home coding project

Final	40%	Final	35%
<i>Split evenly between in-class written exam and take-home final project</i>		<i>Split evenly between in-class written exam and take-home final project</i>	
N/A		Journal Club	15%
		<i>Based on your presentation AND your weekly contribution to discussions</i>	

Grading Scale

Letter Grade	Range
A	100-90%
B+	<90 to 85%
B	<85 to 80%
C+	<80 to 75%
C	<75 to 70%
D	<70 to 60%
F	<60%

Final course grades will not be rounded up.

ATTENDANCE POLICY

Each week will consist of a lecture (Tuesdays) and a laboratory (Thursdays) session. Lecture attendance is not required, and class participation is not included in your grade. But attendance is strongly encouraged as all test material will be taken directly from our lectures.

Lab attendance **IS** required. Missing a lab without a valid excuse will result in a zero grade for any quizzes or homework assignments associated with that laboratory session. Missing three or more labs without a valid excuse with proper documentation will result in an automatic failing grade for the course. Important lab information and coding quizzes will typically be given at the beginning of the lab session. Please be on time as lateness will not warrant a make-up or extra time given.

In the event of illness or emergency, I will arrange to make up missed work/notes. If you expect to miss a lecture or lab, please let me know as soon as possible through the self-

reporting absence form at <https://sims.rutgers.edu/ssra/>. For periods of absence longer than two days due to serious illness, confidential, or sensitive personal reasons, you must contact the office of the Dean of Students (<https://deanofstudents.rutgers.edu/>) to verify your extended absence from class.

ASSIGNMENTS/RESPONSIBILITIES, GRADING AND ASSESSMENT

Homework/Quizzes

Homework assignments will be assigned during your lab period and due the following week, at the start of the next laboratory period, unless otherwise specified. Late submissions will not be accepted.

Assignments with coding components must run properly in a standard development environment. I will not debug your code, but partial credit will be given where appropriate. Lack of submission, empty submissions, or “fake” submissions will receive a score of 0%. Your code must be yours and properly commented.

Any quizzes will be given during the laboratory session, and may be written questions, coding assignments, or both. Quizzes are up to my discretion and may be announced, but do not have to be. The material may come from either lecture or lab but will be appropriate to the current topic covered. There are no make-up quizzes or extra time given for late starts.

Midterm/Final

The midterm exam will consist of 1) a written portion taken during lecture time and 2) a take-home programming assignment. The midterm will be based on material covered in lecture AND lab. The take-home component will be assigned during lab and be due the following week

The final exam will consist of 1) a question-based portion taken during our assigned exam time during finals week that will include some combination of different tools and techniques learned throughout the semester and 2) a writing component that will include designing, running, and writing up a computational analysis of some biological data. Your final writing project should be modeled after primary literature articles including an introduction/background, results, materials and methods, and discussion. You will have at least three weeks to complete the take-home portion.

Journal Club (Graduate Component Only)

Graduate students will be required to attend journal club meetings. Each meeting, everyone is expected to have read the selected paper and participate in the discussion. Every student will be required to choose and present a bioinformatics paper of their choice. You will be expected to present a short presentation and lead the discussion surrounding the paper. Your presentation and weekly participation in journal club will account for 15% of your final grade.

Undergraduates are welcome and encouraged to attend journal club but will not receive extra credit for doing so.

ACCOMMODATIONS FOR STUDENTS WITH DISABILITIES

Rutgers University welcomes students with disabilities into all of the University's educational programs. In order to receive consideration for reasonable accommodations, a student with a disability must contact the appropriate disability services office at the campus where you are officially enrolled, participate in an intake interview, and provide documentation: <https://ods.rutgers.edu/students/documentation-guidelines>. If the documentation supports your request for reasonable accommodations, your campus's disability services office will provide you with a Letter of Accommodation. Please share this letter with your instructors and discuss the accommodations with them as early in your courses as possible.

To begin this process, please complete the Registration form on the ODS web site at: <https://webapps.rutgers.edu/student-ods/forms/registration>. Full policies and procedures can be found at <https://ods.rutgers.edu>.

AVAILABILITY OF TEACHING MATERIALS

There is no required textbook for this course. However, you will be responsible for any information presented or discussed during lecture (regardless of if it is the slides). Slide presentations will be posted to course Canvas site prior to each lecture. Lectures will not be recorded. Student recording of lecture is prohibited and must be discussed with the instructor in advance. Please remember that all lecture materials are protected intellectual property and cannot be shared or posted without permission of the instructor.

Rutgers is committed to maintaining minimum digital accessibility standards. Compliance with these standards as part of the Americans with Disabilities Act (ADA) and Section 504 of the Rehabilitation Act is still in process and will be complete by April 24, 2026. If there is an issue with the accessibility of any digital information, please bring it to the attention of your instructor, who will work to rectify the situation.

ACADEMIC INTEGRITY

Academic dishonesty, in any form, will not be tolerated. This includes copying from another student or online resources. Students are allowed and encouraged to discuss homework problems but should not copy any code directly. Use the “coffee break” rule. If you have a discussion about a problem, you should be able to walk away, have a cup of coffee, and then return and be able to come up with a solution from memory. The same applies to searching the web for solutions to problems. You can use online resources to learn from, but need to be able to write your own code from what you learn. This includes the use of AI tools such as ChatGPT. Copying ANYTHING directly is strictly prohibited, all code and material you submit must be your own.

Working together is only allowed on homework assignments. There will be no group work accepted for midterm and final projects unless otherwise stated. Exams are strictly closed book/notebook and students are not allowed to use outside sources or help on exams.

Students must comply with the university's policy on Academic Integrity, which is available at <https://academicintegrity.rutgers.edu/sites/default/files/pdfs/current.pdf>. The principles of academic integrity require that a student:

- properly acknowledge and cite all use of the ideas, results, or words of others.
- properly acknowledge all contributors to a given piece of work.
- make sure that all work submitted as his or her own in a course or other academic activity is produced without the aid of impermissible materials or impermissible collaboration.
- obtain all data or results by ethical means and report them accurately without suppressing any results inconsistent with his or her interpretation or conclusions.
- treat all other students in an ethical manner, respecting their integrity and right to pursue their educational goals without interference. This requires that a student neither facilitate academic dishonesty by others nor obstruct their academic progress.
- uphold the canons of the ethical or professional code of the profession for which he or she is preparing.

Adherence to these principles is necessary in order to ensure that

- everyone is given proper credit for his or her ideas, words, results, and other scholarly accomplishments.
- all student work is fairly evaluated, and no student has an inappropriate advantage over others.
- the academic and ethical development of all students is fostered.
- the reputation of the University for integrity in its teaching, research, and scholarship is maintained and enhanced.

Failure to uphold these principles of academic integrity threatens both the reputation of the University and the value of the degrees awarded to its students. Every member of the University community therefore bears a responsibility for ensuring that the highest standards of academic integrity are upheld.

STATEMENT OF DIVERSITY, EQUITY, AND INCLUSION

It is our intention that students of all backgrounds will be well served by this course. We will work to create an environment of inclusion which respects and affirms the inherent dignity, value, and uniqueness of all individuals, communities and perspectives. We are lucky to have a diverse university. Diverse voices and life experiences enhance the learning process, and we welcome students to share their personal experiences. We will not tolerate disrespectful language or behavior against any individual or group. If you feel as though you have been disrespected or treated unfairly by the instructors or any other individual, please let us know. You may speak with the instructors in person, over email or report anonymously via the Office of Academic Programs. In addition, you may also report bias to the Rutgers Diversity and Inclusion initiative using this link: <http://inclusion.rutgers.edu/report-bias-incident/>.

RELIGIOUS OBSERVANCES

It is university policy (University Regulation on Attendance, Book 2, 2,47B, formerly 60.1 4f) to excuse, without penalty, students who are absent from class because of religious observance and to allow the makeup of work missed because of such absence. Examinations and special required out-of-class activities shall ordinarily not be scheduled on those days when religiously observant students refrain from participating in secular activities. Absences for reasons of religious obligation shall not be counted for purposes of reporting. Students are advised to provide timely notification to instructors about necessary absences for religious observances and are responsible for making up the work or exams according to an agreed-upon schedule.

STUDENT WELLNESS SERVICES

Counseling, ADAP & Psychiatric Services (CAPS)

(848) 932-7884 / 17 Senior Street, New Brunswick, NJ 08901/ www.rhscaps.rutgers.edu/

CAPS is a University mental health support service that includes counseling, alcohol and other drug assistance, and psychiatric services staffed by a team of professionals within Rutgers Health services to support students' efforts to succeed at Rutgers University. CAPS

offers a variety of services that include individual therapy, group therapy and workshops, crisis intervention, referral to specialists in the community and consultation and collaboration with campus partners.

Access helpful mental health information and resources for yourself or a friend in a mental health crisis on your smartphone or tablet and easily contact CAPS or RUPD.

Violence Prevention & Victim Assistance (VPVA)

(848) 932-1181 / 3 Bartlett Street, New Brunswick, NJ 08901 / <https://vpva.rutgers.edu/>

The Office for Violence Prevention and Victim Assistance provides confidential crisis intervention, counseling, and advocacy for victims of sexual and relationship violence and stalking to students, staff, and faculty. To reach staff during office hours when the university is open or to reach an advocate after hours, call 848-932-1181.

Compliance and Title IX

Rutgers faculty are committed to helping create a safe learning environment for all students and for the university as a whole. If you have experienced any form of gender or sex-based discrimination or harassment, including sexual assault, sexual harassment, relationship violence, or stalking, know that help and support are available. Rutgers has staff members trained to support survivors in navigating campus life, accessing health and counseling services, providing academic and housing accommodations, and more. The University strongly encourages all students to report any such incidents to the University. Please be aware that all Rutgers employees (other than those designated as confidential resources such as advocates, counselors, clergy and healthcare providers as listed in Appendix A to Policy 60.1.33) are required to report information about such discrimination and harassment to the University. This means that if you tell a faculty member about a situation of sexual harassment or sexual violence, relationship violence, stalking or other related misconduct, the faculty member must share that information with the University's Title IX Coordinator. If you wish to speak to a confidential employee who does not have this reporting responsibility, you can find a list of resources in Appendix A to University Policy 60.1.33. For more information about your options at Rutgers, please visit <https://endsexualviolence.rutgers.edu/>.

Disability Services

(848) 445-6800 / Lucy Stone Hall, Suite A145, Livingston Campus, 54 Joyce Kilmer Avenue, Piscataway, NJ 08854 / <https://ods.rutgers.edu/>

DoSomething button through Rutgers Dean of Students office:

<http://health.rutgers.edu/do-something-to-help/>

Wellness Coaching through Rutgers HOPE:

<https://health.rutgers.edu/health-education-and-promotion/health-promotion-peer-education/wellness-coaching>

Self-Help Apps found on the Rutgers Student Health website:

<https://health.rutgers.edu/health-education-and-promotion/self-help/self-help-apps>

NJ Hopeline - (1-855-654-6735) | **National Suicide Hotline** - (1-800-273-8255)

BASIC NEEDS RESOURCES

Any student who has difficulty affording groceries or accessing sufficient food, or who lacks a safe and stable place to live, is urged to contact the Rutgers Student Food Pantry and/or the Dean of Students (details below). Furthermore, please notify the professor if you are comfortable doing so, as they may be able to provide additional support.

Rutgers Student Food Pantry

848-932-5500 / College Ave Student Center, Room 115 (126 College Ave) /

<http://ruoffcampus.rutgers.edu/food/>

Check their website for hours and additional locations. The Rutgers Student Food Pantry is dedicated to helping all Rutgers students in need of food, no questions asked. Students will be provided with groceries that typically last about one week.

Dean of Students Office

848-932-2300 / 88 College Avenue, New Brunswick, NJ 08901 /

<https://deanofstudents.rutgers.edu/>

Mon-Fri, 8:30am-5:00pm

The Dean of Students Office at Rutgers University-New Brunswick provides solutions, services, and support to help students navigate Rutgers University. The Office serves as a student support network by providing advocacy, problem resolution, and critical incident intervention for those times when additional assistance is needed. Please call to schedule an appointment to meet with a representative from the Dean's office.