

# 1 Bio331: Computational Systems Biology

In the era of high-throughput genomics, proteomics, and transcriptomics, we can now computationally explore biological processes at a systems level. Networks, or graphs, have become a dominant mathematical representation in this area of research. We will draw on the vast amount of established graph theory to learn about network models currently applied to biological systems.

## 1.1 Course Details

Professor	Anna Ritz (she/her, aritz@reed.edu, Bio 200B)
Time & Place	<b>Lecture</b> MF 10:05–10:55 in Kaul Gray Lounge (W 10:05–10:55 is available for in-person group meetings). <b>Lab</b> In-person Tu 13:40–17:30 in ETC 205; virtual Th 13:40–17:30, TBD
Office Hours	TBD (virtual)
Moodle <a href="#">[link]</a>	<a href="https://moodle.reed.edu/course/view.php?id=3302">https://moodle.reed.edu/course/view.php?id=3302</a> All reading, videos, and other materials will be freely available via Moodle.
Collab. Policy <a href="#">[pdf]</a>	<a href="http://reed.edu/biology/ritz/files/collaboration-policy.pdf">http://reed.edu/biology/ritz/files/collaboration-policy.pdf</a>

There is also a public-facing [course website](#) that includes previous projects.

## 1.2 Course Goals

At the end of this course, you will be able to:

- Represent biological systems as networks and understand how they are built from experimental data.
- Apply graph algorithms to these networks on small examples and real-world datasets.
- Interpret the results of an algorithm run on a biological network.
- Design and execute a research project motivated by a question in systems biology.
- Use technologies that enable collaboration and communication.
- Present work in oral presentations and written reports.
- Navigate a virtual conference.

## 2 Bio331 Structure

**Lectures.** Bio331 will have synchronous lectures on Monday and Fridays (10:05–10:55) in Kaul Gray Lounge, which will be available for in-person and remote participation. There will typically be an asynchronous activity to be done between the two lecture days, and the room is available on Wednesday 10:05–10:55 for students to work together.

**Labs.** Bio331 labs will have a four-hour time slot (currently scheduled for in-person Tuesday 13:40–17:30 and online Thursday 13:40–17:30, other times TBD), though the labs may be shorter. Importantly, students will work in small groups during the lab time unless there are unavoidable time conflicts.

**Modules.** There are five modules before Thanksgiving Break (see the schedule in Section 2.4). The modules begin with a lot of structure, and gradually have less and less structure. By the time you are in Module 5, you are working to plan and execute a research project of your own.

## 2.1 Assessment

There are three general types of student assessment, which allows you to demonstrate acquired knowledge in multiple ways.

- 40% **Written Assignments:** a combination of take-home quiz questions (which are graded) and reflections (which are marked as complete/incomplete). These should be completed individually, and you can use and cite any resources (notes, internet, course materials, etc.).
- 40% **Programming Assignments:** graded Python programming assignments which build upon content learned in labs and lectures. These can be done in collaboration with others as outlined in the [Collaboration Policy](#).
- 20% **Worksheets & Lab Presentations:** short comprehension questions (which will be reviewed in-class) and oral presentations (joint with Bio372). Worksheets and presentations will be marked as complete/incomplete, and students will receive presentation feedback. These can be done in collaboration with others as outlined in the [Collaboration Policy](#).

There are no formal in-class or take-home exams. Each module will typically have one programming assignment, one written assignment, and a weekly worksheet or presentation. The notable exception is Module 5, where the Research Project includes a written component, a programming component, and a presentation component.

## 2.2 Deadlines

**All assignments and worksheets for a particular module are available when the module starts and are due before the next module begins.** For example, Module 1 materials will be available on the first day of class, and are collectively due on Monday, September 14. This deadline structure is designed to give you flexibility in your work hours outside of class, but should not be seen as a signal to do all work over a single weekend. Worksheets (and, in some cases the writing and programming assignments) are designed to be done in certain weeks of the module, and you are encouraged to turn them in early. Suggested deadlines will be noted on the Google Calendar to help you gauge whether you are on track to complete the work.

## 2.3 Communication and Technology

**The official communications about all course materials and assignments will be done through the [Moodle page](#).** The course content may be adjusted (for example, if we move completely online) - you should check Moodle and your email every day to stay updated. Additionally,

- We will use Zoom for video conferencing.
- We will use Slack and Google Docs for text-based communication.
- Programming assignments will be completed using GitHub Classroom (this will be taught).
- Writing assignments will be completed using LaTeX (this will be taught).
- There will be a Google Calendar with course content and deadlines that students can add to their own accounts. This will be updated regularly.

## 2.4 Schedule

Refer to [Moodle](#) for up-to-date information and more details. Three labs will be jointly held with Bio372 (Cellular Biology).

<b>Module 1: Introduction to Networks and the NMII Project</b> (programming assignment, writing assignment, 2 worksheets)		
<b>Week</b>	<b>Lecture Content</b>	<b>Lab Content</b>
Week 1 (08/31–09/04)	Intro to Graphs & Bio Concepts	NMII Project (Joint)
Week 2 (09/07–09/11)	Local & Global Graph Properties	Animal Social Network Viz
<b>Module 2: Virtually Attending ACM-BCB</b> (programming assignment, writing assignment, 2 worksheets)		
<b>Week</b>	<b>Lecture Content</b>	<b>Lab Content</b>
Week 3 (09/14–09/18)	Centralities & Conference Prep.	Protein Interactomes
Week 4 (09/21–09/25)	ACM-BCB Conference	ACM-BCB Conference
<b>Module 3: Graph Algorithms and Applications</b> (programming assignment, multi-part writing assignment)		
<b>Week</b>	<b>Lecture Content</b>	<b>Lab Content</b>
Week 5 (09/28–10/02)	Ecology Networks & Shortest Paths	Shortest Paths
Week 6 (10/05–10/09)	COVID-19 Networks & Random Walks	Random Walks
Week 7 (10/12–10/16)	Brain Networks & Community Detection	Community Detection
<b>Module 4: NMII Project Recap</b> (programming assignment, lab presentation)		
<b>Week</b>	<b>Lecture Content</b>	<b>Lab Content</b>
Week 8 (10/19–10/23)	NMII Project	NMII Project
Week 9 (10/26–10/30)	Presentation Preparation	NMII Presentation (Joint)
<b>Module 5: Research Project and Special Topics</b> (Set specific milestones for each research project)		
<b>Week</b>	<b>Lecture Content</b>	<b>Lab Content</b>
Week 10 (11/02–11/06)	TBD & Mini-Break	Research Project
Week 11 (11/09–11/13)	TBD	Research Project
Week 12 (11/16–11/20)	TBD	Research Project
<b>Thanksgiving Break</b>		
<b>Wrap-Up</b> (programming assignment, writing assignment, 2 worksheets)		
<b>Week</b>	<b>Lecture Content</b>	<b>Lab Content</b>
Week 13 (11/30–12/04)	Presentation Preparation	Research Presentation (Joint)
Last Day (12/07)	Class Wrap-up	
Finals (12/10–12/15)	Research project due; all resubmitted work due	

## 3 Course Policies

### 3.1 Attendance and Late Policies

#### Lecture Attendance

*Why Attend?* Attending the synchronous lectures and completing the asynchronous activities on time will put you in the best position to succeed in the course. Lectures will provide valuable information about the assignments and worksheets.

*What's the Policy?* There is no penalty for missing class, but you are expected to review the missed material and meet with me if anything is unclear.

#### Lab Attendance

*Why Attend?* Group work is a large component of the class. You should strive to meet during agreed-upon meeting times with your group. Labs also offer time for me to provide guidance – they could be framed as small-group office hours working through problems together.

*What's the Policy?* There is no penalty for missing lab, but you have a responsibility to communicate with your group and catch up with work asynchronously.

#### Late Policy.

*Why Submit Work on Time?* All assignments for a module should be submitted before the next module begins; this is designed so you do not lose ground with current coursework as they finish older assignments.

*What's the Policy?* You must submit whatever work you have by the deadline, but there is no penalty for re-submitting programming and written assignments. If you plan to resubmit their work, you must include a comment or statement to that effect and schedule a time to meet with me within one week of the submission in order to make a plan. You have until Finals Week to re-submit all programming and written assignments. These details will be provided on every written and programming assignment.

#### The Honor Principle is in effect at all times.

Written assignments are completed individually; for all other assignments you can work with each other. Refer to the [Collaboration Policy](#) for details about what is allowed in this course.

### 3.2 Academic Accommodations

Please discuss any documented accommodations with me, especially those that include extensions on assignments. In the world of hybrid and remote-learning, please let me know if there are useful supplements to course content (e.g. closed captioning). Disability Accommodation Notification Letters can be obtained from [Disability & Accessibility Resources](#). All discussions will remain confidential.

### 3.3 Diversity and Inclusion

Bio331 is a combination of biology and computer science, and each field has been claimed to be free of racism and prejudice. This is simply not true. Historically, biological discoveries and advances in computer science have been dominated by privileged voices, namely those of white men. Computational biology, while more recent of a field, also lacks diversity along many important axes (including race, gender, nationality, class, sexuality, religion, ability, etc.). To foster an inclusive learning environment:

- I acknowledge the bias in course materials that stem from systemic privilege, and I aim to make Bio331 content more inclusive each time I teach the course.
- I expect that students come to Bio331 with varying levels of knowledge in both biology and computer science, and I aim to provide course materials to help fill in gaps in both areas.
- Many students will have personal circumstances that may affect their performance in the course. I will work with students to make adjustments to the course schedule as needed, and students should be encouraged to seek guidance on any anticipated or realized issues.
- Mental and physical health is more important than attending all parts of class. If you miss multiple days of class, I will reach out to make sure you are okay.

Bio331 is a better course when students have a diversity of lived experience and previous knowledge.

### 3.4 Feedback for the Instructor

Please give me feedback on anything in the syllabus or course, especially with respect to making Bio331 an inclusive learning environment. Let me know if anything makes you uncomfortable in class, if you would like more instruction on a topic, or if you are experiencing a hardship outside of class. Anonymous feedback is available on Moodle, though with a small class your comments may be identifiable. Further, note that faculty are obligated reporters, who must report possible violations of the Title IX and/or DHSM policies, which govern discrimination and harassment on the basis of sex, gender, and gender identity. If you need additional support, please reach out to Assistant Dean for Student Support Britt Hoover at [hooverb@reed.edu](mailto:hooverb@reed.edu) or [careteam@reed.edu](mailto:careteam@reed.edu).

## 4 Tips for Success

- **Start the assignments early.** The assignments are designed to be done over 2–3 weeks (and you may spend many hours debugging your programs). Read the assignments at the beginning of each module and follow the suggested guidelines to make sure you are on track to complete all the work for each module.
- **This course is cumulative,** meaning the topics build upon each other throughout the semester. If you are having trouble with a concept or activity, talk to me early before you find that you need that concept in a later assignment.
- **When in doubt, ask.** Asking for help can be unintuitive, but a little clarification goes a long way. In addition to posted office hours, students can seek one-on-one tutoring through the [Office of Academic Support](#).
- **When you don't even know where to start, ask.** This can be the toughest thing when working on problems that do not have a nice, clean solution – where to start? Coming to office hours when you don't even have a properly-formed question is still valuable.
- **Working collaboratively is fun!** Try to talk through complicated concepts with others, and make use of the group time in lab to get clarification.
- **Start the assignments early.** Really.

Even though this Fall will undoubtedly have its academic and personal challenges, I am looking forward to working with you all this semester.