

STATISTICS IN BIOLOGICAL RESEARCH

COURSE DETAILS

Course Description:

Time: Monday/Wednesday 2:05 – 3:25

Physical Location: CNS-202

Virtual Location: | [Virtual Office](#)

Welcome to Statistics for Biological Research! Modern biologists, from geneticists to ecosystem ecologists, use standard data analysis techniques to better design, conduct, and evaluate biological research. Consequently, a core understanding of these methods and their conceptual underpinnings is key to success in biology. In this course, we will introduce quantitative skills needed to design, conduct, and evaluate research across all levels of biology. We will also discuss the concepts and rationale that underlie current quantitative methods in biology, with a focus on statistics. Finally, we will discuss the role of these analyses in biology and in day-to-day life.

Professor:

Dr. Nathan T. Fried (neuro.fried@rutgers.edu | www.NeuroFriedLab.com)

Assistant Teaching Professor, Department of Biology, Rutgers Camden

Research Area: Neuroscience, Pain, Opioids, Sleep, Biology Education

Office Hours: [Office Hours Sign-up](#) | [Virtual Office](#)

Note from the professor:

SBR is a team-designed course, meaning that several faculty members came together to create this unique experience. It's a method of teaching you'll often see in medical and graduate school and provides the opportunity to get exposure and expertise from a large range of scientific backgrounds. As such, this course was initially designed, conceived, and created by [Dr. Amy Savage](#), an ecology professor here at Rutgers Camden. Video lectures and hybrid components were designed by [Dr. Nathan Fried](#), a neuroscientist here at Rutgers Camden, and [Dr. Joe Zinski](#), a developmental biologist at the University of Pennsylvania. Finally, several of the workshops were expanded and designed by [Dr. Steven Foltz](#), a computational biologist at the University of Pennsylvania. This range of backgrounds is important because this course has a unique component where students design their very-own research study that can later be carried out in a course called, "PPBR".

Most of the time when a student hates statistics or math, it's because they fear it. This fear can develop early when a student has a bad experience with learning the material or becomes frustrated with using it. No matter what future direction you take, however, you'll need a good grasp of statistics. Even in your personal life when looking at disease-related data, you need to understand the statistics behind the numbers to help make personal decisions. This class will give you exposure to not just statistics, but also research methods used across all biology sub-disciplines whether you pursue a research career in ecology or a health career in neuroscience.

Learning Objectives:

1. Students will learn how to find, interpret and evaluate data and analyses in primary scientific articles in the life sciences.
2. Students will learn how to design & conduct experiments in Biology, as well as how to analyze the data resulting from biological experiments.
3. Students will learn the common pitfalls in experimental design and data analyses in Biology and how to avoid them.
4. Students will learn how to use spreadsheet and data analysis software to collect, track and analyze data from biological experiments.
5. Students will learn the concepts, rationale, and proper use of common statistical tools used in Biology.
6. Students will develop a research proposal they could use in PPBR if they decide to take that course.

Learning Outcomes:

1. Students will recognize how statistics and research methods work together to allow scientists to explore scientific ideas.
2. Students will gain an appreciation for the details necessary in developing a research idea.
3. Students will develop familiarity and confidence in using excel and R to carry out various statistical analyses.
4. Students will become comfortable with discussing how statistics are used in biological research.

COURSE MATERIALS

Recommended Text: We'll have a handful of recommended reading assignments. It's a good book and helpful resource for working with excel and R.

Gardener. 2017. Statistics for Ecologists Using R and Excel: Data Collection, Exploration, Analysis and Presentation, 2nd edition. Pelagic University Press. Available as an ebook at [Amazon](#) (you can also rent it at the bookstore).

Excel: You get it [here](#) for free from Rutgers.

R & R-Studio: R is a free open-source programming language and R-Studio is a GUI with a free version that helps you use R. You can download both for free [here](#). Download the open-source (free) version of R-Studio Desktop.

Zoom: We'll use Zoom to meet during some sessions. You can access a Rutgers Zoom Account [HERE](#).

Canvas: We'll organize the class in canvas.

Computer: You should have a computer and reliable internet access. If you don't, please let me know.

CLASS STRUCTURE

See excel sheet for each week's topic/plan/due dates. Each week will be a different module of material (i.e., Week 2 will be Module 2 material) including 1) pre-class lecture videos, 2) computer workshops, and 3) group workshops. Some days will be virtual and other days will be in-person, but you will have access to the lecture room during the scheduled class hours. Below is an example of how each week will run.

Weekend: Watch pre-lecture videos before coming to class. They'll be available one week prior to the Monday lecture. After watching the videos, you will have to complete a short quiz.

Mondays (class)

Student-led News story
Discussion on Module videos
Workshop

Wednesday (class):

Student-led News story
Workshop

Fridays:

Computer & Group Workshop due at 5pm
Group and Computer Workshop solutions released at 6pm

COURSE ASSIGNMENTS, ACTIVITIES, & DETAILS

This class is designed to be hands-on and requires active, not passive learning. It'll be different than many of your lecture courses because it's what we call "flipped". In a flipped classroom, you watch lectures before coming to class and once you're in class, you do activities that help reinforce the material and discuss anything you might have been confused by. As such, there are several activities students will participate in.

Weekly Quizzes (due 9am on Mondays): Each week, there will be a 10-question quiz you can answer from watching the module videos. They're pretty hard to answer without watching the videos, so don't start the quiz until you've watched the module videos! You will have the whole week to take the quiz. There is no time limit, and you have two tries (*average of both tries is your grade*).

Computer Workshops: It is very important that you get hands-on experience working through problems using software. At the end of each workshop, there will be a series of questions that require you to complete the workshop to answer (for example, you may have to explain how evidence supports or does not support a hypothesis using statistical tests that you conducted). These questions will be great study tools for your exams. You can work with anyone on these workshops. You two should work together during the class period to complete the workshop. You will need to submit your answers or work no later than 5pm on Friday. You receive credit for just submitting it in canvas (i.e., not graded). We will post the answer key for that module by Friday the week it is due. If you are unable to make it to class due to COVID-related or computer-related issues, you will be required to complete the computer workshop on your own and submit it by the due date.

Group Workshops: You will work in groups of 4-5 students for workshops that are focused more on critical thinking. Group workshops include problem sets that you must spend the entire class period working through with your group. You will need to submit your answers no later than 5pm on Friday. You receive credit for just submitting it in canvas (i.e., not graded). We will post the answer key for that module by Friday the week it is due.

Forming Groups: You will be pre-matched with a group of students randomly selected in the class. After the first exam, you will then be able to choose your own group of 4-5 students and develop a "team name". This final group will be responsible for carrying out the final group project together. If a student has no preference for a specific group, I will help them get placed in a group of their liking.

Including team members outside your SBR section: The final group project can be used in PPBR, but for some students, you may want to include students from other SBR sections or even students who have already completed SBR. This is fine, but you need to see me ASAP so the group can plan accordingly. These "extra-curricular team members" will be responsible for meeting with your SBR section group but may not be required to participate in some activities.

Peer/self-evaluation: After each group workshop, your group members will evaluate your effort toward the activity. You will also self-evaluate. This will take the place of an attendance/participation grade. Your final grade for this category will be the average of all your peer evaluations and your own evaluation. If you are absent during the group workshop, your peers will give you a "zero". Just like in the real world, you should communicate with your group about any absence and how you can make up your contribution to the workshop or project for them to agree on giving you a better evaluation for that week. You will also complete a final 2 pt peer/self-evaluation for your final group project.

Final Group Project (Research Proposal): This project will be a series of activities that culminate in a research proposal that could be realistically carried out by you. For those of you who plan to take PPBR, a class that let's you run your own research, in a future semester, you can use this proposal in PPBR.

Intent to join PPBR in Fall Semester Decision (Due in Module 6) – You do not need to take PPBR this coming semester, but it's a great opportunity for you to gain hands-on research experience (seriously, no pressure to join it. Or you can feel free to take it in future semesters!) Plus, there's an opportunity for you to publish in our undergraduate research journal, [The Journal of Biological Science](#). For us to plan, you need to make a decision of whether you intend to use your SBR final group project for a PPBR research project. We recommend you develop your group with other students who want to take PPBR as well, but it is not a requirement. Students who do not develop a strong research proposal will have the option of working on a proposal the PPBR faculty have already created (i.e., pain or circadian rhythms). We

recommend that even if you're on the fence about joining PPBR, you indicate your intent on this due date. You are allowed to change your mind later in the semester at no penalty.

Project proposal pitch days – The first step of developing a research proposal is finding a scientific phenomenon that interests you. The second step is figuring out a research question that is interesting and important to the field. The third step is developing a hypothesis regarding the idea. At these project proposal pitches, your team can informally chat with me and/or the class about your idea and I'll give you feedback on it. My goal will be to help you figure out a project idea that is feasible (usually involving invertebrates ranging from spiders to drosophila to worms or plant/fungi species). The best place to start is by browsing www.the-scientist.com and searching for interesting scientific discoveries. These days are for your benefit and are ungraded. Developing a strong research idea/plan takes lots of time and lots of conversation. That's the goal of these days. For students looking to pitch their project for PPBR, you'll have to also pitch your research idea to Dr. Kwangwon Lee who runs PPBR so he's aware of what you're planning.

Mini-proposal hypothesis (Due in Module 9) – To help with the creation of your proposal, we have a short guide on how to generate a strong hypothesis. I will grade VERY harshly on this because no one does well initially, but you can re-submit as many times as you want to improve the grade.

Mini-proposal (Due in Module 13) – You'll write up a short 1 page mini-proposal of your idea that focuses on the background, research methods, statistical tools, and expected outcomes for your project.

For groups submitting just for a grade, we will grade it based on the sections you fill out and whether it fleshes out the project sufficiently.

For groups looking to apply to PPBR, we will use this document to decide whether it is suitable for a PPBR project. You will receive one chance to make modifications to it if we deny it. If the proposal is accepted, we will give you special permission numbers to register for PPBR. If your idea is rejected, we will give you a project you can work on.

Proposal Defense Presentation – All groups will give a 20 - 25 minute PowerPoint defense presentation with the goal of defending why your proposal is a) important and b) feasible. You'll also need to submit your powerpoint on canvas.

Presentation Rubric (remember, ~2 min for every slide):

Introduction/Background (~7 min) (40%): It is VITAL to frame the a) research area/background, b) scientific phenomenon, c) research question, d) research hypothesis, e) research strategy.

Research Strategy (~7 min) (40%): Discuss your research methods you'll use to study this. Be sure to describe 1) the groups you'll use (positive ctrl, negative ctrl, and experimental group(s)), 2) the methods you'll use, 3) the statistical tests you'll apply, and 4) the feasibility of the project. This NEEDS to be really fleshed out so we can see the specifics of your project, not just the supporting science behind it.

Anticipated Results (~2 min) (10%): Provide 1) a graph demonstrating your predictions of the results if your data support your hypothesis and 2) a graph demonstrating your predictions if the results DO NOT support your hypothesis.

Conclusions (~4 min) (5%): Now discuss what this would mean to the scientific field or phenomenon you're exploring if you are correct. How would this help our understanding of life? How would this help patients? How would this help the world?

Questions/Discussion (~5 min) (5%): Be ready to answer any questions from the audience. I will always ask a question about 1) your methods and another question about 2) your science. Come prepared to answer these appropriately.

Proposal Shopping List (only if doing PPBR) – If you’re using your project in PPBR and you’re accepted into PPBR, we need to know what reagents and experimental tools we must purchase for your project to be successful. You will need to submit this shopping list to us by finals week.

Right-to-Know (RTK) Training Seminar (only if doing PPBR) – If you’re planning to join PPBR, you’ll take a 2-3 hr online training seminar describing how to work safely in a lab. All researchers (including me!) have to take this before we’re allowed to conduct research on campus.

Exams: There will be two exams that will be released on a Monday and due on a Sunday. You can take the exam any time you wish, but once you start, you’ll only have 2 hours to finish. All exams will be scanned for plagiarism.

Final Exam: A final exam will be the entire finals-period. There will be no time limit. The exam will be scanned for plagiarism. Don’t wait until last minute. It takes a long time.

Individual Learning Assessment: A short quiz that allows you to reflect on what you learned in SBR.

EXTRA CREDIT OPTIONS

We give you multiple methods to obtain extra credit up to a total of 5 pts. Below are your options.

In the News: To inspire projects, scientists often start with reading about recent discoveries. Thus, I will give 1 pts if you a) give a brief 2-4 minute presentation about any news story from www.The-Scientist.com and b) post the article and a description of at least one component of their study design (i.e., don’t just tell us the conclusion. Tell us about HOW they found the conclusion) on Canvas Discussions. You can receive up to 2 pts in total for presenting. Try to make it a conversation when you tell us about it. The goal is to contribute to the brain-storming all students are doing for developing their research proposal. You can only do this up to the day the mini-proposals are due.

Rosalind: In this class, you’ll learn excel and R, but several computational biologists (like those who work at 23andMe or Google) also use python. An AMAZING resource to learn how to code in python as a biologist is a website called Rosalind (can you guess where the name comes from?). It’s not easy, but it has TONS of project-based problems that are almost like riddles. If you complete the first set of 6 problems in “Python Village”, screen capture it with your username and submit it on canvas for 2 points. Then, slowly train yourself by running through the “Bioinformatics Stronghold” for the rest of your academic career. Think of it like a game. The further you get through that stronghold, the more marketable you’re going to be after you graduate. I suggest flexing these muscles your entire life. If you can code, you’ll make more money.

Join SBR Slack Channel (due by first exam): Slack is a great tool used by companies across the world to turn emails into conversations. Definitely immerse yourself into it because it’s a tool future employers will want to know if you can use. The Biology department uses it A LOT. We’ve created a special channel called “SBR-F22” where you can come to chat about everything and anything related to the course. I use it daily. I sent you each an invite to the Biology Slack Workspace and SBR-F22 Channel. I suggest downloading the desktop app instead of using the web portal ([windows](#) & [mac](#)). The desktop app is MUCH easier to use and more intuitive. For 1 extra credit point, you can join it and post one message!

CALCULATION OF FINAL GRADES

Module Quizzes (1 pts each x 15)	15 pts
Computer Workshops (1 pts each x 10)	10 pts
Group Workshops (1 pt each x 8)	8 pts
Peer/Self Evaluation	10 pts
Group Mini-proposal hypothesis	3 pts
Group Mini-proposal	7 pts
Group Proposal Defense	15 pts
Exams (9 pts each x 2)	18 pts
Final Exam	13 pts
Individual Learning Assessment	1 pts
Extra credit (up to 5 pts collectively)	5 pts
Total	100 pts (105 w/ extra credit)

CLASSROOM POLICIES

COVID Safety Precautions: I have received the vaccine (Pfizer – two doses) and will be wearing a mask while indoors in both my professional and private life. All students are required to wear masks while in the classroom. Be sure to cover both your mouth and nose. Rutgers is continuing to update their recommendations ([updates](#) & [official protocols](#)).

COVID Compassion Culture: These past two years have not been easy. We want to treat each other with compassion because this semester will continue to throw us curve balls. Let’s cultivate a space where we care about each other and try our best to be understanding, fair, and compassionate. Everyone is going through their own personal struggle. Some have greater risks due to living with unvaccinated children or family and others have their own risk tolerance levels. Let’s cultivate a space where we can 1) respect each other’s boundaries and 2) feel safe to verbalize our boundaries.

Late Assignments or Exams: If an assignment or exam is late, you receive a 10% deduction (i.e., the max grade you can get is a 90%).

Attendance: Since portions of this course will be virtual and some students may be affected by internet connectivity or health-related issues at different times, we will not require attendance. Instead, the peer/self-evaluation will provide us with a grade for how much you have participated throughout the semester.

If you are absent on a computer workshop day, you do not need to tell us. Just submit your workshop by yourself by the deadline.

If you are absent on a group workshop day or day where you plan to meet your group, you do not need to tell us. Instead, reach out to your group members to find alternative arrangements (i.e., zoom in during in-person meetings).

Office hours policy: Please don’t email me to tell me you’re coming to office hours. I get so many emails so it’ll be hard to keep track of it. Instead, just use the bookings link I have at the beginning of this syllabus to book a 20-minute chunk (or more!) of time with me. Booking helps me know if someone is coming so I don’t walk away from my computer and to ensure other students aren’t eating into your time. These office hours are YOUR TIME to chat with me about anything under the sun. Use them liberally.

Email policy: I get a lot of emails every day. I teach all day/night on Mon and Wed so I won’t respond to your email until Wed or Thurs (usually within 24-48 hrs). But if you haven’t received a response, feel free to “ping me” again. Sometimes the flood of emails might bury yours. Pinging the message is common in academia. Always feel free to remind someone of your email. Often, if they don’t respond, it’s just because they missed it, not because they are ignoring you.

Microphone and Video Policy: When we can put a name to a face, it can be helpful to connect virtually. We therefore strongly encourage you to have your video on. For your privacy, you can use a [virtual background in Zoom](#). However, it is ultimately your choice whether to have your video on or not and we will respect that choice. Additionally, please keep your microphone off when not speaking. Background noise can obscure the conversation.

Mental Health Statement: Simply put, college and life are stressful and hard. The demands on you are immense, especially for those balancing a part-time job. If you are struggling or need someone to talk with, please reach out to me or visit the [Rutgers Camden Student Wellness Center](#). We are here to help.

Students with Disabilities Statement: Rutgers University welcomes students with disabilities into all of the University's educational programs. 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 Accommodations. Please share this letter with us to discuss the accommodations needed as early in your course as possible. To begin this process, please complete the Registration form [here](#).

University Academic Integrity Statement: Rutgers University takes academic dishonesty very seriously. By enrolling in this course, you assume responsibility for familiarizing yourself with the Academic Integrity Policy and the possible penalties (including suspension and expulsion) for violating the policy. As per the policy, all suspected violations will be reported to the Office of Community Standards. If in doubt, please consult the instructor and review the [Academic Integrity Policy](#).