RUTGERS School of Engineering

Course Title: Interdisciplinary Biostatistics Research Training
Course Number: 16:125:578
Course Location: BME 115
Course Date & Time: 5:00-8:00 pm on Wednesdays

Course Instructor: Dr. Al Haas, PhD EE, JD, BA Chem.
Instructor Contact: ah1105@connect.rutgers.edu
Office Phone: 732-445-3753
Office Hours: By appointment
Course Grader:

Required Course Software: GraphPad Prism
Recommended Course Text: *INTUITIVE BIOSTATISTICS: A Nonmathematical Guide to Statistical Thinking (Fourth Edition)*. Harvey Motulsky. Oxford University Press, 2018.

Course Description and Objectives:

This course is built to transfect fundamental biostatistical methods, rigorous experimental design and reproducible research reporting into your thirsty brains. Drawing on examples from the bleeding-edge of biomedical research, we will sharpen your statistical acumen, reinforce rigorous research regimens, and practice transparent reporting of results.

This course begins and ends with your own research. The vascularized, dynamic 3D scaffold around which this course is grown is ***your own research***. The monoclonal reporter cell lines with which we will seed this course's high-throughput microfluidic bioreactor arrays are sourced from ***your own research***. And it is the overexpression of ***your own research*** that will enhance neurotransmitter secretion at neuromuscular synapses of the students enrolled in this course. Your first assignment requires you to consider and mitigate sources of error and bias in an experiment from ***your own research.*** From there we work together to develop a biostatistical toolkit from first principles – starting from scratch to make sure no scientist gets left behind – and you select and assemble the right tools for ***your own research***. When we address elements of experimental rigor – e.g. random selection, blinding, controls, power, post-hoc tests and outlier removal – we do so in the context of ***your own research*.** You will share ***your own research*** in class discussions and you will work problems pertaining to ***your own research*** on HW assignments; at the conclusion of the course you will present a carefully conceived proposal detailing how you will conduct experiments from ***your own research***.

Tentative Course Outline*:

Class	Objectives	Assignment
1	Motivate and introduce descriptive statistics; consider sources of experimental error and bias.	
2	Explore rigorous experimental design in context of your own research. Conduct hypothesis-driven hand span lab to collect sample data.	**HW 1 due**
3	Consider the binomial and normal distributions and figure out how to tell when sampled data is normal enough. Calculate confidence intervals.	
4	Determine how large a sample you need to achieve a given study precision and power; review random sample selection.	**HW 2 due**
5	Dive deep into fundamental inferential statistics, including Type I & II errors, α, β, and power. Conduct hypothesis-driven z- and t-tests to ascertain whether samples are from significantly different populations.	**HW 3 due**
6	Real-world research is rarely binary – today we perform one- and two-factor ANOVA to infer statistically significant differences (or fail to reject H_0) between >2 populations while keeping the FWER within acceptable limits.	**HW 4 due**
7	Explore fundamental relationships – covariance, correlation and simple linear regression – between experimental treatment and response variables.	**HW 5 due**
8	Practice the art of multiple linear regression to figure out which of multiple independent predictors best account for specified physiologic response variables. Perform logistic regression to fit binary categorical data to a curve.	
	Spring Break!!!	
9	Work together in small groups to analyze your own experimental data using statistical software.	
10	Learn when and how to use common non-parametric statistics, including the χ^2 test, the sign test, the Wilcoxon signed-rank test, the Wilcoxon rank-sum test, and the Kruskal-Wallis test.	**EXAM due**
11	Address survival analysis in the clinical and biomedical device context. Calculate Kaplan-Meier curves, perform Log-rank tests, evaluate the Cox proportional hazards model.	
12	Critically evaluate the rigor and reproducibility of research literature. Highlight proper use and misuse of statistical analysis.	**HW 6 due**
13	Apply principles of rigor and reproducibility-- unbiased experimental design, repeatable robust methods, rigorous data analysis, uncompromising data interpretation, and transparent reporting of unadulterated results – to your own research.	**PROPOSAL**
14	Present preliminary statistical design and data analysis proposal.	

* This is a tentative schedule; some deviations may be required.

Course Requirements and Grading Policy:

Course assignments – the six homework assignments, the mid-term take-home exam, and the research proposal plan – will be **graded on a scale ranging from 0-100. Individual assignments may be graded on a curve** and extra-credit assignments may be offered; as a result, earned assignment (and participation) grades may be higher than raw assignment or participation scores. **Final grades** are weighted averages – according to the percentages below – and **will NOT be curved**.

FINAL NUMERICAL GRADE	FINAL LETTER GRADE
92-100	A
88-92	B+
82-88	B
78-82	C+
70-78	C
<70	F

A. Homework: 48%. There will be six (**6**) HW assignments for the course, each of equal weight (**8%**) assigned following the relevant lectures. Homeworks are built to reinforce lectures and to challenge students to critically apply lessons to their own research and to bleeding-edge research in other fields. Each HW will consist of between 3-6 problems with subparts. Several of these problems will require a bit of writing to sharpen your research methods; most will require you to extract relevant data from the problem statement and to select and perform the appropriate statistical tests. Homeworks are designed to take an **average of 2-3 hours to complete and write-up legibly**. Unless otherwise specified, HW is **due at the start of class**, one (1) week after it is assigned. Tentative due dates are posted in the Course Outline above. Please note:

- On all HW problem sets, students are encouraged to discuss with one another but assignments **must be performed and written up independently**. You may share ideas, approaches and strategies, but NOT calculations, data or computer output. **Plagiarism is strictly prohibited**.

- Unless otherwise noted, you must ***show all your work*** to receive any credit regardless of whether your final answer is correct. If you use a computer program to perform certain calculations or tests, your write-up must include all input parameters and any non-default settings in addition to a copy of the computer output.

- If you are having difficulties with a concept or specific problem, contact Dr. Haas with sufficient time for him to respond and for you to complete your assignments.

- If you have any issues or concerns regarding a grade, you have one week after an assignment is returned to discuss. This applies to any attendance disputes as well.

- If you will be missing class, assignments due during that period must be emailed to Dr. Haas as a **legible PDF** file by 5:00PM the day it is due to be accepted.

- Late assignments will only be accepted with documentation of a serious situation or by the approval of the instructor on a case-by-case basis. You must reach out to Dr. Haas ***before*** class the day it is due so that the upload of the solutions can be delayed.

- Some notifications pertaining to assignments will happen through Sakai. Please make sure that you have email notification enabled to receive them.

B. Class participation: 10%. In order to receive an A in this course, you must participate. This means ***attending classes*** and contributing where appropriate. FYI:

- **Each unexcused absence will be penalized** and the penalty per missed class will increase with the number of absences; the maximum cumulative penalty (for 4 or more unexcused absences) is the entire class participation grade of 10 points.

- M**ost planned absences will be excused with advance notice**, so long as students do not abuse the privilege.

- **Participation counts**. Speak up when you have a question or know the answer to one. Help your classmate when you see them wrestling with a computation you've performed dozens of times. Share your research and grow the community.

C. Mid-Term Exam: **18%.** There will be one (1) cumulative, group, take-home examination that will be assigned about half-way through the course, after we have completed linear regression. For this mid-term exam and **ONLY for this mid-term assignment** you will be **required to work together** and to **submit one exam per group**. Groups will be between 2-5 people, depending on course enrollment. For your convenience, you will be allowed to self-select your own groups; however, Dr. Haas reserves the right to assign or alter groups selections to correct perceived impropriety or for other educational purposes.

D. Research Proposal Plan and Presentation: 24%. During the course of the semester you will prepare a scientifically rigorous research proposal plan featuring a reproducible experimental design and suitable statistical tests and analyses. You will present this plan to the class at the end of the semester. As with your PhD research, your proposal plan must be your own; HOWEVER, you may coordinate with labmates and/or other

colleagues in developing the elements of the plan and components of your slide deck. Give proper attribution where it is due.

The proposal slide deck, accompanying notes, and oral presentation will be evaluated in three main areas: (1) **experimental design**, (2) **statistical methods and analysis**, and (3) **transparency**, which is code for how well you documented and conveyed your experimental design, methods and analysis. A more detailed rubric adapted from the NIH guidelines on rigor and reproducibility is posted on Sakai.

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 Office of Disability Services (ODS) 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 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://ods.rutgers.edu/students/registration-form.

Academic Integrity:

All students are responsible for abiding by the University Policy on Academic Integrity available online at http://academicintegrity.rutgers.edu/academic-integrity-policy. Each student bears a fundamental responsibility for maintaining academic integrity and intellectual honesty in his or her graduate work. For example, all students are expected to observe the generally accepted principles of scholarly work, to submit their own rather than another's work, to refrain from falsifying data, and to refrain from receiving and/or giving aid on examinations or other assigned work requiring independent effort. In addition to maintaining personal academic integrity, each student is expected to contribute to the academic integrity of the school community by not facilitating inappropriate use of her/his own work by others and by reporting acts of academic dishonesty by others to an appropriate school authority. Violations of the academic integrity policy will not be tolerated.

Policy Concerning Use of Recording Devices and Other Electronic Communications Systems:

The instructor must give written permission prior to the start of the semester to authorize the use of video and/or audio recording devices in the classroom. Use of such devices

without permission constitutes a violation of academic integrity and may subject unauthorized individuals to civil liability and/or criminal penalties. Ask first.

Policy Concerning Food and Drink in the Classroom:

This is a long evening class where you might need more than dew and universe juice to stay engaged. Food and drink are permitted, but please don't leave crumbs, spills or wrappers behind.

Policy Concerning Being Awesome:

Default status of all enrolled students and participating instructors/staff. Strongly encouraged.