BSC 3453C: BIOLOGICAL RESEARCH METHODS + EXPERIMENTAL DESIGN

Department of Biology, College of Sciences
3 credits, Fall 2019

Course Instructor	
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HIP Research Coach	
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Course Description

An introduction to research methods in biology, with specific focus on critical thinking, scientific skepticism, experimental design, and working with data relevant to biological questions. Students will develop an understanding of the logical and philosophical underpinnings of the scientific method, learn how biological research is commonly conducted and disseminated, and develop a skillset of data analysis techniques in relation to experimental questions and hypotheses in biology. Course format will consist of lectures and accompanying hands-on breakout sessions where students will perform data analysis and examine published science. This course includes a semester-long group project in which students will perform a systematic literature review and meta-analysis on a research question of their choice within the field of biology. Through this project, students will find and curate all indexed peer-reviewed studies performed to date on their chosen research question in order to understand the strength of the current body of evidence and whether scientific consensus exists.

Course Goals and Learning Objectives

Upon completion of the course, students will be able to:
- Understand methodological naturalism and the general conceptual process of scientific inquiry.
- Identify and judge key cognitive biases and logical fallacies.
- Think critically about biological questions and evidence.
- Design appropriate experiments to address biological questions.
- Identify common data types and inspect biological data.
- Select appropriate analyses to answer biological questions.
- Confidently perform the most common and useful analyses used in biology.
- Interpret results of statistical tests in biologically relevant terms.
- Evaluate the validity of experiments and data analysis in the scientific literature.
- Understand basic research ethics and how findings are disseminated.
- Learn how to synthesize research on a particular question to determine the limits of knowledge.

This is a **UCF Research-Intensive (RI) Course**. https://our.ucf.edu/faculty/research-intensive-courses/

Class Meetings

Location: Bio 212	Times: Tuesdays 5:30-6:50pm	Thursdays 5:30-7:20pm

Prerequisites

A grade of "C" or better in both BSC 2011C and STA 2023, and a grade of "C" or better in either PCB 3044 or PCB 3063, or permission of course instructor.

Course Materials and Resources - Texts, Software, and Equipment

Webcourses (http://webcourses.ucf.edu) will be used to post materials for the course, including the syllabus, lecture slides, reading materials, and grades for all assignments.

This course will use three texts:

"*Essential Biostatistics: A nonmathematical approach*" by Harvey Motulsky   (ISBN 978-0199365067)
"*How to Lie with Statistics*" by Darrell Huff   (ISBN 978-0393310726)
"*The Skeptic's Guide to the Universe: How to know what's really real*
          in a world increasingly full of fake" by Steven Novella et al.   (ISBN 978-1538760536)

Additional supplementary reading materials (e.g. journal articles, videos, etc) will be provided by the instructor as files through Webcourses.

The course will also use the software package JMP Pro 12, which is site-licensed by UCF and freely available to students via UCF Web Apps http://apps.ucf.edu/.

Bring-Your-Own-Device Policy: Students are required to bring a laptop computer or other similar device capable of running JMP via UCF Web Apps and handling standard data files (e.g. Excel, CSV, etc) to laboratory sessions when indicated. The purpose of this (instead of using a computer lab) is to allow students to more easily complete laboratory modules out of class, and facilitate the semester-long group project. If you do not have such a device available to you, please come speak with the instructor to work out an alternative solution. The UCF library has a technology lending program that allows students to check out laptops for seven days at a time.

Assessment and Grading Procedures

Grades will be assigned on the following scale without rounding:

A: 90-100%   B+: 85-89.9%   B: 80-84.9%   C+: 75-79.9%   C: 70-74.9%   D: 60-69%   F:<60%

The grade for this course will be based on the following components:

(1) Six **in-class/homework assignments** (5% each, 30% total) demonstrating completion of data analysis exercises and interpretation. Assignments are due in class (laboratory session) the week after the laboratory session in which they were assigned.

(2) One **team literature review project** synthesizing existing research on a question of interest, generating a quantitative review of evidence and making informed suggestions for further research (10% proposal, 20% final written report, 10% final presentation; 40% total). This project is graded using the group scores as a baseline, adjusted by individual contributions if needed.

(3) A **research reflection** assesses how your team project went, what you learned, and what you would do differently with a new experience based on what you have learned (5% total).

(4) One **practical final exam**, given in class on the date indicated on the schedule (15% total). This open-book, open-note exam will consist of a series of data analysis questions using JMP.

(5) **Participation** in class discussions and group activities (10% total).

Course Policies and Specific Expectations

1. Attendance is vital in this course. A large portion of the course grade will be based on participation, homework assignments using skills demonstrated in breakout 'laboratory' sessions, and exams will cover material not available outside of class.

2. There is no direct penalty for absences, though late assignments will only be accepted for excused absences. Excused absences include illness, serious family emergencies, special co-curricular activities and requirements, severe weather conditions, and religious holidays. Assignments may be submitted digitally in the event of an absence, or may be submitted late for a 10% per week reduction in the assignment's grade. Make-ups for in-class participation cannot be provided.

3. Assigned readings are very important to this course, and all assigned readings for a given day should be completed **before** attending class.

4. This course may occasionally cover politically or socially controversial topics where they intersect with science and scientific evidence. Students are expected to behave professionally and treat other students and the instructor in a civil manner in the interest of scholarly discourse.

5. Written communication with the instructor should be sent via Webcourses or UCF email. Note that I will not be able to respond to course inquiries sent from third-party email addresses (e.g. Gmail) where student identity cannot be confirmed, in order to comply with FERPA regulations.

6. This course will use technology in class – it is the student's responsibility to be respectful of others by remaining on-topic and not distracting to others.

7. This course will involve a long-term team project. Students will need to communicate and work with one another outside of class to complete it, similarly to working scientists in academia and industry. Teams will be self-selected and based on shared research interests, as is typical for research collaborations in science. Students will need to resolve conflict among team members as much as possible, but the instructor will mediate any major conflicts. Teams should establish a preferred method of communication (email, Webcourses, text, apps, etc) shortly after team establishment. Along with this, students have a responsibility to be professional and reasonably responsive to their team (e.g. responding to correspondence within 1-2 business days on project matters), though team members should also be courteous and mindful that people have diverse work/course schedules and may not be able to respond to last-minute inquiries. Teams should set expectations about communication early.

8. Academic dishonesty (e.g. plagiarism or cheating) is governed by the UCF Golden Rule. Students found to have committed academic dishonesty will receive a minimum of an "F" for the assignment in question, and at the instructor's discretion based on severity of the violation, an "F" for the entire course with referral to the Office of Student Conduct. See university policy below.

9. Students are highly encouraged to discuss any and all portions of this course with me. If you are struggling, please do not wait until you fall behind to meet with me. I am available during my weekly office hours or by appointment and will always be happy to discuss the course.

Make-up Assignments for Authorized University Events or Co-curricular Activities (UCF Policy 401.2)
      Students are frequently asked to represent the university in authorized events and activities. In some cases, this participation conflicts with the students' course assignments and requirements. It is university policy that instructors of record offer a reasonable opportunity for such students to complete missed classroom assignments, including written or oral examinations, quizzes, term papers, or other assignments. Furthermore, the make-up assignment and grading scale should be equivalent to the missed assignment and its grading scale. No penalty due to absence may be applied to these make-up assignments. The names of students participating in authorized activities such as, intercollegiate athletics, band, choir, co-curricular activities, and other academically related programs and events to represent the university will be listed on a Program Verification Form. It is the student's responsibility to present a copy of this form signed by the appropriate individual to the instructor(s) of record responsible for the class from which the student will be absent. The student must provide the Program Verification Form prior to the class in which the absence occurs. The university sponsor signs a copy of the Program Verification Form and files it with the Office of Student Rights and Responsibilities for verification purposes.

Make-up Assignments for Religious Observances (UCF Policy 5.020)
      The University of Central Florida will reasonably accommodate the religious observances, practices, and beliefs of individuals in regard to admissions, class attendance, and the scheduling of examinations and work assignments. A student who desires to observe a religious holy day of his or her religious faith must notify all of the instructors teaching the class(es) from which the student desires to be excused no later than the tenth business day of the term. The student will be held responsible for any material covered during the excused absence, but will be permitted a reasonable amount of time to complete any work missed. Where practicable, major examinations, major assignments and University ceremonies will not be scheduled on a major religious holy day. Students who are absent because of religious observances and have complied with this regulation will not be penalized. A student who believes that he/she has been unreasonably denied an educational benefit due to his/her religious belief or practices may seek redress with the Office of Institutional Equity in accordance with that office's Investigation Procedures.

Academic Integrity
      The Center for Academic Integrity (CAI) defines academic integrity as a commitment, even in the face of adversity, to five fundamental values: honesty, trust, fairness, respect, and responsibility. From these values flow principles of behavior that enable academic communities to translate ideals into action. http://academicintegrity.org/

UCF Creed: Integrity, scholarship, community, creativity, and excellence are the core values that guide our conduct, performance, and decisions.
1. Integrity: I will practice and defend academic and personal honesty.
2. Scholarship: I will cherish and honor learning as a fundamental purpose of my membership in the UCF community.
3. Community: I will promote an open and supportive campus environment by respecting the rights and contributions of every individual.
4. Creativity: I will use my talents to enrich the human experience.
5. Excellence: I will strive toward the highest standards of performance in any endeavor I undertake.

The following definitions of plagiarism and misuse of sources come from the Council of Writing Program Administrators (http://wpacouncil.org/node/9) and have been adopted by UCF's Department of Writing & Rhetoric.

Plagiarism

In an instructional setting, plagiarism occurs when a writer deliberately uses someone else's language, ideas, or other original (not common-knowledge) material without acknowledging its source. This definition applies to texts published in print or on-line, to manuscripts, and to the work of other student writers.

Misuse of Sources

A student who attempts (even if clumsily) to identify and credit his or her source, but who misuses a specific citation format or incorrectly uses quotation marks or other forms of identifying material taken from other sources, has not plagiarized. Instead, such a student should be considered to have failed to cite and document sources appropriately.

Responses to Academic Dishonesty, Plagiarism, or Cheating

UCF faculty members have a responsibility for your education and the value of a UCF degree, and so seek to prevent unethical behavior and when necessary respond to infringements of academic integrity. Penalties can include a failing grade in an assignment or in the course, suspension or expulsion from the university, and/or a "Z Designation" on a student's official transcript indicating academic dishonesty, where the final grade for this course will be preceded by the letter Z. For more information about the Z Designation, see http://goldenrule.sdes.ucf.edu/zgrade. For more information about UCF's Rules of Conduct, see http://www.osc.sdes.ucf.edu/.

In-Class Recording Policy

Outside of the notetaking and recording services offered by Student Accessibility Services, the creation of an audio or video recording of all or part of a class for personal use is allowed *only* with the advance and explicit written consent of the instructor. Such recordings are only acceptable in the context of personal, private studying and notetaking and are not authorized to be shared with *anyone* without the separate written approval of the instructor.

Course Accessibility Statement

The University of Central Florida is committed to providing access and inclusion for all persons with disabilities. This syllabus is available in alternate formats upon request. Students with disabilities who need specific access in this course, such as accommodations, should contact the professor as soon as possible to discuss various access options. Students should also connect with Student Accessibility Services (Ferrell Commons, 7F, Room 185, sas@ucf.edu, phone (407) 823-2371). Through Student Accessibility Services, a Course Accessibility Letter may be created and sent to professors, which informs faculty of potential access and accommodations that might be reasonable.

Deployed Active Duty Military Students

If you are a deployed active duty military student and feel that you may need a special accommodation due to that unique status, please contact your instructor to discuss your circumstances.

Campus Safety Statement

Emergencies on campus are rare, but if one should arise in our class, we will all need to work together. Everyone should be aware of the surroundings and familiar with some basic safety and security concepts.

- In case of an emergency, dial 911 for assistance.
- Every UCF classroom contains an emergency procedure guide posted on a wall near the door. Please make a note of the guide's physical location and consider reviewing the online version at http://emergency.ucf.edu/emergency_guide.html.
- Familiarize yourself with evacuation routes from each of your classrooms and have a plan for finding safety in case of an emergency. (Insert class-specific details if appropriate)
- If there is a medical emergency during class, we may need to access a first aid kit or AED (Automated External Defibrillator). To learn where those items are located in this building, see http://www.ehs.ucf.edu/AEDlocations-UCF (click on link from menu on left). (insert class specific information if appropriate)
- To stay informed about emergency situations, sign up to receive UCF text alerts by going to my.ucf.edu and logging in. Click on "Student Self Service" located on the left side of the screen in the tool bar, scroll down to the blue "Personal Information" heading on your Student Center screen, click on "UCF Alert", fill out the information, including your e-mail address, cell phone number, and cell phone provider, click "Apply" to save the changes, and then click "OK."
- If you have a special need related to emergency situations, please speak with me during office hours.
- Consider viewing this video (https://youtu.be/NIKYajEx4pk) about how to manage an active shooter situation on campus or elsewhere.

Resources for Success

University Writing Center

The University Writing Center (UWC) offers writing support to UCF students from first-year to graduate in every discipline. Trained peer consultants provide help at every stage of the writing process, including understanding assignments, researching, drafting, revising, incorporating sources, and learning to proofread and edit. The UWC's purpose is not merely to fix papers or to make better writers, but to teach writers strategies to navigate complex situations for writing, both in and outside the University. Consultations are available for individuals and small groups. https://uwc.cah.ucf.edu/

UCF Libraries

The Research and Information Services Department exists to help students and faculty use library resources and services to find high-quality information both in the physical library collections and online. This unit provides one-on-one research consultations with a librarian for extensive, in-depth assistance with research. Sandy Avila is our science librarian, and she will participate directly in this course. https://library.ucf.edu/about/departments/reference/

Counseling and Psychological Services

Counseling and Psychological Services (CAPS) is a campus agency designated to provide psychological services to currently enrolled students free of charge. CAPS provides a variety of services from career assessment and stress management to crisis intervention. The office is located in Counseling Center 101, which is next to the UCF Health Center. http://caps.sdes.ucf.edu/

Course Schedule

Course schedule is an approximation and will be updated throughout the semester. Please bring a laptop on days marked with an 'L'.

Week	Day	Topics	In-Class Activity	L?	Readings before Class
1	Aug 27 (1.5 hrs)	What is Science? Skeptic's Guide to the Universe	Lecture [Naomi Oreskes]		• *Skeptic's Guide* – Intro. through Ch. 7 • Take Demonstration Quiz!
	Aug 29 (2 hrs)	*~ No class thanks to sportsball game ~*	--		• I strongly encourage you to get ahead on Week 2 readings in *Skeptic's Guide*!!!
2	Sept 3 (1.5 hrs)	Cognitive Bias and Logical Fallacies The Dunning-Kruger Effect Confirmation Bias	Lecture Activity: Name That Logical Fallacy!		• *Skeptic's Guide* – Ch. 8 – Ch. 18 • Cognitive Bias Lists • Logical Fallacy List • Kruger and Dunning, 1999
	Sept 5 (2 hrs)	Science Versus Pseudoscience The Demarcation Problem Baloney Detection Methods	[Massimo Pigliucci] Activity: Index Card Demarcation Problem	**L**	• *Skeptic's Guide* Ch. 19 - Ch.39 • Science vs. Pseudoscience: Where is the Difference? • "The Demarcation Problem" - Massimo Pigliucci • *Demon-Haunted World* Ch. 12: "The Fine Art of Baloney Detection" • 20 Tips for Interpreting Claims
3	Sept 10 (1.5 hrs)	Decoding a Published Study Common Observational + Manipulative Approaches The Importance of Controls	Lecture Paper Discussion		• *Skeptic's Guide* Ch. 40 – Ch. 45 • Motulsky Ch. 25 • How to Read a Scientific Paper • How to (Seriously) Read a Scientific Paper
	Sept 12 (2 hrs)	The Peer Review Process Researcher Degrees of Freedom, P-hacking Method Reliability/Validity Publication Bias + Research Ethics	Lecture [Ben Goldacre] Paper Discussion		• Guide to Peer Review • *Skeptic's Guide* Ch. 46 – Ch. 56 • Statistics Done Wrong – Researcher Degrees of Freedom, Everybody Makes Mistakes, Hiding the Data • Radiolab – "Stereothreat" • Simmons et al. 2011 (Researcher DF)

4	Sept 17 (1.5 hrs)	Systematic Reviews and Meta-Analysis	Lecture **Team Literature Review Project Planning**		• Cochrane Guide to SRs • Sambunjak et al. 2011 (Flossing) • Whitehead et al. 2017 (Crops) • Schoenfeld and Ioannidis 2013 (Cancer) • Project Rubrics for Draft + Final
	Sept 19 (2 hrs)	Library Skills and Citation Visit from UCF Librarian	Activity: Web of Science vs. Google Scholar	L	• Beckmann and Von Wehrden 2012 • **Librarian Appt. Sign-Up!**
5	Sept 24 (1.5 hrs)	Intuition, Statistics, and Probability Theory	Lecture, FlexStats Demonstration		• Motulsky Ch. 1-3 • Statistics Done Wrong – P-values
	Sept 26 (2 hrs)	Statistical Significance vs. Effect Size The Base Rate Fallacy	Lecture Paper Discussion **TEAM LITERATURE REVIEW PROPOSALS DUE**		• Motulsky Ch. 4, 18 • Miller et al. 2000 (Whale Song) • Klein et al. 2011 (SELECT) • Carlson et al. 2015 (Telomeres)
6	Oct 1 (1.5 hrs)	Peer Review of Proposals	Peer Review of Proposals		• Rubric (each group review two other proposals, each proposal receives two reviews)
	Oct 3 (2 hrs)	Best Practices for Figures	Activity: Figure Critique		• "How To Lie With Statistics" – Darrell Huff
7	Oct 8 (1.5 hrs)	Replication and Pseudoreplication Sample Size and Power, Bayesian Thinking	Lecture Paper Discussion		• Statistics Done Wrong- Statistical Power, Pseudoreplication, Regression to the Mean • Hurlbert 1984 • Davies and Gray 2015 • Steidl et al 1997
	Oct 10 (2 hrs)	Replication and Pseudoreplication Sample Size and Power, Bayesian Thinking	Data Workshop 1: Design and Power Analysis	L	
8	Oct 15 (1.5 hrs)	Data types and Distributions, Describing Variation	Lecture		

	Oct 17 (2 hrs)	Data types and Distributions, Describing Variation	Data Workshop 2: Data Visualization + Descriptive Statistics **ASSIGNMENT 1 DUE**	**L**	• Motulsky Ch. 5-11, 21
9	Oct 22 (1.5 hrs)	Hypothesis Testing and Significance Differences among Groups/Treatments	Lecture		• Motulsky Ch. 12-15, 19
	Oct 24 (2 hrs)	Hypothesis Testing and Significance Differences among Groups/Treatments	Data Workshop 3: Chi-Square, T-test, ANOVA **ASSIGNMENT 2 DUE**	**L**	
10	Oct 29 (1.5 hrs)	Correlation and Regression Multiple and Logistic Regression	Lecture		• Motulsky Ch. 22-24
	Oct 31 (2 hrs)	Correlation and Regression Multiple and Logistic Regression	Data Workshop 4: Correlation Approaches **ASSIGNMENT 3 DUE**	**L**	
11	Nov 5 (1.5 hrs)	Factorial Designs, Split-Plot Designs Blocking and Block Designs	Lecture Paper Discussion		• Franke and Fisher 2013
	Nov 7 (2 hrs)	Factorial Designs, Split-Plot Designs Blocking and Block Designs	Data Workshop 5: Two-way + Block designs **ASSIGNMENT 4 DUE**	**L**	
12	Nov 12 (1.5 hrs)	Survival Analysis Repeated Measures/Time Series Data Analysis of Covariance	Lecture Paper Discussion		• Skrip et al. 2016
	Nov 14 (2 hrs)	Survival Analysis Repeated Measures/Time Series Data Analysis of Covariance	Data Workshop 6: Time Series and ANCOVA **ASSIGNMENT 5 DUE**	**L**	

13	Nov 19 (1.5 hrs)	Multiple Comparisons and Type I Error Data Mining	Lecture Paper Discussion		• Motulsky Ch. 16-17, 25 • Statistics Done Wrong – Wrought? Leung et al. 2014 and Slate Article
	Nov 21 (2 hrs)	Meta-analysis JMP Help Day	In-Class Analysis **ASSIGNMENT 6 DUE**	**L**	• Download +Install OpenMEE http://www.cebm.brown.edu/openmee/
14/15	Nov 26 (1.5 hrs)	Advanced Topics: Principal Components Analysis Path Analysis	Lecture		• Dudley 1996 • Whitall and Hodges, 2007
	Dec 3 (1.5 hrs)	**Team Research Project Presentations**	10 minutes each		• **Final Research Project Reports Due** • Research Reflections Due on Webcourses by Dec 5