BSC 3453C: BIOLOGICAL RESEARCH METHODS + EXPERIMENTAL DESIGN

Department of Biology, College of Sciences
3 credits, Fall 2022

Course Instructor

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**contact via Webcourses message is preferred and will receive the fastest replies.*

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 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.

BSC 3453C is designated as a Research-Intensive (RI) course. This designation will be noted on your transcripts. Research-Intensive is one of the four High Impact Practice course designations at UCF, along with Service Learning, Integrative Learning, and Global Learning. High Impact Practice courses are some of the most challenging and rewarding at UCF. You will actively engage in research processes and a significant portion of your grade will be derived from course-related project(s) based on original research and/or creative scholarship. If you have any questions about this designation or HIP designations at UCF, please contact hip@ucf.edu.

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.

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.

Class Meetings

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

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 two texts:
"*Essential Biostatistics: A nonmathematical approach*" by Harvey Motulsky (ISBN 978-0199365067)
"*The Skeptic's Guide to the Universe: How to know what's really real in a world increasingly full of fake* " by 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 free open-source software package JASP: https://jasp-stats.org/ A full manual for this software can be found here: https://jasp-stats.org/wp-content/uploads/2020/11/Statistical-Analysis-in-JASP-A-Students-Guide-v14-Nov2020.pdf

Bring-Your-Own-Device Policy: Students are required to bring a laptop computer or other similar device capable of running JASP 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.

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) Successful completion of **Responsible Conduct of Research training** (5% total) covering topics in research ethics and responsible project management.

(2) Six **in-class/homework assignments** (8% each, 5 graded, 40% 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. The lowest grade will be dropped (five total).

(3) One **team systematic 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.

(4) 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).

(5) One **practical final exam**, given in class on the date indicated on the schedule (10% total). This open-book, open-note exam will consist of a series of data analysis questions using JASP.

Course Policies and Specific Expectations

1. This is a research-intensive course with major hands-on components, and attendance is therefore very important. A large portion of the course grade will be based on assignments resulting from group participation in laboratory sections and the group research project, and final exam will cover material not available outside of class. **HOWEVER**, no student will be penalized for being away from class due to pandemic-related absences (e.g., illness). There is no direct penalty for absences, and late assignments will 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 from unexcused absences may be submitted late for a 10% per week reduction in the assignment's grade.

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

3. 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.

4. Written communication with the instructor should be sent via Webcourses (preferred) 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. I strive to respond to all inquiries within 1-2 business days (M-Fr).

5. This course will involve a semester-long team research project. Students will need to communicate and work with one another outside of class to complete it, similarly to working scientists in academia, government, 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 and that pandemic-related absences are a possibility. Groups should set expectations early.

6. As researchers, you are expected to conduct yourself with the highest standards of professionalism and research ethics. All students will be required to complete Responsible Conduct of Research training: http://www.rcr.ucf.edu/rcr_AccessingCITI_RCR_Training.pdf.

7. 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.

8. 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 be happy to discuss the course.

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	What's In-Class?	L?	Readings before Class/Assignments Due
1	8/23	What is Science? Scientific Skepticism	Lecture [Naomi Oreskes]		• Take Survey for Financial Aid! • *Skeptic's Guide* – Intro. through Ch. 7 (45p.)
	8/25	Cognitive Bias and Logical Fallacies	Lecture Activity: Name That Logical Fallacy!		• *Skeptic's Guide* – Ch. 8 – Ch. 18 (100p.) • Cognitive Bias and Logical Fallacy Lists
2	8/30	Science Versus Pseudoscience Baloney Detection Methods	[Sabine Hossenfelder] [Massimo Pigliucci] Discussion of Readings		• *Skeptic's Guide* Ch. 19 - Ch. 28 (93p.) • *Demon-Haunted World* Ch. 12: "The Fine Art of Baloney Detection" (18p.) • Science vs. Pseudoscience: Where is the Difference? (2p.) • 20 Tips for Interpreting Claims (3p.)
	9/1	The Demarcation Problem **No Class – Campus Closed for Sports**	--		• **RCR Training Due 9/2** • *Skeptic's Guide* Ch. 29 - Ch. 39 (78p.) • "The Demarcation Problem" - Massimo Pigliucci (26p.)
3	9/6	Decoding a Published Study The Peer Review Process Common Observational + Manipulative Approaches The Importance of Controls	Lecture Activity: Decoding a Study in Real Time		• *Skeptic's Guide* Ch. 40 – Ch. 45 (57p.) • Motulsky Ch. 25 (6p.) • How to Read a Scientific Paper (2p.) • How to (Seriously) Read a Scientific Paper (5p.) • Guide to Peer Review (20p.)
	9/8	Researcher Degrees of Freedom P-hacking Method Reliability/Validity Publication Bias + Research Ethics	Lecture [Ben Goldacre] Paper Discussion [Simmons et al.]		• *Skeptic's Guide* Ch. 46 – Ch. 56 (69p.) • Statistics Done Wrong – Researcher Degrees of Freedom, Everybody Makes Mistakes, Hiding the Data (5p.) • Radiolab – "Stereothreat" (30 min) • Simmons et al. 2011 (8p.)

4	9/13	Systematic Reviews and Meta-Analysis	Lecture **Team Literature Review Project Planning**		• Cochrane Guide to SRs (8p.) • Sambunjak et al. 2011 (Flossing – ~20p.) • Whitehead et al. 2017 (Crops – 9p.) • Schoenfeld and Ioannidis 2013 (Cancer – 8p.) • McArt et al. 2014 (Floral Diseases - • Read Project Rubrics for Proposal + Final
	9/15	Library Skills and Citation	Activity: EndNote Workshop	**L**	• Beckmann and Von Wehrden 2012 (3p.)
5	9/20	Intuition, Statistics, and Probability Theory	Lecture, FlexStats Demonstration		• Motulsky Ch. 1-3 (~14p.) • Statistics Done Wrong – P-values (2p.)
	9/22	Statistical Significance vs. Effect Size The Base Rate Fallacy	Lecture Paper Discussion		• Motulsky Ch. 4, 18 (~21p.) • Miller et al. 2000 (Whale Song – 2p.) • Klein et al. 2011 (SELECT – 8p.) • Carlson et al. 2015 (Telomeres – 9p.) • **TEAM PROJECT PROPOSALS DUE – 3 copies!**
6	9/27	Peer Review of Proposals	Peer Review of Proposals		• Read the Rubric
	9/29	Best Practices for Figures	Activity: Figure Critique		• "*How To Lie With Statistics*" – Darrell Huff (140p.) • Best et al. 2005 (Response to *HTL* – 5p.)
7	10/4	Replication and Pseudoreplication Sample Size and Power	Lecture Paper Discussion		• Statistics Done Wrong - Statistical Power, Pseudoreplication (8p.) • Hurlbert 1984 (26p.) • Steidl et al. 1997 (11p.) • Davies and Gray 2015 (10p.)
	10/6	Replication and Pseudoreplication Sample Size and Power	Data Workshop 1: Design and Power Analysis	**L**	

8	10/11	Data types and Distributions, Describing Variation **No Class – Dr. Mason away giving a seminar at UC Santa Barbara**	Lecture **recording on Webcourses**		
	10/13	Data types and Distributions, Describing Variation **No Class – Campus Closed for Sports**	Data Workshop 2: Data Visualization + Descriptive Statistics **recording on Webcourses**	L	• Motulsky Ch. 5-11, 21 (46p.)
9	10/18	Hypothesis Testing and Significance Differences among Groups/Treatments	Lecture		• **ASSIGNMENT 1 DUE** • Motulsky Ch. 12-15, 19 (32p.)
	10/20	Hypothesis Testing and Significance Differences among Groups/Treatments	Data Workshop 3: Chi-Square, T-test, ANOVA	L	• **ASSIGNMENT 2 DUE**
10	10/25	Correlation and Regression Multiple and Logistic Regression	Lecture		• Motulsky Ch. 22-24 (22p.)
	10/27	Correlation and Regression Multiple and Logistic Regression	Data Workshop 4: Correlation Approaches	L	• **ASSIGNMENT 3 DUE**
11	11/1	Factorial Designs, Split-Plot Designs Blocking and Block Designs	Lecture		
	11/3	Factorial Designs, Split-Plot Designs Blocking and Block Designs	Paper Discussion Data Workshop 5: Two-way + Block designs	L	• Franke and Fisher 2013 (12p.) • **ASSIGNMENT 4 DUE**

12	11/8	Repeated Measures/Time Series Data Survival Analysis Analysis of Covariance	Lecture Paper Discussion		• Skrip et al. 2016 (10p.)
	11/10	Repeated Measures/Time Series Data Survival Analysis Analysis of Covariance	Data Workshop 6: Time Series and ANCOVA		• **ASSIGNMENT 5 DUE**
13	11/15	Multiple Comparisons and Type I Error Data Mining and Meta-Analysis	Lecture Paper Discussion		• Motulsky Ch. 16-17, 25 (20p.) • Statistics Done Wrong – Wrought? (1p.) • Leung et al. 2014 and Slate Article (~10p.)
	11/17	Meta-Analysis Statistics Project Analysis JASP Help Day	In-Class Analysis	**L**	• JASP Manual Pages 142-149 (7p.) • **ASSIGNMENT 6 DUE**
14	11/22	A Peek at Bayesian Statistics	Lecture		
	11/24	**No Class – Thanksgiving Break**			
15	11/29	Research Project Last Day	In-Class Project Work/Help Time		
	12/1	**Team Research Project Presentations**	[10 min. per group]		• **Final Research Project Reports Due** • Research Reflections Due on Webcourses by Dec 2

University- Level Policies

COVID-19 and Illness Notification

Students who believe they may have a COVID-19 diagnosis should contact UCF Student Health Services (407-823-2509) so proper contact tracing procedures can take place. Students should not come to campus if they are ill, are experiencing any symptoms of COVID-19, have tested positive for COVID, or if anyone living in their residence has tested positive or is sick with COVID-19 symptoms. CDC guidance for COVID-19 symptoms is located here: (https://www.cdc.gov/coronavirus/2019-ncov/symptoms-testing/symptoms.html). This course has been designed so that absences due to illness will not disrupt the ability of students to participate (e.g., pre-recorded versions of lectures). Students should contact the instructor if they need accommodations to assignment or quiz/exam deadlines.

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.

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

Students should familiarize themselves with UCF's Rules of Conduct. According to Section 1, "Academic Misconduct," students are prohibited from engaging in:

1. Unauthorized assistance: Using or attempting to use unauthorized materials, information or study aids in any academic exercise unless specifically authorized by the instructor of record. The unauthorized possession of examination or course-related material also constitutes cheating.
2. Communication to another through written, visual, electronic, or oral means: The presentation of material which has not been studied or learned, but rather was obtained through someone else's efforts and used as part of an examination, course assignment, or project.
3. Commercial Use of Academic Material: Selling of course material to another person, student, and/or uploading course material to a third-party vendor without authorization or without the express written permission of the university and the instructor. Course materials include but are not limited to class notes, Instructor's PowerPoints, course syllabi, tests, quizzes, labs, instruction sheets, homework, study guides, handouts, etc.
4. Falsifying or misrepresenting the student's own academic work.
5. Plagiarism: Using or appropriating another's work without any indication of the source, thereby attempting to convey the impression that such work is the student's own.
6. Multiple Submissions: Submitting the same academic work for credit more than once without the express written permission of the instructor.
7. Helping another violate academic behavior standards.
8. Soliciting assistance with academic coursework and/or degree requirements.

Responses to Academic Dishonesty, Plagiarism, or Cheating

Students should also familiarize themselves with the procedures for academic misconduct in UCF's student handbook, *The Golden Rule* <https://goldenrule.sdes.ucf.edu/>. UCF faculty members have a responsibility for students' education and the value of a UCF degree, and so seek to prevent unethical behavior and respond to academic misconduct when necessary. Penalties for violating rules, policies, and instructions within this course can range from a zero on the exercise to an "F" letter grade in the course. In addition, an Academic Misconduct report could be filed with the Office of Student Conduct, which could lead to disciplinary warning, disciplinary probation, or deferred suspension or separation from the University through suspension, dismissal, or expulsion with the addition of a "Z" designation on one's transcript.

Being found in violation of academic conduct standards could result in a student having to disclose such behavior on a graduate school application, being removed from a leadership position within a student organization, the recipient of scholarships, participation in University activities such as study abroad, internships, etc. Let's avoid all of this by demonstrating values of honesty, trust, and integrity.

In-Class Recording Statement

Students may, without prior notice, record video or audio of a class lecture for a class in which the student is enrolled for their own personal educational use, for use in a complaint against the institution, or for use as evidence in a civil or criminal proceeding. Students may not record for any other purpose without the consent of the faculty member. A class lecture is defined as a formal or methodical oral presentation as part of a university course intended to present information or teach students about a particular subject. Recording classroom activities other than class lectures, including but not limited to lab sessions, student presentations (whether individually or part of a group), class discussion (except when incidental to and incorporated within a class lecture), clinical presentations such as patient history, academic exercises involving student participation, test or examination administrations, field trips, and private conversations is prohibited. Recordings may not be used as a substitute for class participation and class attendance, and may not be published or shared without the written consent of the faculty member. Failure to adhere to these requirements may constitute a violation of the University's Student Code of Conduct as described in the Golden Rule. Under existing Florida law (Florida Statutes 1004.097), a recorded lecture may not be published without the consent of the faculty member, except it may be shared with university officials or state and federal government officials in connection with a complaint to or against the university, or used as evidence in a criminal or civil proceeding. Violation of this provision may subject the student to disciplinary action by the university and/or to a legal action by a person injured by the publication. To publish means to share, transmit, circulate, distribute or otherwise provide access to the recording, regardless of format or medium, to another person, or persons, including but not limited to another student in the class. Additionally, a recording, or transcript of the recording, is published if it is posted on or uploaded to, in whole or in part, any media platform, including but not limited to social media, book, magazine, newspaper, leaflet, picket signs, or any mode of print. Under this law, a faculty member may bring legal action *"against a person who has published video or audio recorded in a classroom in violation of paragraph (3)(g) in a court of competent jurisdiction to obtain declaratory and injunctive relief and may be entitled to damages plus court costs and reasonable attorney fees, with the total recovery not to exceed $200,000."*

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.
- 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.

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/