BIOL827: Biological Statistics

Department of Biology, University of Nebraska-Kearney

Course Credits: 3
Course Delivery: Online - Asynchronous

Course Overview

This class is divided into two main areas. The first is biological statistics: the collection and analysis of scientific data. The second area is experimental design: how an experimental hypothesis is built and what are the pieces and procedures needed to conduct a successful experiment. The class is not mathematically intensive and relies on the power of computers beyond a few examples done by hand. The class includes both parametric and non-parametric statistics with continuous and categorical variables. Per the UNK Graduate Course Catalog.

Course Learning Objectives

At the completion of the course, you will be able to

1. Identify best practices for data management, including creation of metadata, to ensure longevity of datasets.
2. Construct testable hypotheses about biological systems and identify appropriate experimental designs to statistically test those hypotheses.
3. Calculate descriptive statistics to examine the character of a dataset and evaluate statistical power.
4. Conduct and interpret results of standard statistical tests as appropriate for the experimental design used and data collected.
5. Apply statistical concepts in critically evaluating research conducted by others.
6. Communicate research results that are accurately, concisely, and straightforwardly supported by statistics.

Instructor

Dr. Jayne Jonas, UNK Department of Biology, jonasj@unk.edu, office: 308.865.8224

Office hours – Zoom link available in Canvas

- Tuesdays 3:30PM – 4:30PM Central Time
- Or, by appointment

Please take advantage office hours to get help or just to check-in. I will be available for office hours on Zoom during these times. If 2 or more students are in the Zoom session at the same time, I will rotate through student questions in the order in which they joined. We may go into a breakout session to discuss grades or any issues you are not comfortable discussing in front of others.

Important University Dates

- First day of the session: May 22, 2023
- Last day of the session: August 11, 2023
- See the UNK Academic Calendar for other important University dates

Required Texts and Materials

- Whitlock, M.C., Schluter, D. The Analysis of Biological Data. Freeman-Macmillan, New York.
  - 2015 Second edition or 2020 Third edition
  - To purchase the textbook, visit the course page of the UNK online book supplier: http://unk.textbookx.com/institutional/index.php?action=browse#books/3421169/
- Other:
  - Some required and optional reading materials may be provided via the Library Reserves or require accessing via Library citation finder.
  - Any other course readings, website, and interactives (required or optional) will be posted for download or linked on the Learning Content pages in Canvas.

Required Technology

- As an online course, access to an **up-to-date computer** and **Canvas** several times a week is required (checking in daily is encouraged). Use of an obsolete computer operating system may hinder functionality of both Canvas and RStudio.
- All quizzes should be completed from a computer browser. Issues may arise if using the Canvas mobile app or browser on a mobile device to complete quizzes.
- Application of concepts via statistical software is central to current research practice and eases the need for you to complete complex computations manually. Familiarity with statistical computing is also seen as a valuable skill by many employers in the biological sciences. In this course, we will use one of the most common programs, the R program, as it is implemented using RStudio Desktop. Both are free and available for Windows, Mac, and Linux operating systems. **Please install both software programs** prior to beginning Module 1. No prior knowledge of or experience with this software is needed at the beginning of the course – we will start from the beginning and build skills incrementally during the semester. Although current builds of RStudio are designed for 64-bit computers, you can download and install an older build of RStudio compatible with 32-bit computers.
  - For issues installing R/RStudio, please contact the instructor as soon as possible.
  - If you prefer using a different program (ex., MSExcel, SAS, SPSS), that is okay if it produces comparable output and results as RStudio; I will not provide support for these other software programs.
- You may need to use a word processing software, such as Microsoft Word, Apple Pages, or Google Docs.
  - Word processing programs include tools for typing equations; you should familiarize yourself with the equation editor in the word processing software of your choice. The equation editor is launched by selecting 'Equation' from the 'Insert' menu in all three word-processing programs listed above.

    - Microsoft 365 software is available to UNK students for free download.
- Familiarity with spreadsheet programs such as Microsoft Excel or Google Sheets is helpful.
- Ability to use search engines (for example, Google Scholar or the Calvin Library search engine) to locate scholarly works is expected of graduate students. If you are not already comfortable with this, I encourage you to reach out to me or the Natural Sciences Librarian at Calvin Library for assistance.
- For issues with Canvas or other technologies associated with your university account, please contact the University technology help desk.

Course Organization

There are 16 content modules assigned over 12 weeks in this course. As a 3-credit course completed in 12 instructional weeks, it is expected that an average student achieving an average grade will spend at least 12 - 16 hours per week on this course.

Each module consists of module learning objectives, a set of mini-lectures, assigned readings, and any other assigned learning materials. One or two modules will be covered each week (Monday 12:01 am to the next Monday 11:59 pm). Consecutive modules overlap on Mondays to provide students completing problem sets over the weekend time to email questions and receive answers from me prior to them being due. All materials will be listed, posted, or linked in Canvas.

Participation

The more students are engaged in a course, the more they tend to get out of it. I encourage you to spend at least a little time each day with course material or activities though I recognize this is not always possible.

Communication

Please check Announcements in Canvas frequently. This is the primary way I will communicate with the class.

Please feel free to reach out to me at any time via Canvas messages, email, or office phone. I will respond as quickly as possible, usually within 24-48 hours depending on the type of question and depth of response is required. If sending an email or leaving a voicemail, please be sure to include BIOL827 in the subject (email) or message (voicemail) so I can prioritize responding to it.

Course Assessments

All work is assigned individually to all students and due by 11:59PM Central Time on the date listed in Canvas and on the course schedule, unless otherwise indicated. If there is a discrepancy between the course schedule and Canvas, dates in the course schedule takes precedence. Students are responsible for all material covered, even for assignments that are missed or for which the score is dropped.

Discussion Weekly discussions provide students an opportunity to critically examine a peer-reviewed scientific study and discuss how concepts presented that week apply to it. Importantly, they also allow students to support one another in learning. Students are expected to uphold UNK Values and any other principles of community identified by your group to establish the discussion board as a supportive and inclusive learning space.

Discussion participation: You are expected to compose at least **three posts** for each discussion (more are encouraged!): one in direct response to a discussion prompt on or before **Thursday** and a response to two other students on or before **Sunday** of the assigned week. The grading rubric and information regarding expectations for discussion participation are available in Canvas. Participation in each discussion is worth 12 points. There will be 11 graded discussions, the lowest 1 discussion score dropped (i.e., 10 will count toward the semester grade).

I will follow discussions throughout each module. However, being cognizant that students will be posting at different times during the week and to avoid steering discussion too much, I will generally limit my contributions to areas in need of immediate attention. If there is more than one Discussion Group, a summary of each group's discussion for review by all students in the course will be posted to the corresponding Discussion Recap page by the discussion leader following the end of that discussion (see below).

Discussion leading: Each student will be assigned **one module to lead discussion** (30 points). Student leaders are expected to **also participate** in and will receive a separate participation grade for the discussion they are assigned to lead. See the Discussion Leading Assignment in Canvas for complete instructions, expectations, schedule, and grading rubric.

Materials are due to be posted to the discussion board by the discussion leader no later than 11:59PM Central Time on **Tuesday of the assigned module**. At the conclusion of the module, the leader will write a *brief* summary highlighting the main points discussed for each question and post it to the Discussion Recap page of the corresponding module by 11:59PM on **the last Monday of the module**.

Problem sets

Each week will have a 31.25-point problem set assigned except during weeks with an exam. Problem sets will provide students practice applying concepts relevant to each module, handling data, conducting analyses in R, and interpreting results in the context of a biological question/hypothesis. Each will be due by of before 11:59PM on **the last Monday of the module** unless otherwise indicated. There will be a total of 9 graded problem sets, with the lowest 1 score being dropped (i.e., 8 scores will contribute to the semester grade).

A file with detailed instructions and any datafiles will be provided for each problem set in Canvas. Students are expected to read and follow these instructions. Students may work through problem sets collaboratively, but each student must submit their own unique work and will be responsible for that material on exams.

Most problem sets will be submitted by entering responses in a Canvas quiz page. If there is a discrepancy between the instructions document and the Canvas quiz form, the instructions document takes precedence. When entering problem set responses into a Canvas quiz form, students will not have a time limit in which to complete the assignment or be limited in the number of attempts (the last submission will be graded) until due.

Quizzes

There will be a 25-point quiz each week related to the learning objectives of the module(s) covered except in weeks with an exam. Quizzes are to be completed by each student independently (i.e., no collaboration with others). They may require students to refer to tables in the text or other materials provided in the module and may include simple calculations requiring a calculator or spreadsheet.

Weekly quizzes must be completed by or before 11:59PM each **Saturday**. Quizzes are open book/note (no proctor needed), students will not be able to stop then resume once started. Once started, students will have 25 minutes to complete the quiz. Students will have **two attempts** to take each quiz (highest score kept). Of the 9 weekly quizzes, the lowest 1 score will be dropped (i.e., 8 scores will contribute to the semester grade).

Important note: Canvas quizzes should be completed from a computer browser. Issues tend to arise when using the Canvas mobile app or browser on a mobile device.

Exams

Students are responsible for all material covered on exams, even for assignments that are missed or for which the score is dropped.

There are two unit exams (100 points each) and a comprehensive final exam (200 points). Exams have the following components:

1) timed quiz,
2) problem set, and
3) [final exam only] paper critique.

All exam components are to be completed by each student independently and without collaboration or outside assistance. All timed quiz portions are open note/open book (proctor not required). Students have **one attempt** to take the timed exam and will not be able to stop then resume once started. Specific instructions and expectations for exam problem sets (unit exams and final exam) and critique (final exam only) will be provided in Canvas one-week prior to their due date.

Unit exams (Modules 6 and 11): Unit exams will cover material relevant to learning objectives of each module in the unit, including the module in which the exam occurs. Exams will be cumulative in so far as the material in the course builds upon itself. The timed exam will be due by 11:59PM CT **Saturday of exam week**, and the problem set will be due by 11:59PM CT **on the last Monday of the module**. Once started, students will have 75 minutes to complete the timed portion of the unit exam. Timed and problem set

portions of each exam can be submitted at any time from when they become available to when they are due.

Comprehensive final exam (Module 17): All portions of the final exam are due during the last week of the semester. The paper critique will be due by 11:59PM CT on **Tuesday.** The timed quiz portion of the comprehensive final will be available only on **Wednesday (12:01AM to 11:59PM CT)** and must be submitted by 11:59PM CT that day. Once started, students will have 90 minutes to complete the timed portion of the final exam; otherwise, the timed portion of the final will run similarly to unit exams. The take-home problem set will be due by **5:00PM CT** on **Thursday**.

Basis for final grade

Assessments and point distribution*	Points	% of grade
Module discussions	**150**	**15%**
Participation (11 @ 12 points each, 1 dropped)	120	12%
Leading (1 @ 30 points each)	30	3%
Weekly problem sets	**250**	**25%**
(9 @ 31.25 points each, 1 dropped)		
Quizzes/Exams	**600**	**60%**
Quizzes (9 @ 25 points each, 1 dropped)	200	20%
Unit exams (2 @ 100 points each)	200	20%
Final exam	200	20%
Total	**1000**	**100%**

*Adjustments may be made if deemed necessary by the instructor

Final letter grades will be assigned following a straight letter scheme (i.e., no +/- except as described under Grading Policy below) as follows:

A:	90 - 100%	D:	60 - < 70%
B:	80 - < 90%	F:	< 60%
C:	70 - < 80%		

Course Policies

Grading Policy

I take my role as your instructor very seriously; I care about how well you do in this course and that you have a challenging and rewarding experience. It is my commitment to you to respond individually to the work you submit in this class and to return your work promptly. Discussions, problem sets, and weekly quizzes will be returned within one week. Exams will be returned within ten days. If grading will take longer than the times listed here, I will keep you informed of my progress and return your work as soon as I can.

If you think there was a grading error or do not understand the feedback you receive on graded work, please contact me as soon as possible. If you would like me to regrade your work, requests should be made within three days after the graded work has been returned to you. Regrade requests may result in a lower grade.

Accommodations for cases in which an end of semester grade percentage falls within 0.50% of the next highest letter grade must be requested by the student by 8AM CT on the Tuesday after finals week. I will take participation and engagement throughout the semester into consideration in deciding whether to make a final grade accommodation. When granted, course letter grade accommodations will result in a half-letter increase (for example, an 89.51% would be an A- for an accommodated student). Accommodations will not be considered for semester grade percentages more than 0.50% from the next letter grade.

Late Work Policy

As a student enrolled in this course, one of your responsibilities is to submit course work on time. With that said, I recognize there may be times when you are unable to complete or submit these tasks by their due dates. To accommodate this, one weekly problem set, one discussion participation, and one weekly quiz score will be dropped. Canvas automatically adjusts your course grade throughout the semester to reflect dropping the lowest value at a given time.

> ***Exams:*** These assessments should be completed within the designated timeframe. Exams will not be accepted late unless prior arrangements have been made due to *documented* professional or extenuating personal circumstances (e.g., family emergency, participation in University-sanctioned activities, religious observation, etc.). Please contact me as soon as possible to discuss alternative arrangements.
>
> ***Quizzes, Discussions, Problem Sets:*** These assignments will receive a one letter grade deduction (10% of points possible on assignment) for each day late unless prior arrangements have been made or if there are professional or extenuating circumstances (e.g., family emergency, participation in University-sanctioned activities, religious observation, etc.). Late assignments will be accepted up to 4 days late. If more than 4 days late, the assignment will not be accepted and a grade of 0 (zero) will be recorded for that assignment. Please contact me as soon as possible.

Extra Credit Policy

Extra credit opportunities may be provided at the discretion of the instructor.

University Policies and Resources

Final Exam Policy

Final examination week is part of the regular semester. Student attendance shall be consistent with University policy.

Professionalism and Academic Integrity Policy

Academic honesty is essential to the existence and integrity of an institution of higher education. The responsibility for maintaining that integrity is shared by all members of the academic community. To further serve this end, the University of Nebraska at Kearney has a policy relating to academic integrity. You can find the Graduate Academic Integrity Policy online.

> ***Plagiarism:*** It is of utmost importance in this course to understand and avoid plagiarism. Writing discussion posts and a paper critique are a core feature of this course. TurnItIn may be used for assignments submitted in Canvas. For more information and tips, please visit the TurnItIn's webpage "Preventing Plagiarism when Writing" or reach out to me for guidance. If you plagiarize in your submitted work you could fail the assignment or fail the course. Each instance of plagiarism, classroom cheating, and other types of academic dishonesty will be addressed in accordance with the above UNK Academic Integrity policy.

All students at the University of Nebraska Kearney should be aware of the following university-wide course policies and resources.

Attendance Policy

Your instructor may have indicated on their syllabus an attendance policy specific to their class. If so, that is the policy with which you must comply. If no other policy is stated, the University-wide attendance policy will apply. You can find the Student Attendance Policy Statement online.

Reporting Student Sexual Harassment, Sexual Violence or Sexual Assault

Reporting allegations of rape, domestic violence, dating violence, sexual assault, sexual harassment, and stalking enables the University to promptly provide support to the impacted student(s), and to take appropriate action to prevent a recurrence of such sexual misconduct and protect the campus community. Confidentiality will be respected to the greatest degree possible. Any student who believes they may be the victim of sexual misconduct is encouraged to report to one or more of the following resources:

- Local Domestic Violence, Sexual Assault Advocacy Agency 308-237-2599
- Campus Police (or Security) 308-865-8911
- Title IX Coordinator 308-865-8655

Retaliation against the student making the report, whether by students or University employees, will not be tolerated.

Students with Disabilities

It is the policy of the University of Nebraska at Kearney to provide flexible and individualized reasonable accommodation to students with documented disabilities. To receive accommodation

services for a disability, students must be registered with the UNK Disabilities Services for Students (DSS) office, 175 Memorial Student Affairs Building, 308-865-8214 or by email unkdso@unk.edu.

Students Who are Pregnant

It is the policy of the University of Nebraska at Kearney to provide flexible and individualized reasonable accommodation to students who are pregnant. To receive accommodation services due to pregnancy, students must contact the Student Health office at 308.865.8218. The following links provide information for students and faculty regarding pregnancy rights. https://thepregnantscholar.org/title-ix-basics/

https://nwlc.org/resource/faq-pregnant-and-parenting-college-graduate-students-rights/

UNK Statement of Diversity & Inclusion

UNK stands in solidarity and unity with our students of color, our Latinx and international students, our LGBTQIA+ students and students from other marginalized groups in opposition to racism and prejudice in any form, wherever it may exist. It is the job of institutions of higher education, indeed their duty, to provide a haven for the safe and meaningful exchange of ideas and to support peaceful disagreement and discussion. In our classes, we strive to maintain a positive learning environment based upon open communication and mutual respect. UNK does not discriminate on the basis of race, color, national origin, age, religion, sex, gender, sexual orientation, disability or political affiliation. Respect for the diversity of our backgrounds and varied life experiences is essential to learning from our similarities as well as our differences. The following link provides resources and other information regarding D&I: https://www.unk.edu/about/equity-access-diversity.php

BIOL827: Biological Statistics

Tentative Summer 2023 Course Schedule

All work due by 11:59PM CT unless otherwise indicated. Required assignments/content not listed here may be provided in Canvas.

Module 1 Introduction to Statistics

22 May	**Module begins**	
	Mini lectures (4)	
	Textbook (1)	Chapter 1
	Journal article (1)	
Due	*Assignment*	
	*See Module 2 Assignments	
29 May	**Module ends**	

Module 2 Data Management

22 May	**Module begins**	
	Mini lectures (4)	
	Textbook (0)	No assigned textbook readings
	Journal articles (1)	
	Websites (3)	
	Optional materials (6)	
Due	*Assignment (over Modules 1 and 2)*	
23 May	Discussion	Instructor posts article and questions
25 May	Discussion	Initial response
27 May	Quiz	
28 May	Discussion	Replies to classmates
29 May	Problem set	
29 May	**Module ends**	

Module 3 Describing and Visualizing Data

29 May	**Module begins**	
	Mini lectures (4)	
	Textbook (2)	Chapters 2 and 3
	Journal article (1)	
	Booklet (1)	
Due	*Assignment*	
	*See Module 4 Assignments	
5 Jun	**Module ends**	

Module 4 Uncertainty and Probability

29 May	**Module begins**	
	Lectures (2)	
	Textbook (2)	Chapters 4 and 5
	Optional video (1)	
	Web interactive (1)	
Due	*Assignment (over Modules 3 and 4)*	
30 May	Discussion	Leader posts article and questions
1 Jun	Discussion	Initial response

3 Jun	Quiz	
4 Jun	Discussion	Replies to classmates
5 Jun	Problem set	
5 Jun	**Module ends**	

Module 5 Hypothesis testing

5 Jun	**Module begins**	
	Mini lectures (4)	
	Textbook (1)	Chapter 6
	Journal article (1)	

Due	*Assignment*	
6 Jun	Discussion	Leader posts article and questions
8 Jun	Discussion	Initial response
10 Jun	Quiz	
11 Jun	Discussion	Replies to classmates
12 Jun	Problem set	
12 Jun	**Module ends**	

Module 6 Experimental Design (Unit 1 Exam)

12 Jun	**Module begins**	
	Mini lectures (3)	
	Textbook	Chapter 14

Due	*Assignment*	
13 Jun	Discussion	Leader posts article and questions
15 Jun	Discussion	Initial response
17 Jun	Unit 1 Exam Timed Portion	
18 Jun	Discussion	Replies to classmates
19 Jun	Unit 1 Exam Problem set	
19 Jun	**Module ends**	

Module 7 Binomial Data and the Binomial Distribution

19 Jun	**Module begins**	
	Mini lectures (4)	
	Textbook (3)	Chapter 7

Due	*Assignment*
	*See Module 8 Assignments
26 Jun	**Module ends**

Module 8 Categorical Data and the χ^2 Distribution

19 Jun	**Module begins**	
	Mini lectures (4)	
	Textbook (3)	Chapters 8, 9

Due	*Assignment (over Modules 7 and 8)*	
20 Jun	Discussion	Leader posts article and questions
22 Jun	Discussion	Initial response
24 Jun	Quiz	
25 Jun	Discussion	Replies to classmates

26 Jun	Problem set	
26 Jun	**Module ends**	

Module 9 The Normal Distribution

26 Jun	**Module begins**	
	Mini lectures (4)	
	Textbook (2)	Chapter 10, Chapter 13 sections 13.1-13.3
	External video (1)	
	Optional materials (3)	

Due	*Assignment*	
27 Jun	Discussion	Leader posts article and questions
29 Jun	Discussion	Initial response
1 Jul	Quiz	
2 Jul	Discussion	Replies to classmates
3 Jul	Problem set	
3 Jul	**Module ends**	

Module 10 One-sample and Paired *t*-Tests

3 Jul	**Module begins**	
	Mini lectures (7)	
	Textbook (3)	Chapter 11, Chapter 12 sections 12.1-12.2, Chapter 13 sections 13.4 and 13.7

Due	*Assignment*	
5 Jul*	Discussion	Leader posts article and questions
6 Jul	Discussion	Initial response
8 Jul	Quiz	
9 Jul	Discussion	Replies to classmates
10 Jul	Problem set	
10 Jul	**Module ends**	

*due date shifted because of the Fourth of July holiday

Module 11 Two-sample *t*-Tests

10 Jul	**Module begins**	
	Mini lectures (5)	
	Textbook	Chapter 12, Chapter 13 sections 13.5-13.7
	Journal article (1)	
	Optional interactive (1)	

Due	*Assignment*	
11 Jul	Discussion	Leader posts article and questions
13 Jul	Discussion	Initial response
15 Jul	Unit 2 Exam Timed	
16 Jul	Discussion	Replies to classmates
17 Jul	Unit 2 Exam Problem set	
17 Jul	**Module ends**	

Module 12 Introduction to ANOVA

17 Jul	**Module begins**	
	Mini lectures (5)	
	Textbook	Chapter 15, Interleaf 8

Optional materials (2)

Due	*Assignment*	
18 Jul	Discussion	Leader posts article and questions
20 Jul	Discussion	Initial response
22 Jul	Quiz	
23 Jul	Discussion	Replies to classmates
24 Jul	Problem set	
24 Jul	**Module ends**	

Module 13 Complex ANOVA

24 Jul	**Module begins**	
	Mini lectures (5)	
	Textbook	Chapter 18
	Journal article (1)	Same as “optional” article in Module 11

Due	*Assignment*	
25 Jul	Discussion	Leader posts article and questions
27 Jul	Discussion	Initial response
29 Jul	Quiz	
30 Jul	Discussion	Replies to classmates
31 Jul	Problem set	
31 Jul	**Module ends**	

Module 14 Correlation

31 Jul	**Module begins**	
	Mini lectures (6)	
	Textbook	Chapter 16

Due	*Assignment*
	*See Module 15 Assignments
7 Aug	**Module ends**

Module 15 Regression

31 Jul	**Module begins**	
	Mini lectures (6)	
	Textbook	Chapter 17

Due	*Assignment (over Modules 14 and 15)*	
1 Aug	Discussion	Leader posts article and questions
3 Aug	Discussion	Initial response
5 Aug	Quiz	
6 Aug	Discussion	Replies to classmates
7 Aug	Problem set	
7 Aug	**Module ends**	

Module 16 Meta-analysis

7 Aug	**Module begins**	
	Mini lectures (3)	
	Textbook	2nd Ed. Chpt 21 (available on eReserves), Interleaf 10
	Journal articles (3)	
	Optional materials (1)	

Due	*Assignment*
	*No dedicated assignments, but will be covered on Final Exam
11 Aug	**Module ends**

Module 17 Final Exam Week

7 Aug	**Module begins**

Due	*Assignment*	
8 Aug	Final Exam Critique	
9 Aug	Final Exam Timed	
10 Aug	Final Exam Problem Set	Due by **5:00PM CST**
11 Aug	**Course ends**	