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 using RStudio statistical software.
4. Use RStudio to conduct standard statistical tests as appropriate for different experimental designs and datasets.
5. Interpret results of standard statistical tests.
6. Apply statistical concepts in critically evaluating research conducted by others.
7. Communicate research results that are accurately and concisely 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

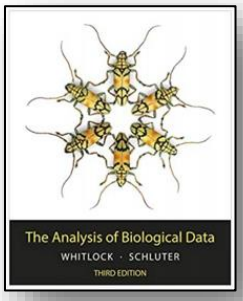
Mondays 1 PM – 3 PM and Thursdays 8 AM – 9 AM Central Time, or by appointment.

I will be available in Zoom each week during the times listed above. Please take advantage office hours to check-in or ask any questions you might have. 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 private matters. I also have in-person office hours during these times, so there may be times I need to rotate between Zoom and on-campus students.

Important University Dates

- First day of the session: August 21, 2023
- Fall Break: October 16-17, 2023
- Last day to withdraw: November 10, 2023
- Thanksgiving Break: November 22-24, 2023
- Last day of the session: December 14, 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.
- 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.
  - You will need to be able to download and install software from the internet on the computer you use for this course. See more about R and RStudio below.
- 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 or RStudio, please contact the instructor as soon as possible.
- You may need to use a word processing software, such as Microsoft Word 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 16 weeks prior to Finals Week. As a 3-credit course completed in 16 instructional weeks, it is expected that an average student achieving an average grade will spend at least 9 - 12 hours per week on this course.

Each module consists of module learning objectives, a set of short lectures, assigned readings, and any other assigned learning materials, as well as assessments. One or two modules will be covered each week (Monday 12:01 am CT to the next Monday 11:59 pm CT). Specific assignments and due dates are listed separately in the Course Schedule. 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 your UNK email and Canvas Announcements frequently. These are the primary ways I will communicate with you about any changes, updates, and reminders.

I encourage you to reach out to me at any time via Canvas messages (preferred), email, or office phone. I will respond by email or through Canvas as quickly as possible, usually within 24-48 hours depending on the type of question and depth of response 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 11:59 PM 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 take precedence. Students are responsible for all material covered, even for assignments that are missed or for which the score is dropped. Adjustments to assessments and point values may be made if deemed necessary by the instructor; students will be notified as soon as possible of any changes.

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 13 points. Each week will have a discussion except exam weeks. There will be 12 discussions, the lowest 1 discussion score will be dropped (i.e., 11 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. 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.

Discussion leading: You will be assigned **one module** to lead discussion (37 points). You are expected to also participate in and will receive a separate participation grade for the discussion you 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 11:59 PM Central Time on Tuesday of the assigned module. At the conclusion of the module, the leader will write a summary highlighting the main points the group discussed for each question and post it to the Discussion Recap page of the corresponding module by 11:59 PM CT on the last Monday of the module.

Problem sets

Each week will have a 18-point problem set 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 and hypothesis. Each will be due by 11:59 PM CT on the last Monday of the module unless otherwise indicated. There will be a total of 12 graded problem sets, with the lowest 2 scores being dropped (i.e., 10 scores 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 all 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 submitted prior to the due date/time. The last submission will be graded.

Quizzes

There will be a 15-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). Quizzes 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 11:59 PM CT 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; the highest score will be graded. Of the 13 weekly quizzes, the lowest 1 score will be dropped (i.e., 12 scores will contribute to the semester grade).

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

Exams

Exams will assess your progress toward reaching the course learning objectives. You are responsible for all material covered for exams, even for assignments that are missed or for which the score is dropped.

There are two unit exams (90 points each) and a comprehensive final exam (180 points). Exams have the following components:

1) timed quiz over concepts,
2) problem set over application of concepts,
3) [final only] paper critique.

Timed quiz and problem set components are to be completed by you independently and without collaboration or outside assistance. All timed quiz portions are open note/open book (proctor not required). You will 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 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 quiz portion** will open by Wednesday of the exam week and be due by 11:59 PM CT Saturday of exam week. Once started, students will have 75 minutes to complete the timed portion of the unit exam. The **problem set portion** will be due by 11:59 PM CT on the last Monday of the module. You may submit the timed and problem set portions of each exam at any time between when they become available and when they are due.

Comprehensive final exam (Module 17): All portions of the final exam are due during Finals Week. The **paper critique** (20 points) will be due by 11:59 PM CT on Tuesday**.** The **timed quiz portion** (70 points) of the comprehensive final will be available only on Wednesday (12:01AM to 11:59PM CT) and is due by 11:59PM CT that day. Once started, you 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 **problem set portion** (90 points) will be due by 5:00PM CT on Thursday. You may submit these components at any time between when they become available and when they are due.

Basis for final grade

Assessments and point distribution*	Points	% of grade
Module discussions	**180**	**20%**
Participation (12 @ 13 points each, 1 dropped)	144	16%
Leading (1 @ 37 points each)	36	4%
Weekly problem sets	**180**	**20%**
(12 @ 18 points each, 2 dropped)		
Quizzes/Exams	**540**	**60%**
Quizzes (13 @ 15 points each, 1 dropped)	180	20%
Unit exams (2 @ 90 points each)	180	20%
Final exam	180	20%
Total	**900**	**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%
B: 80 - < 90%
C: 70 - < 80%
D: 60 - < 70%
F: < 60%

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. I will make every effort to return discussions, problem sets, and weekly quizzes within one week and exams 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 any or all of an assessment, 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 8 AM CT on the day after final course grades are posted in Canvas. 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, two discussion participation, and two weekly quiz scores will be dropped. Canvas automatically adjusts your course grade throughout the semester to reflect dropping the lowest value at a given time.

Grading of work submitted late may take longer than the times described under Grading Policy. If you have submitted work late and it has not been returned within two weeks, please let me know to make sure I am aware it was submitted.

> ***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:*** I encourage you to submit assignments for up to 4 days after they are due for partial credit. 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 documented professional or extenuating circumstances (e.g., family emergency, participation in University-sanctioned activities, religious observation, etc.). Please contact me as soon as possible with questions.

Group Work Policy

Forming study groups can be very beneficial for learning concepts and their application in this course. While working with other students on problem sets is encouraged in this class, your submitted problem set work needs to demonstrate your own words and thought. You are expected to complete quizzes and exams on your own and without assistance. It is of utmost importance in this course to understand and avoid plagiarism. Writing discussion posts and biological conclusions based on statistical tests is a core feature of this course. 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 the course. Each instance of plagiarism, classroom cheating, and other types of academic dishonesty will be addressed on a case-by-case basis and in accordance with the UNK Academic Integrity policy.

Extra Credit Policy

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

University Policies and Resources

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

Final Exam Policy

The final exam will be administered in the time period scheduled during finals week in accordance with University policy (Final Exam Schedule). More information about UNK's Finals Week Policy, including when it is appropriate to ask for special accommodations to move a course's final exam, can be found here: Finals Week Policy.

Academic Honesty 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.

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 Fall 2023 Course Schedule

All work due by 11:59PM CT unless otherwise indicated.

Adjustments may be made if deemed necessary by the instructor; students will be notified as soon as possible of any changes. Required content not listed here may be provided in Canvas.

Module 1 Introduction to Statistics

21 Aug	**Module begins**	
	Mini lectures (4)	
	Textbook (1)	Chapter 1
	Journal article (1)	

Due	*Assignment*	
22 Aug	Discussion	Leader posts article and questions
24 Aug	Discussion	Initial response
26 Aug	Quiz	
27 Aug	Discussion	Replies to groupmates
28 Aug	Problem set	
28 Aug	**Module ends**	

Module 2 Data Management

28 Aug	**Module begins**	
	Mini lectures (4)	
	Textbook (0)	No assigned textbook readings
	Journal articles (1)	
	Websites (3)	
	Optional materials (6)	

Due	*Assignment*	
29 Aug	Discussion	Leader posts article and questions
31 Aug	Discussion	Initial response
2 Sep	Quiz	
3 Sep	Discussion	Replies to groupmates
3 Sep	Problem set*	
3 Sep	**Module ends***	

*Note module end adjusted for the Labor Day Holiday. No late deduction on the problem set if submitted by 11:59 PM CT on September 4.

Module 3 Describing and Visualizing Data

5 Sep	**Module begins**	
	Mini lectures (4)	
	Textbook (2)	Chapters 2 and 3
	Journal article (1)	
	Booklet (1)	

Due	*Assignment*	
5 Sep	Discussion	Leader posts article and questions
7 Sep	Discussion	Initial response
9 Sep	Quiz	
10 Sep	Discussion	Replies to groupmates

11 Sep	Problem set	
11 Sep	**Module ends**	

*Note module beginning adjusted for the Labor Day Holiday.

Module 4 Uncertainty and Probability

11 Sep	**Module begins**	
	Lectures (2)	
	Textbook (2)	Chapters 4 and 5
	Optional video (1)	
	Web interactive (1)	

Due	*Assignment*	
12 Sep	Discussion	Leader posts article and questions
14 Sep	Discussion	Initial response
16 Sep	Quiz	
17 Sep	Discussion	Replies to groupmates
18 Sep	Problem set	
18 Sep	**Module ends**	

Module 5 Hypothesis testing

18 Sep	**Module begins**	
	Mini lectures (4)	
	Textbook (1)	Chapter 6
	Journal article (1)	

Due	*Assignment*	
19 Sep	Discussion	Leader posts article and questions
21 Sep	Discussion	Initial response
23 Sep	Quiz	
24 Sep	Discussion	Replies to groupmates
25 Sep	Problem set	
25 Sep	**Module ends**	

Module 6 Experimental Design

25 Sep	**Module begins**	
	Mini lectures (3)	
	Textbook	Chapter 14

Due	*Assignment*	
30 Sep	Unit 1 Exam Timed	Modules 1 - 6
2 Oct	Unit 1 Exam Problem set	Modules 1 - 6
2 Oct	**Module ends**	

Module 7 Binomial Data and the Binomial Distribution

2 Oct	**Module begins**	
	Mini lectures (4)	
	Textbook (3)	Chapter 7

Due	*Assignment*	
3 Oct	Discussion	Leader posts article and questions
5 Oct	Discussion	Initial response
7 Oct	Quiz	
8 Oct	Discussion	Replies to groupmates
9 Oct	Problem set	
9 Oct	**Module ends**	

Module 8 Categorical Data and the χ^2 Distribution*

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

Due	*Assignment*	
10 Oct	Discussion	Leader posts article and questions
12 Oct	Discussion	Initial response
14 Oct	Quiz	
15 Oct	Discussion	Replies to groupmates
15 Oct	Problem set*	
15 Oct	**Module ends***	

*Due date shifted to Sunday, 10/15, due to Fall Break. No late penalty if submitted by 10/16.

Fall Break

16 Oct – 22 Oct: No new material will be presented this week. You are encouraged to review Modules 7 and 8 material and/or begin working on Module 9 material.

Module 9 The Normal Distribution*

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

Due	*Assignment*	
24 Oct	Discussion	Leader posts article and questions
26 Oct	Discussion	Initial response
28 Oct	Quiz	
29 Oct	Discussion	Replies to groupmates
30 Oct	Problem set	
30 Oct	**Module ends**	

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

30 Oct	**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*	
31 Oct	Discussion	Leader posts article and questions
2 Nov	Discussion	Initial response
4 Nov	Quiz	
5 Nov	Discussion	Replies to groupmates
6 Nov	Problem set	
6 Nov	**Module ends**	

Module 11 Two-sample *t*-Tests

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

Due	*Assignment*	
11 Nov	Unit 2 Exam Timed	Modules 7 - 11
13 Nov	Unit 2 Exam Problem set	Modules 7 - 11
13 Nov	**Module ends**	

Module 12 Introduction to ANOVA

13 Nov	**Module begins**	
	Mini lectures (5)	
	Textbook	Chapter 15, Interleaf 8
	Optional materials (2)	

Due	*Assignment*	
14 Nov	Discussion	Leader posts article and questions
16 Nov	Discussion	Initial response
18 Nov	Quiz	
19 Nov	Discussion	Replies to groupmates
20 Nov	Problem set	
20 Nov	**Module ends**	

Module 13 Complex ANOVA*

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

Due	*Assignment*
27 Nov	Quiz*
27 Nov	**Module ends**

*Shortened module due to Thanksgiving Break. Quiz (only assignment) due Monday after Break.

Modules 14 Correlation and 15 Regression

27 Nov	**Module begins**

	Module 14 Correlation	
	Mini lectures (6)	
	Textbook	Chapter 16
	Module 15 Regression	
	Mini lectures (6)	
	Textbook	Chapter 17

Due	*Assignment*	
28 Nov	Discussion	Leader posts article and questions
30 Nov	Discussion	Initial response
2 Dec	Quiz	
3 Dec	Discussion	Replies to groupmates
4 Dec	Problem set	
4 Dec	**Module ends**	

Module 16 Meta-analysis

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

Due	*Assignment*	
5 Dec	Discussion	Leader posts article and questions
7 Dec	Discussion	Initial response
9 Dec	Quiz	
10 Dec	Discussion	Replies to groupmates
11 Dec	Problem set	
11 Dec	**Module ends**	

Module 17 Final Exam Week

11 Dec	**Module begins**

Due	*Assignment*	
12 Dec	Final Exam Critique	Due by 11:59PM CST
13 Dec	Final Exam Timed Quiz	Due by 11:59PM CST
14 Dec	Final Exam Problem Set	Due by 5:00PM CST
14 Dec	**Course ends**	