BIOL827: Biological Statistics

Department of Biology, University of Nebraska-Kearney

Term: Fall 2022
Course Credits: 3
Course Delivery: Online - Asynchronous

Instructor

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

Zoom office hours

Mondays and Wednesdays, 11:00AM – 12:00PM Central Time, or by appointment.

Please contact me any time with questions or concerns. If emailing outside of Canvas, please include BIOL827 in the subject line to ensure a timely response. I respond to messages as quickly as I can, generally within 24-48 hours.

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.

Important University Dates
- First day of the session: August 22, 2022
- University Breaks/Holidays: September 5, 2022, October 17-18, November 23-27
- Last day to withdraw: November 11, 2022
- Last day of the session: December 15, 2022
- 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 (preferred), 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 Canvas 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 both current research practice and critical evaluation of scientific literature. Familiarity with statistical computing is also seen as a valuable skill by many employers in the biological sciences. In this course, we will use the R program implemented using the free software RStudio Desktop. Both are 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 square one and work on building 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 with R/RStudio, please contact the instructor.
  - If you prefer using a different program (ex., MSExcel, SAS, SPSS), that is okay as long as it produces comparable output and results as RStudio; I will not provide support for other software.
- 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.

- o 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 15 weeks in 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; modules overlap on Mondays). All materials will be listed, posted, or linked in Canvas. As a 3-credit course completed in 12 instructional weeks (plus Finals Week), it is expected that you will spend at least 9 - 12 hours per week on this course.

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 course announcements in Canvas frequently. This the primary way I will communicate. 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. 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, the date in the course schedule takes precedence.

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 10 points. There will be 15 graded discussions, the lowest discussion score will be dropped (i.e., 14 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 unless there are areas in need of immediate attention. Following each module, a summary of group discussions will be posted by the discussion leader (see below) to the corresponding Discussion Recap page for review by all students in the course.

Discussion leading: Each student will be assigned **one module to lead discussion** (40 points). Student leaders are also expected to 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, schedule, and grading rubric.

Discussion leaders are expected to find a peer-reviewed scientific study (journal article, book chapter, etc.) from any field of biology relevant to that week's topic for the group to critique. The leader wll pose two to three thought-provoking questions about the study and how it relates to the week's topic for their group to discuss.

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 the 11:59PM on **the Monday of the next module**.

Problem sets

Each week will have a 15-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 output produced by R. Each will be due by 11:59PM on **the Monday of the next module**. There will be a total of 13 graded problem sets, with the lowest score being dropped (i.e., 12 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 quizzes and exams.

Most problem sets will be submitted by entering responses to the questions in the instructions file using 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 the due date/time.

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). 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 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 20 minutes to complete the quiz. Students will have two attempts to take each quiz (highest score kept). Of the 14 weekly quizzes, the lowest two scores 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 tend to arise when using the Canvas mobile app or browser on a mobile device.

Exams

There are two unit exams (90 points each) and a comprehensive final exam (180 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 (i.e., no collaboration). 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 (all exams) and critique (final only) will be provided in Canvas one-week prior to being due. Additional office hours may be offered during exam weeks, watch Canvas Announcements.

Unit exams (Modules 5 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 only in so far as the material in the course builds upon itself. The timed exam will be due by 11:59PM **Saturday of exam week**, and the problem set will be due by 11:59PM **Monday** after the timed exam is due. Once started, students will have 75 minutes to complete the timed portion of the unit exam. Problem sets can be submitted at any time prior to being due.

Comprehensive final exam (Module 17): All portions of the final exam are due in the last week of the semester. The paper critique will be due by 11:59PM on **Tuesday.** The timed quiz portion of the comprehensive final will be available <u>only</u> on **Wednesday (12:01AM to 11:59PM)** and must be submitted by 11:59PM 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** on **Thursday of Final's week**.

Basis for final grade

Assessments and point distribution*	Points	% of grade
Module discussions	**180**	**20%**
Participation (15 @ 10 points each, 1 dropped)	140	16%
Leading (1 @ 40 points each)	40	4%
Weekly problem sets	**180**	**20%**
(13 @ 15 points each, 1 dropped)		
Quizzes/Exams	**540**	**60%**
Quizzes (14 @ 15 points each, 2 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%	D:	60 - < 70%	
B:	80 - < 90%	F:	< 60%	
C:	70 - < 80%			

Course Policies

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.

Grading Policy

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 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, instead of a B an accommodated student would receive an A-). 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 discussion participation, one weekly problem set, and two weekly quiz scores will be dropped. Canvas automatically adjusts your course grade throughout the semester to reflect dropping these values.

> *Quizzes, Exams:* These assessments should be completed within the designated timeframe. Quizzes and 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.

> *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.

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

Students are expected to uphold UNK Values by being engaged in the course, conducting yourself with integrity, and treating others with respect and inclusivity. Critical questions and discussion to advance knowledge and understanding are strongly encouraged but must be done in a respectful way. Students who habitually disturb the class and have been warned may suffer a reduction in their final class grade.

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. To ensure all students understand the expectations, UNK has adopted Academic Integrity Policy.

"Academic Integrity" is a term that encapsulates honesty, trust, fairness, respect, and responsibility among students and faculty. You are expected to follow the University of Nebraska Student Code of Conduct. In particular,

> "Students are expected to approach and complete their academic work with integrity. They are expected to do their own work, to be honest in the statements they make, to refrain from harming others, to refrain from improperly helping others, and to follow the rules. Students must read instructions and syllabi carefully so that they know what their instructors expect in terms of academic integrity.

> Students who are unsure whether or not particular conduct is appropriate should ask their instructors or university administrators. Failing to act with integrity is a violation of the Code." (Student Code of Conduct, Section IIA)

You may be asked to affirm the statement as true on submitted work: *"By submitting this test or assignment, I unequivocally state that all work is entirely my own and does not violate UNK's Academic Integrity policy."*

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 UNK Academic Integrity policy.

University Policies and Resources
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 she or he 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 2022 Course Schedule
All work due by 11:59PM CT unless otherwise indicated. Required content not listed here may be provided in Canvas.

Module 1 Introduction to Statistics

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

Due	*Assignment*	
23 Aug	Discussion	Leader posts article and questions
25 Aug	Discussion	Initial response
27 Aug	Quiz	
28 Aug	Discussion	Replies to groupmates
29 Aug	Problem set	
29 Aug	**Module ends**	

Module 2 Data Management

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

Due	*Assignment*	
30 Aug	Discussion	Leader posts article and questions
1 Sep	Discussion	Initial response
3 Sep	Quiz	
5 Sep	Discussion	Replies to groupmates
5 Sep	Problem set	
5 Sep	**Module ends**	

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*	
6 Sep	Discussion	Leader posts article and questions
8 Sep	Discussion	Initial response
10 Sep	Quiz	
11 Sep	Discussion	Replies to groupmates
12 Sep	Problem set	
12 Sep	**Module ends**	

Module 4 Uncertainty and Probability

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

Due	*Assignment*	
13 Sep	Discussion	Leader posts article and questions
15 Sep	Discussion	Initial response
17 Sep	Quiz	
18 Sep	Discussion	Replies to groupmates
19 Sep	Problem set	
19 Sep	**Module ends**	

Module 5 Hypothesis testing

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

Due	*Assignment*	
20 Sep	Discussion	Leader posts article and questions
22 Sep	Discussion	Initial response
24 Sep	Unit 1 Exam Timed	
25 Sep	Discussion	Replies to groupmates
26 Sep	Unit 1 Exam Problem set	
26 Sep	**Module ends**	

Module 6 Experimental Design

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

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

Module 7 Binomial Data and the Binomial Distribution

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

Due	*Assignment*	
4 Oct	Discussion	Leader posts article and questions
6 Oct	Discussion	Initial response
8 Oct	Quiz	
9 Oct	Discussion	Replies to groupmates

10 Oct   Problem set
10 Oct   Module ends

Module 8 Categorical Data and the χ^2 Distribution*

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

Due   *Assignment*
11 Oct   Discussion   Leader posts article and questions
13 Oct   Discussion   Initial response
15 Oct   Quiz
16 Oct   Discussion   Replies to groupmates
16 Oct   Problem set*
17 Oct   Module ends
*Due date shifted to Sunday, 10/16, due to Fall Break. No late penalty if submitted by 10/17.

Module 9 The Normal Distribution*

19 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*
19 Oct*   Discussion   Leader posts article and questions
20 Oct   Discussion   Initial response
22 Oct   Quiz
23 Oct   Discussion   Replies to groupmates
24 Oct   Problem set
24 Oct   Module ends
*Dates shifted for Fall Break. Discussion leader due to post article & questions on Wednesday.

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

24 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*
25 Oct   Discussion   Leader posts article and questions
27 Oct   Discussion   Initial response
29 Oct   Quiz
30 Oct   Discussion   Replies to groupmates
31 Oct   Problem set
31 Oct   Module ends

Module 11 Two-sample *t*-Tests

31 Oct   Module begins
             Mini lectures (5)
             Textbook   Chapter 12, Chapter 13 sections 13.5-13.7

Journal article (1)
Optional interactive (1)

Due	*Assignment*	
1 Nov	Discussion	Leader posts article and questions
3 Nov	Discussion	Initial response
5 Nov	Unit 2 Exam Timed	
6 Nov	Discussion	Replies to groupmates
7 Nov	Unit 2 Exam Problem set	
7 Nov	**Module ends**	

Module 12 Introduction to ANOVA

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

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

Module 13 Complex ANOVA

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

Due	*Assignment*	
15 Nov	Discussion	Leader posts article and questions
17 Nov	Discussion	Initial response
19 Nov	Quiz	
20 Nov	Discussion	Replies to groupmates
21 Nov	Problem set	
21 Nov	**Module ends**	

Module 14 Correlation*

21 Nov	**Module begins**	
	Mini lectures (6)	
	Textbook	Chapter 16

Due	*Assignment*	
28 Nov*	Quiz	
5 Dec*	Problem set	Correlation questions included in Mod 15 Problem Set
28 Nov	**Module ends**	

*Due dates shifted for Thanksgiving Break; Modules 14 and 15 overlap. No Mod 14 discussion.

Module 15 Regression

28 Nov	**Module begins**	
	Mini lectures (6)	
	Textbook	Chapter 17

Due	*Assignment*	
29 Nov	Discussion	Leader posts article and questions
1 Dec	Discussion	Initial response
3 Dec	Quiz	
4 Dec	Discussion	Replies to groupmates
5 Dec	Problem set	
5 Dec	**Module ends**	

Module 16 Meta-analysis

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

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

Module 17 Final Exam Week

12 Dec	**Module begins**	

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