SCHOOL OF PUBLIC HEALTH
UNIVERSITY OF MINNESOTA

PUBH 6450, SECTION 320

Biostatistics I
Spring 2019

COURSE & CONTACT INFORMATION

Credits: 4 credits
Meeting Day(s), Time, and Place: This course is entirely web-based, delivered via Moodle at http://moodle.umn.edu.

Contact Type	Contact Information	Role	When to Contact
Instructor	Baolin Wu, PhD baolin@umn.edu [Phone] 612-624-0647 [Fax] 612-626-0660 (Attn. Baolin Wu)	Primary instructor for this course	Questions or concerns about the class etc.
Teaching Assistant	Rachel Zilinskas (zilin006@umn.edu) Trang Le (le000036@umn.edu)	Grade homeworks, and provide individual feedback on assignments]	Questions or concerns about the class, assignments, deadlines, etc. Your TA will respond promptly and is your first line of contact.
Technical Support	Technical support options are available on the SPH website. https://z.umn.edu/sphquickhelp	Troubleshoots technical issues related to the course site or course content.	Technical issues with the course site, media, quizzes or assignments.

Please save this contact information to your computer or print it. That way, you can still contact us in the event that you have difficulty connecting to the Internet or accessing the syllabus.

COMMUNICATION IN ONLINE COURSES

Communication is especially important in an online course. Course-related announcements (changes to the schedule or due dates, topics covered on exams, etc.) will be made available on the class Moodle page in the Course Q&A forum. It is your responsibility to be aware of any announcements made. All students are subscribed to this forum and will receive copies of all posts by email.

Communications during the online course consist of email and discussion forums:

- The Q&A Discussion Forums in Moodle are the primary mechanism for interaction between students and the instructor and TAs, as well as among students. All of the students, the teaching assistants and the instructor can read all of the postings in the General Q&A Forums. Normally, someone initiates a topic and others reply to this topic. Please use thoughtful subject headings if you initiate a topic. This will help cut down on starting redundant or duplicate topics on the same question and help everyone find the topic at a later date. Because the instructor and the TAs check the forums regularly on a rotating basis, asking a question in the Forums is the quickest way to get an answer to your question. You may also subscribe to any forum in order to receive emails of each post. This setting is available on the left hand side of the page after clicking on a forum link.
- Email is available as a secondary method of contact. Email is best used for specific questions about grades or grading of assignments. We strongly prefer questions on course material or routine administrative matters be asked in the forums so that everyone can benefit from the answer to the question and the instructors and TAs do not receive multiple emails asking the same question. However, if you would be more comfortable asking a question about material in private, then email is encouraged and an appropriate way to do this. Generally, your question (without your name) and the answer will be added to the forums as a thread afterwards.
- You MUST use your University of Minnesota email address (X.500 address) for email. All course communication will be sent to your email account. If you have not yet initiated your U of M email account, you will need to do so at http://www.umn.edu/initiate. The instructor and TAs cannot respond to emails sent from other accounts.

- In-person contact. Anyone may make an appointment for meeting by telephone. Students located in the area may make appointments to see your instructor or TA during regular business hours. Per University policy, we cannot support face-to-face in-person meetings when the University offices are closed, but can talk on the phone.

COURSE DESCRIPTION

Descriptive statistics. Gaussian probability models, point/interval estimation for means/proportions. Hypothesis testing, including t, chi-square, and nonparametric tests. Simple regression/correlation. ANOVA. Health science applications using output from statistical packages.

COURSE PREREQUISITES

College Algebra (e.g. Math 1031), health science grad student, or instructor permission.

COURSE GOALS & OBJECTIVES

By the end of the course, students should have a basic understanding of the fundamentals of biostatistical methods. This includes:

- Summarizing data with numerical measures and graphs
- Basic concepts of randomness and data distributions
- Point/Interval estimation for categorical and continuous outcomes
- Hypothesis testing for categorical and continuous outcomes
- Simple and multiple linear regression
- Basic SAS and/or R programming language skills

METHODS OF INSTRUCTION AND WORK EXPECTATIONS

Course Workload Expectations

PubH 6450 Biostatistics I is a 4 credit course. The University expects that for each credit, you will spend a minimum of three hours per week attending class or comparable online activity, reading, studying, completing assignments, etc. over the course of a 15-week term. Thus, this course requires approximately 1 hours of effort spread over the course of the term in order to earn an average grade.

- Weekly online lecture slide sets (with audio) and text readings, excepting exam weeks.
- Computer lab sessions – one per week beginning Week 1. Labs will be available in the statistical software packages SAS and R. Students may use one or both of these packages, or are welcome to use any other statistical software of their choosing. Course staff will not be able to support any other software except SAS and R. Certain degree programs may require use of particular software. Students are strongly encouraged to consult with their program or intended program for such requirements.
- Online discussion forums for asking questions about the material and course.
- Two midterm exams – online, conducted in Moodle.
- One final exam – online, conducted in Moodle.
- Homework assignments – due approximately weekly, submitted in Moodle.

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This course is entirely online. Therefore, time you would otherwise be in class will be incorporated into work for the course in the form of online discussions, lectures, etc.

Technology

Students will require a personal computer and statistical software to complete homework assignments and exams in the course. This course will be taught using SAS and R. Students may choose to use one or both of these programs. R is free and open source. SAS is available for a nominal fee under the University's site license; however, when you are no longer enrolled at the University, the site license and the software will eventually expire. More information on choosing between R and SAS (or using both) is given on the course Moodle page. Students are recommended to use SAS/R, which will be supported by instructional staff. Some programs within the University of Minnesota may require either SAS or R for students in their program. You will need to consult with your degree program (or intended program) for their requirements.

Learning Community

School of Public Health courses ask students to discuss frameworks, theory, policy, and more, often in the context of past and current events and policy debates. Many of our courses also ask students to work in teams or discussion groups. We do not come to our courses with identical backgrounds and experiences and building on what we already know about collaborating, listening, and engaging is critical to successful professional, academic, and scientific engagement with topics.

In this course, students are expected to engage with each other in respectful and thoughtful ways. In group discussion, this can mean:

- Respecting the identities and experiences of your classmates.

- Avoid broad statements and generalizations. Group discussions are another form of academic communication and responses to instructor questions in a group discussion are evaluated. Apply the same rigor to crafting discussion posts as you would for a paper.
- Consider your tone and language, especially when communicating in text format, as the lack of other cues can lead to misinterpretation.

IMPORTANT: PUBH 6450 Online is NOT a "go at your own pace" online course. There are weekly units to keep up with and fixed deadlines for homework (weekly, except exam weeks) and exams (approximately every 5 weeks). Exams will be two hours long. You may start the exam at any time on the designated weekend, but once started, you have two hours to fully complete the exam. You cannot "stop the clock" by logging out and coming back later.

Like other work in the course, all student to student communication is covered by the Student Conduct Code (https://z.umn.edu/studentconduct).

COURSE TEXT & READINGS

Required:

- Moore, David S., McCabe, George P., & Craig, Bruce. **Introduction to the Practice of Statistics.** W. H. Freeman & Co., New York, 8th edition.

Since readings will be assigned out of the eighth edition, students with alternate editions of the book (e.g. sixth or seventh, or ninth) are responsible for obtaining the homework problems and readings from the eighth edition (numbering of problems and page numbers change across editions). For students on campus, a copy of the textbook is on reserve in the Bio-Med Library, Diehl Hall. We do not recommend using any edition older than the sixth. You do NOT need the CD that comes with the textbook; any material we require on the CD can alternatively be obtained directly from the publisher 's web site: http://bcs.whfreeman.com/ips8e/.

Optional

- Delwiche, L & Slaughter, S. **The Little SAS Book.** SAS Institute. ISBN 978-1599947259
- Cody, R. & Smith, J. **Applied Statistics and SAS Programming Language.** Prentice-Hall Inc. ISBN 978-0131465329
- Everitt, Brian S. & Hothorn, Torsten. **A Handbook of Statistical Analyses Using R.** Chapman & Hall/CRC. ISBN 978-1-4200-7933-3
- Kleinman , Ken & Horton, Nicholas J. **SAS and R: Data Management, Statistical Analysis, and Graphics.** Chapman & Hall/CRC. ISBN 978-1-4200-7057-6

COURSE OUTLINE/WEEKLY SCHEDULE

This course has specific deadlines. All coursework must be submitted via the course site before the date and time specified on the site. **Note: assignments are due by 11:55pm CST unless indicated otherwise.**

Week	Topic	Readings	Activities/Assignments

Week 1
Jan 22-27
	• **Introduction**
	  ○ Types of Data, Bar Charts, Pie –Charts, Stem-Plots, Histograms Exploratory Data Analysis for Univariate Data: Measures of Central Tendency, Measures of Dispersion, Box-plots
	• **Study designs**
		• **Text**
		  ○ **Introduction to the Practice of Statistics, 8th Edition**
		  • Chapter 1, pp. 1-53; Chapter 3, pp.167-205
			• **Activities and Assignment**
			  ○ Homework 1 (due Sun 1/27)
			  ○ Install software
			  ○ Lab 1

Week 2
Jan 28-Feb 3
	• **Overview of Sampling Variability**
	• **Probability, Probability Models, conditional Probability and Diagnostic Testing**
		• **Text**
		  ○ **Introduction to the Practice of Statistics, 8th Edition**
		  • Chapter 3, pp. 205-216; Chapter 4, pp.231-249 & 282-297
			• **Assignment**
			  ○ Homework 2 (due Sun 2/3)
			  ○ Lab 2

Week 3
Feb 4-10
	• **Random Variables, Probability Distributions for Discrete and continuous Variables, The Normal Distribution, The Binomial Distribution**	• **Text**
		  ○ **Introduction to the Practice of Statistics, 8th Edition**
		  • Chapter 4, pp. 252-261; Chapter 1, pp. 53-77;
		  • Chapter 5, pp. 301-316
			• **Assignment**
			  ○ Homework 3 (due Sun 2/10)
			  ○ Lab 3

Week 4
Feb 11-17
	• **Expected Value (Mean) and Variance of a Random Variable, Sampling Distribution of the Mean and the Sample Proportion, The Central Limit Theorem**
	• **One-sample: Moving from Point Estimates to Interval Estimates, Confidence Intervals**
		• **Text**
		  ○ **Introduction to the Practice of Statistics, 8th Edition**
		  • Chapter 4, pp. 263-280; Chapter 5, pp. 320-349; Chapter 6, pp. 351-368
			• **Assignment**
			  ○ Homework 4 (due Sun 2/17)
			  ○ Lab 4

Week 5 **Feb 18-24**	***Exam 1***	*Exam 1 "opens" on the Moodle site at 8:00 am on Friday, February 22 and closes at 11:55pm on Monday, February 25.*	• **Assignment** ○ Lab 5

Week 6 **Feb 25-Mar 3**	• **Confidence Intervals When Sigma is Unknown, Student's T Distribution** • **Introduction to Hypothesis Testing When Sigma is Known and When Sigma is Unknown**	• **Text** ○ **Introduction to the Practice of Statistics, 8th Edition** • Chapter 6, pp. 372-390; Chapter 7, pp. 417-429 (to Matched Pairs)	• **Assignment** ○ Homework 5 (due Sun 3/3) ○ Lab 6
Week 7 **Mar 4-10**	• **Type I and II Errors and Power for Hypothesis Testing** • **Linking Confidence Intervals and Hypothesis Testing; Matched Pairs t-test**	• **Text** ○ **Introduction to the Practice of Statistics, 8th Edition** • Chapter 6, pp. 394-413; Chapter 7, pp. 429-441	• **Assignment** ○ Homework 6 (due Sun 3/10) ○ Lab 7
Week 8 **Mar 11-17**	• **Two-sample t-tests and Two-sample Confidence Intervals** • **Confidence Intervals and Hypothesis Testing for One Proportion**	• **Text** ○ **Introduction to the Practice of Statistics, 8th Edition** • Chapter 7, pp. 447-481; Chapter 8, pp. 487-504	• **Assignment** ○ Homework 7 (due Sun 3/17) ○ Lab 8
May 18-24	**SPRING BREAK**		
Week 9 **Mar 25-31**	• **2 by 2 Tables: confidence Intervals and Hypothesis Testing for the Difference in Two Proportions** • **2 by 2 Tables: confidence Intervals and Hypothesis Testing for Odds Ratios and Relative Risks**	• **Text** ○ **Introduction to the Practice of Statistics, 8th Edition** ▪ Chapter 8, pp. 505-525 ▪ Odds Ratios and Relative Risks not in the book	• **Assignment** ○ Homework 8 (due Sun 3/31) ○ Lab 9
Week 10 **Apr 1-7**	***Exam 2***	*Exam 1 "opens" on the Moodle site at 8:00am on Friday, April 5 and closes at 11:55pm on Monday, April 8.*	• **Assignment** ○ Lab 10
Week 11 **Apr 8-14**	• **Contingency Tables: Simpson's Paradox; Chi-Square Test** • **2 by 2 Tables: McNemar's Test for Matched Pairs in the Binomial Setting**	• **Text** ○ **Introduction to the Practice of Statistics, 8th Edition** ▪ Chapter 2, pp. 139-148; Chapter 9, pp. 530-550 ▪ Matched Pairs for Binomial Data not in the book	• **Assignment** ○ Homework 9 (due Sun 4/14) ○ Lab 11
Week 12 **Apr 15-21**	• **Relationships Between Quantitative Variables: Correlation, Scatterplots** • **Simple Linear Regression, Residuals and Cautions**	• **Text** ○ **Introduction to the Practice of Statistics, 8th Edition** ▪ Chapter 2, pp. 81-136	• **Assignment** ○ Homework 10 (due Sun 4/21) ○ Lab 12

Week 13 **Apr 22-28**	• **Simple Linear Regression: Inference, Predictions and Diagnostics**	• **Text** ○ **Introduction to the Practice of Statistics, 8th Edition** ▪ Chapter 10, pp. 553-600	• **Assignment** ○ Homework 11 (due Sun 4/28) ○ Lab 13
Week 14 **Apr 29-May 5**	• **Analysis of Variance (ANOVA)** • **Nonparametric Methods**	• **Text** ○ **Introduction to the Practice of Statistics, 8th Edition** ▪ Chapter 12, pp. 643-678; Chapter 15 (Note: Companion Chapter)	• **Assignment** ○ Homework 12 (due Sun 5/6) ○ Lab 14
Final	***Final Exam: May 10 - May 13***	*Exam 1 "opens" on the Moodle site at 8:00am on Friday, May 10 and closes at 11:55pm on Monday, May 13.*	

SPH AND UNIVERSITY POLICIES & RESOURCES

The School of Public Health maintains up-to-date information about resources available to students, as well as formal course policies, on our website at www.sph.umn.edu/student-policies/. Students are expected to read and understand all policy information available at this link and are encouraged to make use of the resources available.

The University of Minnesota has official policies, including but not limited to the following:

- Grade definitions
- Scholastic dishonesty
- Makeup work for legitimate absences
- Student conduct code
- Sexual harassment, sexual assault, stalking and relationship violence
- Equity, diversity, equal employment opportunity, and affirmative action
- Disability services
- Academic freedom and responsibility

Resources available for students include:

- Confidential mental health services
- Disability accommodations
- Housing and financial instability resources
- Technology help
- Academic support

EVALUATION & GRADING

Homework
25% of your final grade

There will be homework assignments each worth 10 points. We will drop your two worst scores before computing your homework total for the semester.

Homework is posted on the Moodle page in each unit, listing a future due date. Homework is to be submitted through the Moodle page using the link at the bottom of the assignment. Homework is often due on Tuesday evening by 11:55pm, but some exceptions occur due to holidays or exams. Homework should not be emailed to the instructors.

Most homework assignments will be made up of text book questions from Moore/McCabe/Craig AND questions that require learning and using statistical software. Similar problems may be covered step-by-step in the lab in the week before the assignment is due. You are NOT required to use SAS or R to do the problems that require statistical software; you may use another statistical software package of your choosing. However, course staff cannot offer assistance with any other package besides SAS and R.
We encourage you to work together in computing and discussing the problems. However, each student is expected to independently write up the submitted assignment using her or his own computing and giving explanations in her or his own words. Using your own computing means writing your own code, generating your own graphs and output, and editing and incorporating that output in a final version. Copying someone else's code or using their graphics or statistical output is not allowed. All assignments will involve computing; please attach only relevant computer output to what you turn in.

Homework may be submitted up to 12 hours late at a 2- point penalty. Homework that is more than 12 hours late will not be accepted. Extensions may be requested from the instructor in advance of the original due date and may be granted at the instructor's discretion.

Exams
75% of your final grade. Each exam is worth up to 100 points.

- Exam 1: February 23 – 25 (Saturday-Monday)
- Exam 2: April 6 – 8 (Saturday-Monday)
- Exam 3: May 11 – 13 (Saturday-Monday)

You may use any or all of the following during the exams: class books, lecture notes and any other lecture materials (e.g., personal class notes, lecture worksheets, homework and their solutions, labs). A calculator capable of natural log transformations (or equivalent computer software) is required ("ln" button) for all of the exams. Sharing of books, notes, worksheets, homework/solutions, labs, calculators, or verbal or electronic comments is not permitted during the exams. Note: the R statistical software is very handy as a calculator.

Labs
The lab exercises will NOT be graded. You do NOT need to turn them in.
Occasionally part of a homework assignment will be included in a lab exercise; in this case, computer code and output relevant for the homework assignment should be turned in with your homework.

There will be lab sessions, one per week. Lab exercises will be posted to the class web site; you may wish to print or have the lab document open as you view the lab video for taking notes or following along with the TA.

By completing the lab exercises, you will learn how to program your own statistical data summaries and analyses using the SAS statistical package (www.sas.com)or the R statistical package (www.r-project.org). Students may use SAS and/or R , or are welcome to

use any other statistical software. Course staff will not be able to support any other software except SAS and R. Only SAS and R are installed for this course in the SPH Computer Lab. Students in the Division of Epidemiology are required by their degree program to use SAS.

Grading Scale
The University uses plus and minus grading on a 4.000 cumulative grade point scale in accordance with the following, and you can expect the grade lines to be drawn as follows:

% In Class	Grade	GPA
93 - 100%	A	4.000
90 - 92%	A-	3.667
87 - 89%	B+	3.333
83 - 86%	B	3.000
80 - 82%	B-	2.667
77 - 79%	C+	2.333
73 - 76%	C	2.000
70 - 72%	C-	1.667
67 - 69%	D+	1.333
63 - 66%	D	1.000
< 62%	F	

- A = achievement that is outstanding relative to the level necessary to meet course requirements.
- B = achievement that is significantly above the level necessary to meet course requirements.
- C = achievement that meets the course requirements in every respect.
- D = achievement that is worthy of credit even though it fails to meet fully the course requirements.
- F = failure because work was either (1) completed but at a level of achievement that is not worthy of credit or (2) was not completed and there was no agreement between the instructor and the student that the student would be awarded an I (Incomplete).
- S = achievement that is satisfactory, which is equivalent to a C- or better
- N = achievement that is not satisfactory and signifies that the work was either 1) completed but at a level that is not worthy of credit, or 2) not completed and there was no agreement between the instructor and student that the student would receive an I (Incomplete).

Evaluation/Grading Policy	Evaluation/Grading Policy Description
Scholastic Dishonesty, Plagiarism, Cheating, etc.	You are expected to do your own academic work and cite sources as necessary. Failing to do so is scholastic dishonesty. Scholastic dishonesty means plagiarizing; cheating on assignments or examinations; engaging in unauthorized collaboration on academic work; taking, acquiring, or using test materials without faculty permission; submitting false or incomplete records of academic achievement; acting alone or in cooperation with another to falsify records or to obtain dishonestly grades, honors, awards, or professional endorsement; altering, forging, or misusing a University academic record; or fabricating or falsifying data, research procedures, or data analysis (As defined in the Student Conduct Code). For additional information, please see https://z.umn.edu/dishonesty The Office for Student Conduct and Academic Integrity has compiled a useful list of Frequently Asked Questions pertaining to scholastic dishonesty: https://z.umn.edu/integrity. If you have additional questions, please clarify with your instructor. Your instructor can respond to your specific questions regarding what would constitute scholastic dishonesty in the context of a particular class-e.g., whether collaboration on assignments is permitted, requirements and methods for citing sources, if electronic aids are permitted or prohibited during an exam. Indiana University offers a clear description of plagiarism and an online quiz to check your understanding (http://z.umn.edu/iuplagiarism).
Late Assignments	This course covers a large amount of material in a short time. Therefore late assignments or quizzes will not be accepted.
Attendance Requirements	Students are expected to review weekly course/lab notes and submit the homeworks on time.
Makeup Work for Legitimate Reasons	If you experience an extraordinary event that prevents you from completing coursework on time and you would like to make arrangements to make up your work, contact your instructor within 24 hours of the missed deadline if an event could not have been anticipated and at least 48 hours prior if it is anticipated. Per University policy, legitimate reasons for making up work may include: • illness • serious accident or personal injury • hospitalization • death or serious illness within the family • bereavement • religious observances • subpoenas • jury duty • military service • participation in intercollegiate athletic events Because this course is entirely online and all materials are available to students from the first day of the term, we expect students to plan accordingly if travels or access to internet will cause them to miss a deadline. Note that our deadlines are generally set for 11:55 p.m. CST, so traveling to a different time zone will require additional planning. Further, circumstances that qualify for making up missed work will be handled by the instructor on a case-by-case basis; they will always be considered but not always granted. For complete information, view the U of M's policy on Makeup Work for Legitimate Absences (http://z.umn.edu/sphmakeupwork).
Saving & Submitting Coursework	**Documents that students submit are considered final;** students may not submit more than one version or draft of each assignment.

Technical Issues with Course Materials	You are expected to submit all coursework on time and it is your responsibility to ensure that your work is submitted properly before the deadline.
	
	If you experience technical difficulties while navigating through the course site or attempting to submit coursework:
	
	• Go to Quick Help: http://z.umn.edu/sphquickhelp.
	• Connect with the appropriate person or office within 30 minutes of the problem's occurrence.
	  ○ Provide as much information as possible, so the tech team can best help you as soon as possible.
	  ○ You can expect a response within 1-2 business days to help resolve the problem.

CEPH COMPETENCIES

Competency	Learning Objectives	Assessment Strategies* (*see Assessment Descriptions below this table)
Analyze quantitative and qualitative data using biostatistics, informatics, computer-based programming and software, as appropriate.	**Descriptive and Graphical Summaries** • Create summary statistics, tables, and graphs are appropriate for each variable type (e.g., categorical variable(s): bar plot, count, proportion, 2x2 table, risk, odds, odds ratio, relative risk, difference in proportions; continuous variable(s): histogram, boxplot, mean, median, SD, IQR, difference in means) via their chosen software. • Calculate any of screening test summary statistics from a table of cell counts, or the equivalent information in words (e.g. in an article) (e.g., prevalence, sensitivity, specificity, PPV, NPV). **Confidence Intervals** • Calculate a confidence interval for a population parameter (e.g., mean(s), proportion(s), relative risk, odds ratio) from data or summary statistics via their chosen software. **Hypothesis Testing** • Identify situations when a particular statistical test would be used (e.g., one, paired, and two-sample t-test; Chi-squared test; Fisher's exact test; McNemar's test; ANOVA) and carry out the tests via their chosen software. **Regression** • Create a scatterplot via their chosen software to assess the relationship between variables. • Calculate the correlation or the fitted regression coefficients to obtain slope values for simple regression via their chosen software. • Create diagnostic plots via their chosen software to assess how well the model fits the data. • Carry out statistical inference via their chosen software for the correlation or the fitted regression coefficients in simple linear regression.	• Homework • Exams
Interpret results of data analysis for public health research, policy or practice.	**Descriptive and Graphical Summaries** • Recognize the variable type, categorical or continuous. • Distinguish between the standard deviation (SD or s) and the standard error of the mean (SE or SEM). • Interpret summary statistics, tables, and graphs for each variable type (e.g., categorical variable(s): bar plot, count, proportion, 2x2 table, risk, odds, odds ratio, relative risk; continuous variable(s): histogram, boxplot, mean, median, SD, IQR, difference in means).	• Homework • Exams

	• State the limitations of the commonly-used measures of center and spread. • Interpret a Z-score value. • Define screening test summary statistics (e.g., prevalence, sensitivity, specificity, false positive, false negative, PPV, NPV) and correctly interpret them. • Explain how the screening test summary statistics are related to each other. **Confidence Intervals** • Explain the purpose of a confidence interval and meaning of the confidence level. • Make a conclusion about the significance of a result, based off of the confidence interval (e.g., for a mean, for a proportion, for a difference in means, for a difference in proportions, for an OR, for a RR, for a slope). **Hypothesis testing** • Know the terminology of hypothesis testing (e.g., null hypothesis, alternative hypothesis, test statistic, sampling distribution of the test statistic, *p*-value, Type I error, Type II error, power). • For a particular statistical test, state the appropriate null and alternative hypotheses (e.g., one, paired, and two-sample t-test; Chi-squared test; Fisher's exact test; McNemar's test; ANOVA). • For a particular statistical test, make a conclusion based off of the *p*-value and a significance level (e.g., one, paired, and two-sample t-test; log-rank test; Chi-squared test; Fisher's exact test; McNemar's test; ANOVA). • Recognize situations in which multiple comparisons may be an issue. • Explain the consequences of failing to properly account for multiple comparisons. • Explain the purpose of post-hoc tests following ANOVA and interpret the results. • Explain the difference between statistical significance and clinical/practical significance. **Regression** • Know what it means to say that two variables are "associated". • Interpret statistics (correlation or fitted coefficients) from simple linear regression and make a conclusion from its confidence interval or *p*-value. • Write down the equation for a simple linear regression model and describe what each parameter means. • Interpret both the diagnostic plots and the model R^2 value.	

Assessment Descriptions	
Homework	The weekly homeworks are intended to assess what the students have learned from the readings, the lectures, and the labs as outlined in the unit overview. The questions are all open-ended format, and may include analyses via their chosen software. Students are encouraged to work in your groups, but each student is expected to *independently* write up the submitted assignment.
Exams	The exams are intended to assess student's ability to analyze the data or summary data via their chosen software and interpret the results. The exams are comprehensive; they assess student's ability to integrate the concepts and programming from multiple weeks, apply their knowledge to new scenarios, and evaluate the results based on the output from the software. The exams must be completed independently.