Tennessee State University

College of Life and Physical Sciences
Department of Biological Sciences

BIOL 3110
Biometrics (Biostatistics)

Spring 2021

Professor: Dafeng Hui, Ph.D. **Office:** Harned Hall 320 (Zoom)
Office Hours: M W, 9-10 am or by appointment using Zoom
Telephone Extension: 963-5777 **Email address:** dhui@tnstate.edu

Required Texts:
Statistics for the Life Sciences, 3rd ed., Samuels, M. L. and J. A. Witmer, 2003; Prentice-Hall.

Required Materials:
SAS documents will be provided.

Class Time/Place:

	Day	Time	Place
Lecture	T, R	11:10-12:35 PM	Zoom online (202 Harned Hall)

Course Description

Credit Hours: 3 credit hours
Prerequisites: MATH 1040 (Precal Math 1), BIOL 1110 & BIOL 1120 (Intro to Biology I and II), BIOL 2120 (Genetics), BIOL 2110 (Cell Biology).
Catalog Description. An introduction to statistical methods that are of particular interest to biologists for experimental design and interpretation.

Course Rationale

The goal of biostatistics is to understand and learn to use it as tool to solve problems in biological sciences.

Course Objectives and Student Learning Outcomes

This is an introductory statistical course for biology majors. The course will introduce common methods for presenting biological data in summary form, analyzing biological data, and designing experiments. It is not a mathematics course, so will not stress derivations of formulae but, rather, will emphasize the application of statistical ideas and methods to the design and interpretation of biological experiments and comparative data.

The student will be able to assess a situation involving data analysis, state the nature of the biological question and the null and alternative hypotheses proposed, decide on the correct statistical procedure to test the null hypothesis and the assumptions of the test used, calculate the statistic, assess its statistical significance, and interpret the data in light of the calculated results.

Assessment of a student's performance will be done through the use of problem-oriented, in-class tests, successful completion of assigned homework problems, and their ability to present problem solutions to the class during problem-solving sessions.

At the completion of the course, students will be able to:

- calculate descriptive (summary) statistics
- calculate common probability distributions and apply those calculations to solve problems based on biological studies
- calculate the distribution of observations about the mean based on the assumption of normality and apply those calculations to solve problems based on biological data
- calculate the distribution of sample means about the mean and apply those calculations to solve problems based on biological data
- compare two means (from paired and unpaired data) using both parametric and non-parametric methods and use those methods to test hypotheses
- design simple biological experiments
- randomly allocate experimental units to treatments and apply this technique to solve problems based on biological studies
- compare more than two means using analysis of variance methods and use those methods to test hypotheses derived from both single-factor and two-factor experimental designs
- calculate least-squares regression lines and apply those calculations to solve problems based on biological studies
- analyze categorical data to test both goodness-of-fit and contingency hypotheses.

Course Requirements

The primary source for the student is the TEXTBOOK. The second source of information is lecture, which is supplemented with material on the E-learn course website. Not all of the information in the text can be presented in lecture but the student is responsible for all of the information in the text and anything added in lecture. The lectures are intended to give an overview of the material and cover material from the book that bears repetition and close reading: complex ideas and mathematical formalizations of ideas and hypotheses. Time will be given in each lecture for questions stemming from the reading and problems assigned.

You should be aware that the material in the course is truly cumulative. Concepts and methods presented in the first lecture are necessary to understand the material presented in the last chapter. Thus, it is very important to keep up by doing problems. Reading the material alone will not be enough to allow you to move forward as new material is presented.

You need to have a laptop computer for SAS programming. We will use SAS University Edition (SAS Studio). This is a free version of SAS for university faculty and students, and can be installed on both PC and Mac. It can be downloaded and installed by accessing the website (https://www.sas.com/en_za/software/university-edition/download-software.html). You need to register to SAS before downloading it. Because SAS University Edition is a virtual application (or vApp), you need virtualization software to run it. You can download Oracle VirtualBox for

Windows/Mac, a free virtualization software package using the link provided at the SAS website. The detailed instruction can be found at the SAS website. I will also posted these instructions at the E-learn website.

Methods of Evaluation

There will be two exams in class on the days noted in the lecture schedule. Exams will cover only the material presented since the previous exam. Exams are open book and open note and will require a calculator or a computer. Make-up exams will be given only if the student has an excuse from the Office of Student Affairs. As per Tennessee State University policy, attendance is mandatory and a record of attendance will be kept. Excessive absences will be reported to the Office of Admissions and Records, again as per school policy. Attendance makes no contribution to earning points toward the final grade.

Homework: Each lecture topic will be accompanied by a homework assignment. After presentation of the material in a chapter during one lecture period, we will follow that with a problem-solving session (lab) during the next lecture period. Do not feel that you must confine yourself to working only on problems listed in the lectures. If you need additional practice, more problems on the topic can always be found in the book.

The final examination will be comprehensive. All dates for lecture examinations are subject to change. Changes will be announced in class.

Class Attendance

Class attendance is required. Students are expected to show up for class on time and be prepared for the class. Cell phones should not be used in the class, and set to be silenced during class.

Grading Policy

Homework assignments will be described during the discussion/laboratory periods and are due on the dates listed in the discussion/laboratory schedule.

All dates for both homework and lecture examinations are subject to change but this will be announced in class. The overall grade for the course will be based on the standard TSU point-to-grade scale. The distribution of points is:

Homework	50
Mid-term and Final	50
Total	**100**

Grading Scale

Grade	Score Range	Significance
A	90 - 100%	Excellent, work of exceptional quality
B	80 - 89%	Good, work above average
C	70 - 79%	Work of average quality
D	60 - 69%	Poor, representing passing work
F	0 - 59%	Failure, representing unacceptable performance

Other Sources:

Textbook website: http://www.mypearsonstore.com/bookstore/statistics-for-the-life-sciences-9780321989581.

SAS (https://www.sas.com/en_za/software/university-edition.html)

Student Course Evaluation

On-line course evaluations will be available at the end of the semester.

Other Course Policies

Make-up exams: Students with excused absences (i.e., absences due to health-related issues or family emergencies) will be allowed to reschedule an exam.

Late assignments: All late assignments will be marked down by 5% per day (and down to zero once the solutions are posted online). In special circumstances, short extensions can be granted, but extensions must be requested at least one week in advance of the due date. Special consideration will be given in circumstances where health-related or family emergencies arise around the due date.

E-learn: All lecture PowerPoint slides, homework, and other documents will be posted at E-learn website. Please check this website periodically. Answers to homework assignments should be submitted through Dropbox in the E-learn.

POLICY ON PLAGIARISM AND CHEATING

Cheating on exams or plagiarizing on a paper will result in a 0 grade for that exam or paper. The Department Chair will be informed of the occurrence. To plagiarize is 1. to appropriate and pass off as one's own (the writings, ideas, etc., of another). 2. To appropriate and use passages, ideas, etc. from another's text or product (Funk and Wagnells Standard Dictionary of the English Language, 1965). All papers will be kept by the instructor.

DISABILITY ACCOMMODATION STATEMENT

TSU is committed to creating inclusive learning environments and providing all students with opportunities to learn and excel in their course of study. Any student with a disability or condition which might interfere with his/her class performance or attendance may arrange for reasonable accommodations by visiting the Office of Disability Services (ODS). ODS is located in Kean Hall, room 131 and can be reached at 963-7400 or www.tnstate.edu/disabilityservices . You will be required to speak with ODS staff and provide documentation of the need for an accommodation. If you qualify for an accommodation you will be provided with a document stating what type of classroom accommodations are to be made by the instructor. It is your responsibility to give a copy of this document to the instructor **as soon as you receive it**. Accommodations will only be provided **AFTER** the instructor receives the accommodation instructions from ODS; accommodations are not retroactive. You must follow this process for each semester that you require accommodations.

SEXUAL MISCONDUCT, DOMESTIC/DATING VIOLENCE, STALKING

TSU recognizes the importance of providing an environment free of all forms of discrimination and sexual harassment, including sexual assault, domestic violence, dating violence, and stalking. If you (or someone you know) has experienced or is experiencing any of these incidents, there are resources to assist you in the areas of accessing health and counseling services, providing academic and housing accommodations, and making referrals for assistance with legal protective orders and more.

Please be aware that most TSU employees, including faculty and instructors, are "responsible employees", meaning that they are required to report incidents of sexual violence, domestic/dating violence or stalking. **This means that if you tell me about a situation involving sexual harassment, sexual assault, dating violence, domestic violence, or stalking, I must report the information to the Title IX Coordinator.** Although I have to report the situation, you will still have options about how your situation will be handled, including whether or not you wish to pursue a formal complaint. Our goal is to make sure you are aware of the range of options available to you and have access to the resources you need.

You are encouraged to contact TSU's Title IX Coordinator to report any incidents of sexual harassment, sexual violence, domestic/dating violence or stalking. The Title IX coordinator is located in the Office of Equity and Inclusion, McWherter Administration Building, Ste. 260 and can be reached at 963-7494 or 963-7438. For more information about Title IX and TSU's SART or policies and procedures regarding sexual, domestic/dating violence and stalking please visit: www.tnstate.edu/equity.

If you wish to speak to someone confidentially, who is not required to report, you can contact the TSU Counseling Center, located in the basement of Wilson Hall, at 963-5611 or TSU Student Health Services, located in the Floyd Payne Campus Center room 304, at 963-5084. You may also contact the following off campus resources: Sexual Assault Center of Nashville at 1-800-879-1999 or www.sacenter.org or the Tennessee Coalition to End Domestic & Sexual Violence at 615-386-9406 or www.tncoalition.org .

HARASSMENT & DISCRIMINATION

Tennessee State University is firmly committed to compliance with all federal, state and local laws that prohibit harassment and discrimination based on race, color, national origin, gender, age, disability, religion, retaliation, veteran status and other protected categories. TSU will not subject any student to discrimination or harassment and no student shall be excluded from participation in nor denied the benefits of any educational program based on their protected class. If a student believes they have been discriminated against or harassed because of a protected class, they are encouraged to contact the Office of Equity and Inclusion at McWherter Administration Building, Ste. 260, 615-963-7494 or 963-7438, www.tnstate.edu/equity.

Schedule of Lectures, Reading, and Discussion
11:10-12:35pm

Week	Date	Day	Topic	Lecture Note	Reading/Exam
1	1/26,28	T R	Introduction Descriptive Statistics	Lecture 1	Chapters 1 and 2
2	2/2,4	T R	Descriptive Statistics SAS: Introduction and Data Steps	Lecture 2	Chapters 1 and 2
3	2/9,11	T R	Random Sampling SAS: Procedure	Lecture 3	Chapter 3
4	2/16,18	T R	Normal Distribution SAS: Functions	Lecture 4	Chapter 4
5	2/23,25	T R	Sampling Distribution SAS: Descriptive Stat	Lecture 5	Chapter 5
6	3/2,4	T R	Estimation of Mean SAS: Proc Means and Others	Lecture 6	Chapter 6
7	3/9,11 (Mid-term)	T R	Estimation of Mean Exam 1	Lecture 6	Chapter 6
8	3/16 (18 Spring Break; Last Day to withdraw)	T	Comparison of Two Means SAS: t-test	Lecture 7	Chapter 7
9	3/23,25	TR	Paired Samples Basic ANOVA	Lecture 8, 9	Chapter 8
10	3/30,4/1	T R	SAS: Proc ANOVA I	Lecture 9	Chapter 11
11	4/6,8	T R	2-way ANOVA SAS: Proc ANOVA II	Lecture 10	Chapter 11
12	4/13,15	T R	Experimental Design SAS: Exp design	Lecture 11	Chapter 11
13	4/20,23	T R	Regression SAS: Proc REG	Lecture 12	Chapter 12
14	4/27,29	TR	Final Exam		

* Lecturer reserves the right to make changes on the dates and contents of lecture.

LEARNING OBJECTIVES

After reading the following chapters and attending lecture, students should be able to complete the indicated learning objectives.

Lecture 01/02

Students will be able to:

- distinguish between categorical and quantitative variables or data and, within each type, respectively, to distinguish between ordinal and non-ordinal categorical variables and betweendiscrete and continuous quantitative variables.
- define distributions and frequency tables.
- distinguish between bimodal, unimodal, normal, leptokurtic, platykurtic, skewed, and symmetric distributions
- construct histograms from raw data, including setting category boundaries for continuous data (or discrete data with low frequencies within data classes).
- calculate the value of a summation notation expression.
- calculate summary statistics (mean, mode, median, range, interquartile range, standard deviation, and variance) from raw data.
- select the appropriate transformation to add or subtract a constant or to alter the scale of a data set.
- select the appropriate transformation and transform raw data to normalize skewed data.
- predict the effect of the transformation on the mean and standard deviation of the data.

Lecture 03

Students will be able to:

- determine whether or not a situation represents random sampling or not.
- distinguish between a parameter and a statistic
- define sampling error and be able to identify both bias and homogeneity in samples.
- use both theoretical means and empirical means to estimate probability.
- calculate combined probabilities when each probability is independent of other probabilities (including both the union and intersection of independent probabilities) using both algebraic formulas and probability tree diagrams.
- define the axes for probability distributions.
- calculate binomial probabilities and binomial distributions.
- apply the binomial distribution to make predictions of the outcomes from situations that conform to the assumptions of the binomial distribution.
- calculate the mean and standard deviation of the binomial distribution.

Lecture 04

Students will be able to:

- define the normal curve and explain each axis.
- explain the difference between a symmetric and a skewed distribution and apply these concepts to the normal curve.
- calculate the inflection points of a normal curve, given its mean and standard deviation.
- describe the relationship between probability and the area under the normal curve.
- calculate z-scores.
- calculate the appropriate probabilities and z-scores from actual data as an answer to a question about the data, assuming the data is normally distributed.
- calculate actual and expected (based on normality) cumulative percentages, plot one versus the other, and correctly conclude whether or not the data is distributed normally based on the plot.
- calculate the continuity correction and apply it to situations that require it.

Lecture 05

Students will be able to:

- define sampling variation.
- define, in their own words, a sampling distribution.
- draw a sampling distribution from given data and label the axes.
- evaluate a variable and correctly decide if it is a dichotomous or if it can be transformed so that it becomes dichotomous.
- calculate and graph the binomial distribution.
- evaluate the area under the curve of a binomial distribution in terms of probability.
- apply the binomial distribution to problem scenarios.
- distinguish between quantitative versus qualitative variables.
- define and calculate the expected mean and standard deviation of sample means drawn from a quantitative variable.
- calculate the standard deviation of sample means.
- predict the effect of the central limit theorem on the mean of sample means and the standard deviation of sample means.
- predict and calculate the effect of sample size on the mean of sample means and the standard deviation of sample means.
- apply the continuity correction when calculating the probability of a defined set of outcomes.

Lecture 06

Students will be able to:

- distinguish between estimation in general and statistical estimation using the concept of p-values.
- define a confidence limit.
- distinguish between the standard deviation of a sample and the standard error of the mean.
- calculate the standard error of the mean from a sample.

- use the tables in the book to look up t values for given sample sizes and tail probabilities.
- calculate a confidence interval for the true mean of a population given the true mean and standard deviation.
- calculate a confidence interval for the true mean of a population given a sample randomly drawn from that population.
- use a confidence interval calculation to correctly evaluate questions about a research scenario.
- give the conditions of validity for the use of the confidence interval.
- determine if it is appropriate to use the confidence interval for a given scenario.
- calculate the appropriate sample size to use when given an estimate of the true standard deviation, a level of confidence, and a estimation of the experimental effect.
- list the assumptions pertinent to confidence intervals and correctly detect what about a scenario conforms or fails to conform to each assumption.
- calculate a confidence interval for the mean expressed as a proportion (or an expected value expressed as a proportion).

Lecture 07

Students will be able to:

- determine if a two populations are independent of one another.
- compute the standard error of the difference between sample means using the unpooled method.
- calculate the confidence interval for the difference between two sample means given either sample data or means, standard deviations, and sizes of two samples.
- calculate the degrees of freedom appropriate for use in comparing means.
- give the conditions of validity for the use of the confidence interval for the difference between two sample means.
- determine if it is appropriate to use the confidence interval for the difference between two sample means for a given scenario.
- state the null hypothesis appropriate to a given scenario.
- state the alternative hypotheses (both one- and two-way) appropriate to a given scenario.
- calculate the t statistic given the means, standard deviations, and sizes of two samples.
- use the t statistic and degrees of freedom to determine a p-value (both one- and two-way).
- correctly reject or accept the null and alternative hypotheses from a comparison of the p value with a given critical (alpha) value (both one- and two-way).
- give the conditions of validity for the use of the t-test for testing the significance of a difference between two sample means.
- determine if it is appropriate to use the t-test for testing the significance of a difference between two sample means for a given scenario.
- describe both type I and II errors for a given scenario.
- define significant effect size and calculate it for a given scenario.
- define the power of a statistical test and determine, using the tables in the textbook, the minimum sample size that will provide for a specified level of power given an expected standard deviation and an alpha level.
- explain why the t-test is parametric and the Wilcoxson-Mann-Whitney test is not.

- choose the correct test to use (t or Wilcoxson-Mann-Whitney) given a scenario calling for a test for a difference between two populations.
- explain the choice made in the previous objective.
- calculate the Wilcoxson-Mann-Whitney statistic.
- use the Wilcoxson-Mann-Whitney test to test directional and non-directional hypotheses about the difference between two populations (given a scenario as background).
- give the conditions of validity for the use of the Wilcoxson-Mann-Whitney test for testing the significance of a difference between two samples.
- determine if it is appropriate to use the Wilcoxson-Mann-Whitney test for testing the significance of a difference between two samples for a given scenario.

Lecture 08

Students will be able to:

- determine if a given scenario describes an observational study and identify the observational unit, response variable, explanatory variable, and any relevant extraneous variables.
- correctly assess the effect of observational studies' weaknesses on a given observational study.
- define spurious association and describe a scenario that illustrates the concept.
- define confounding and describe a scenario that illustrates the concept.
- describe case studies and explain why they are a type of observational study.
- distinguish an experiment from an observational study.
- identify the experimental unit, treatment, treatment levels, control, and controlled variables in a given experiment.
- define blinding and double blindiing and describe scenarios that illustrate the concepts.
- distinguish positive from negative controls and and describe scenarios that illustrate the concepts.
- define placebo and explain the placebo effect.
- define historical control and describe a scenario that illustrates the concept.
- define bias and describe a scenario that illustrates the concept.
- distinguish error from bias.
- distinguish mistakes from error.
- distinguish measurement error from sampling error.
- correctly block a given experimental scenario.
- plan a randomized blocks design experiment given an experimental scenario.
- explain the necessity for replication in experiments.
- define pseudoreplication association and correctly assess if pseudoreplication occurs in a given scenario.
- determine if nesting is part of a given experimental design and, if so, which variables are nested.
- explain the reason for nesting in a given experimental variable.
- identify the combinations of allocation of experimental units and sampling method.
- identify and explain which combinations can be used to draw cause-effect inferences.

Lecture 09

Students will be able to:

- identify correctly paired observations.
- state the null and alternative hypotheses (directional and non-directional) that apply to a given experimental scenario involving the comparison of paired samples.
- calculate the paired sample t and determine the corresponding p value (both directional and non-directional) .
- correctly reject or accept the null and alternative hypotheses from a comparison of the p value with a given critical (alpha) value (both one- and two-way).
- give the conditions of validity for the use of the t-test for testing the significance of a difference between two sample means.
- determine if it is appropriate to use the t-test for testing the significance of a difference between two sample means for a given scenario.
- calculate the confidence interval for the difference between the means of paired samples given a p value.
- give the conditions of validity for the use of the confidence interval for the difference between paired sample means
- determine if it is appropriate to use the confidence interval for the difference between paired sample means for a given scenario.
- explain why the paired t-test may be more precise than the unpaired t-test.
- choose the correct test to use (paired t-test, signs test, or Wilcoxson Signed-Ranks test) given a scenario calling for a test for a difference between paired populations and correctly explain the choice.
- state the null and alternative (both directional and non-directional) hypotheses for the Signs test given an experimental scenario.
- calculate the Signs test statistic and determine the corresponding p value (both directional and non-directional) .
- use the p value from the Signs test to evaluate the null and alternative (both directional and non-directional) hypotheses about the difference between paired samples (given a scenario as background).
- give the conditions of validity for the use of the Signs test for testing the significance of a difference between paired samples.
- determine if it is appropriate to use the Signs Test for testing the significance of a difference between paired samples for a given scenario.
- state the null and alternative (both directional and non-directional) hypotheses for the Wilcoxson Signed-Ranks test given an experimental scenario.
- calculate the Wilcoxson Signed-Ranks test statistic and determine the corresponding p value (both directional and non-directional) .
- use the p value from the Wilcoxson Signed-Ranks test to evaluate the null and alternative (both directional and non-directional) hypotheses about the difference between paired samples (given a scenario as background).
- give the conditions of validity for the use of the Wilcoxson Signed-Ranks test for testing the significance of a difference between paired samples.

- determine if it is appropriate to use the Wilcoxson Signed-Ranks Test for testing the significance of a difference between paired samples for a given scenario.

Lecture 10

Students will be able to:

- distinguish between categorical and quantitative variables.
- distinguish between goodness-of-fit models and contingency models of data prediction.
- graphically compare the normal and Chi-square distributions and the changes in the shape of the Chi-square distribution as the degrees of freedom increase.
- state the null and alternative hypotheses (directional and non-directional) that apply to a given experimental scenario involving categorical data and a goodness-of-fit situation.
- calculate the Chi-square statistic and determine the corresponding p value (both directional and non-directional) for the above scenario.
- correctly reject or accept the null and alternative hypotheses from a comparison of the p value with a given critical (alpha) value (both one- and two-way) for the above scenario.
- give the conditions of validity for the use of the Chi-square test for testing the significance of fit between data and predicted data from a goodness-of-fit model.
- determine if it is appropriate to use the Chi-square test for testing the significance of fit between data and predicted data from a goodness-of-fit model for a given scenario.
- state the null and alternative hypotheses (directional and non-directional) that apply to a given experimental scenario involving categorical data and a contingency probability situation (for both 2 x 2 and r x k tables).
- calculate the Chi-square statistic and determine the corresponding p value (both directional and non-directional) for the above scenario.
- correctly reject or accept the null and alternative hypotheses from a comparison of the p value with a given critical (alpha) value (both one- and two-way) for the above scenario.
- give the conditions of validity for the use of the Chi-square test for testing the significance of fit between data and predicted data from a contingency model (for both 2 x 2 and r x k tables).
- determine if it is appropriate to use the Chi-square test for testing the significance of fit between data and predicted data from a contingency model for a given scenario (for both 2 x 2 and r x k tables).
- state the null and alternative hypotheses (directional and non-directional) that apply to a given experimental scenario involving categorical data and the use of Fisher's Exact Test.
- calculate the p value (both directional and non-directional) for the above scenario based on Fisher's Exact Test.
- correctly reject or accept the null and alternative hypotheses from a comparison of the p value with a given critical (alpha) value (both one- and two-way) for the above scenario.
- give the conditions of validity for the use of Fisher's Exact Test for testing the significance of fit between data and predicted data from a goodness-of-fit model.
- determine if it is appropriate to use Fisher's Exact Test for testing the significance of fit between data and predicted data from a goodness-of-fit model for a given scenario.

- calculate the confidence interval for the difference between probabilities for a 2 X 2 contingency table.
- give the conditions of validity for the use of the confidence interval for the difference between probabilities for a 2 X 2 contingency table.
- determine if it is appropriate to use the confidence interval for the difference between probabilities for a 2 X 2 contingency table for a given scenario.
- given an appropriate scenario based on paired data points, construct a 2 x 2 contingency table to test for concordance.
- calculate the p value from the above table and evaluate the null hypothesis of equal probabilities.
- using McNemar's Test, calculate the p-value and evaluate the null hypothesis of equal probabilities.
- calculate the relative risk and odds ratio from appropriate scenarios.

Lecture 11a

Students will be able to:

- predict the effect of multiple statistical tests on the experiment-wide error rate.
- state the null and alternative hypotheses for one-way analysis of variance.
- calculate the total, between group, and within group sum of squares.
- calculate mean squares for within and between groups.
- calculate the pooled standard deviation for the total data from the within-group mean square.
- state and explain the experimental model for one-way ANOVA.
- explain what is meant by partitioning the variation.
- state and explain the partitions of variation for a one-way ANOVA.
- construct a one-way ANOVA table.
- use global F tests to accept or reject the null hypothesis for one-way ANOVA.
- relate the F statistic with the t statistic.
- identify the blocking scheme from a given experimental scenario.
- calculate the sum of squares for blocks, treatment sum of squares, and error sum of squares from a blocked experiment.
- state and explain the experimental model for one-way ANOVA for a blocked experiment.
- state the equation that predicts the data as a sum of effects for a blocked experiment.
- construct a one-way ANOVA table for a blocked experiment.
- use global F tests to accept or reject the null hypothesis for one-way ANOVA of a blocked experiment.

Lecture 11b

Students will be able to:

- distinguish between fixed-effects and random-effects models.

- set up a two-way factorial experimental design from a given research scenario and correctly identify the factors, levels and replications involved.
- detect and interpret graphical representations of interactions among independent factors.
- state the null and alternative hypotheses tested by a factorial design.
- calculate sum of squares for the main effects, interaction, error, and total for a two-way ANOVA.
- state and explain the experimental model for a two-way ANOVA.
- state and explain the partitions of variation for a two-way ANOVA.
- construct a two-way ANOVA table.
- use global F tests to accept or reject the null hypothesis for one-way ANOVA.
- use linear contrasts to compare levels of a factor, stating the null hypothesis and evaluating the results of the contrast calculation using a t-test.
- adjust post-hoc comparisons of levels using the Student-Neuman-Keuls test and the Bonferroni Adjustment

Lecture 12

Students will be able to:

- contrast regression and correlation.
- relate regression to causation and association.
- calculate least-squares regression lines (both slope and intercept)
- define and diagram a residual value.
- calculate sum of squares for the residuals and the residual standard deviation.
- interpret the meaning of the residual standard deviation in an experimental context.
- state the assumptions of linear regression.
- diagram outliers, influential datapoints, and curvilinearity and explain how each affects the estimated regression line.
- use residual plots to detect bias and violations of assumptions.
- use transformations to reduce curvilinearity.
- calculate the standard error of beta-1 (estimate of the slope).
- calculate a confidence interval for beta-1.
- test the hypothesis that beta-1 is equal to zero.
- interpret the results of testing beta-1 in an experimental context.
- calculate the coefficient of determination.
- calculate the correlation coefficient.
- distinguish between the coefficient of determination and the correlation coefficient.
- use the correlation coefficient to interpret a regression in an experimental context.