

## BIostatistics (BIO 293) Syllabus Spring 2017

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Office hrs: See website for office hours and office hour updates

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### Course Description:

Examines experimental design, descriptive statistics, basic parametric and nonparametric hypothesis tests, and multivariate techniques used in biology. Emphasizes applications in the lab and field. Lecture 3 hours, recitation 3 hours, total 6 hours per week.

### General Course Purpose:

Introduces students to a suite of statistics commonly used to answer various quantitative biological questions. Prepares students for more advanced independent inquiry in the biological sciences via the use of peer-reviewed scientific journal articles, self-directed research, sample data, and professional statistical software.

### Course Prerequisites/Corequisites:

None

### Course Objectives:

Upon completing the course the student should be able to independently create, execute and complete a small-scale scientific research project that accurately addresses a biologically meaningful question. This involves:

- Applying all standard aspects of the scientific method
- Designing one or more statistically appropriate scientific experiments or research projects
- Recording and transcribing data such that they are analyzable
- Analyzing data with strict adherence to assumptions of the statistics
- Interpreting results of analysis generated by professional software and correctly plotting or displaying data
- Writing a research paper based on their independent inquiry with the formatting consistent with a professional scientific journal
- Presenting their research in a manner that is consistent with professional scientific conferences
- Defending their results in a structured way, similar to that which is seen in theses defenses

### Major Topics to be Included:

- The purpose of using statistics, experimental design, types of data
- Entering, managing, transcribing and interpreting biological data (notation, tables, histograms, bar charts, box plots, line graphs, etc.)
- Descriptive statistics (means, variance, standard deviation, standard error, etc.), samples, populations, and randomness
- Probability, and probability distributions (normal, binomial, Poisson, etc.)
- Sampling distributions, z-scores and confidence intervals
- Hypothesis testing such as one and two sample t-tests and nonparametric alternatives, chi-square based tests (goodness of fit, contingency tables), correlation and regression, one and two-way analysis of variance and nonparametric alternatives
- Statistical significance and biological relevance

- Scientific writing and presenting
- Use of statistical software, particularly those commonly used in biological sciences
- Review and evaluation of peer-reviewed scientific journal articles
- Independent biological research projects in conjunction with classroom presentations

#### Recommended Course Materials:

- Samuels ML, Witmer JA, Schaffner AA. 2012. Statistics for the life sciences. Prentice Hall 654 pgs. ISBN: 978-0-321-65280-5. (2) McKenzie JD Jr. 2004. This is optional.
- Use of the statistical software Minitab is necessary for successful completion of this course. Although NVCC computer labs are equipped with Minitab 17 (which is much better than older versions), it is best if you also have the software on your personal computer for home practice. If you chose to do so, I recommend just getting an old version of minitab (14). Version 14 is cheap, there is no kill date (on version 14), and you'll likely be able to figure out the differences. Go here: <https://www.amazon.com/MINITAB-Release-14-Windows-CD/dp/0131436619>. You can also go to <https://www.minitab.com/en-us/> to get a temporary site license to the new version.

#### Evaluation:

Students will be graded according to the results of four hourly exams (totaling 800 points), one project/presentation (200 points), and four written and oral critiques of the scientific literature (totaling 100 points). Attendance is mandatory; if a student misses more than three or more class sessions (including recitation) he/she will automatically receive a failing grade for the course. All exams will contain problem-based practical questions that are completed with data in the computer lab. There are no make-up exams and there is no extra credit. Exams 1-3 are worth 150 points each, and the comprehensive final is worth 350 points.

#### Students with Special Needs:

Students with physical disabilities who may require accommodations are encouraged to contact the college center for students with disabilities. Students with learning disabilities should contact disability services; here is the link: (<http://www.nvcc.edu/current-students/disability-services/>). I cannot make accommodations unless I'm presented with the appropriate accommodations form.

#### Plagiarism and Academic Honesty:

At Northern Virginia Community College, we expect the highest standards of academic honesty. Academic dishonesty is prohibited in accordance with the Student Conduct, Rights and Responsibilities described in the student handbook (<http://www.nvcc.edu/students/handbook/conduct.html>). NVCC's policies prohibits cheating on examinations, unauthorized access to examinations or course materials, plagiarism and other proscribed activities. Students that violate plagiarism and academic honesty codes will receive a failing grade and will be expelled from this course.

#### Cancellation Days:

In the event of class/lab cancellation, we will resume where we left off during the next meeting. For example, if we were to have an exam scheduled on September 1, and it snowed, the exam would take place on our next scheduled meeting on September 7<sup>th</sup>.

#### Important Dates, Audit Policy and Incompletes:

For critical dates regarding refunds, withdraw, etc. see: <https://www.nvcc.edu/calendars/academic.html>. Last day to drop with a refund is January 26<sup>th</sup>; last day to withdraw without a refund and grade penalty is March

21<sup>st</sup>. Final exams are the week of May 1<sup>st</sup>. A student may not audit this course. Incompletes are only granted if the student's circumstances are dire (health issues, deaths in the family). Incompletes will only be granted if students have completed all lab assignments and 4 exams. Incompletes must be approved by the division dean and the provost. Health claims must be documented by medical professionals. The final exam times are different than your normal class meeting time and are posted on my website.

#### Extension (Incompletes):

My policy on extensions is as follows: I will not grant any student an extension unless there are serious and uncontrollable circumstances that prevent the student from completing the work. Falling behind in the work because you get busy juggling work, life and various other "normal" activities is not justification for an extension. Also, in order for an extension to be granted, you must have completed all labs and all but one of your exams. My Dean has to approve these extensions. Unless your requests meet the aforementioned criteria, your request will invariably be denied.

#### How to Submit Assignments:

To submit assignments in blackboard, scroll to the bottom of the page and click on the, "view/complete assignments" tab that corresponds with the assignment that you want to submit. Attach the appropriate file and click, "submit". If for some reason your blackboard interface is different than mine, please contact me and we will figure out the problem together.

#### Comments on Submitting Work:

Your work must (1) be free of common spelling errors and typos, and (2) contain one font only, please be consistent. If you cut and paste, clean it up before submitting. Use Times New Roman or similar font. Use only one color, black. When submitting work please label it as the following (as an attachment, use caps lock): LAST NAME\_ASSIGNMENT\_DATE. You do not need to put your section since you are submitting via Blackboard. All papers and presentations are to be proofed before you submit to me. I will not accept papers that have not been first proofed by the writing center staff. They will provide you with verification that you were there. For assistance with writing contact staff at academic center for reading and writing:

1. Bisdorf room AA 234; 703-575-4709
2. writinghelp@nvcc.edu
3. [Writing Center Website](http://www.nvcc.edu/alexandria/writing/) (http://www.nvcc.edu/alexandria/writing/)

#### Emails and Discussion Board:

Please use proper English when composing emails and posting discussions. Please keep writing formal, free of slang and as grammatically correct as possible. Please address me in the emails as Dr. or Professor Tupper, not as 'hey.'" Also (I mean following respectfully): Just because we all have email addresses does not mean you should email me and expect an immediate response, nor does it mean you should email me with every question that you have. I will reply to your emails within 48 business hours from its sent time. There are times when I miss an email, or it gets sent to my junkbox. If you do not hear from me within 48 business hours, do not get angry, please just email me again. That said, I will not reply to your emails unless you ask me a specific question. Do not email me if you missed a class and want me to tell you what material you've missed in class. Do not email me telling me that you are going to be late to class, or that you are going to miss a class, or that you have missed class. Do not email me asking for any logistics/instructions that I explained previously in class. For all of those types of questions, please use the discussion board, or ask your classmates. Do not email me asking for extensions. Please feel free to email me if you have questions about the course content or if you want to set up a time to meet and discuss some of the course content. Please email me if there are serious circumstances that are beyond your control that may need my attention (i.e. health or job related issues or conflicts). Again, the majority of questions can be answered by emailing a classmate, or by using the discussion board.

Introductory Letter, General Comments on Success in this Course, and Miscellaneous Stuff:

Please write a brief statement and include something semi-personal about yourself, (e.g. a couple of hobbies/sports/major etc; it's optional). Also let us know where (if) you work and how many hours you work per week. I am sure your classmates (myself as well) are interested to know a little about you. Also include your name, and what you preferred to be called. Post this on the discussion board during the first week of the class. Doing well in this course will require you to be switched on and engaged during our lecture/recitation sessions. Most of the learning will occur in a hands on manner. There is very little traditional lecture time in this course. I consider this course to be partially flipped. The whole point of this class is to get you prepared to answer biological questions with statistics and statistical software. That takes supervised practice, and that's largely what this course will be. Please make use of the discussion board and become friendly with other students in the class. It helps calm anxieties about the course if you have some peer support. Be on time to class. I will lock the door 10 minutes after the start of lecture and will not open the door until we break (unless I see you). So give yourself plenty of time to get to class. We all live in the DC metro area and understand that there is always traffic. Please do not knock while I am lecturing. Use of any type of cell phone/tablet/computer is prohibited during lecture unless you have my permission; think of it as a break from the devices. Recording devices are not allowed for note taking purposes without my permission. I'd prefer that you take notes via pen and paper. For most people, seeing information, hearing information, and physically writing information is superior to computer use when it comes to getting the information into your short-term memory. So, get a notebook, and be prepared to write.

Tentative Lecture Schedule (We may deviate from the schedule, I will notify you a week before each exam of the date):

Unit 1: Introduction to Biostatistics, Descriptive Statistics, Probability, the Normal Distribution, and Experimental Design

- Introduction Sampling, experimental design, descriptive statistics ( $S^2$ , SD, SE, CI, Mean, Median, Mode, Range)
- Evaluating results from samples with tables, figures and descriptive statistics
- The normal distribution, z-scores
- Testing a hypothesis about a single mean: the one sample z-test and one sample t-test. Diagnostics: Normal probability plots, Kolmogorov-Smirnov tests. Nonparametric option: One sample sign test
- Critique 1
- **Exam 1 Week 4**

Unit 2: Testing a Hypothesis about two Related Means, Two Independent Means, and Multiple Independent Means

- Testing a hypothesis about two related means: paired t-test. Nonparametric option: One sample sign test
- Testing hypothesis about two independent means: independent sample t-test, Diagnostics: Normal probability plots, Kolmogorov-Smirnov tests, Levene's test for equality of variances. Nonparametric option: Mann-Whitney U test
- Testing a hypothesis about multiple means: One way Analysis of Variance. Diagnostics: Normal probability plots, Kolmogorov-Smirnov tests, Levene's test for equality of variances. Tukey's post-hoc multiple comparison. Nonparametric option: Kruskal-Wallis
- Critique 2

- Exam 2 Week 8

Unit 3: Testing a Hypothesis about Multiple Independent Means When with More than One Factor, Comparing Expected and Observed Count Data, Correlation and Regression

- Testing a hypothesis about multiple means when you have more than one factor: Two way Analysis of Variance
- Comparing expected and observed counts: Chi-square analysis. “Univariate” chi square and contingency tables. Alternative when cell counts are less than 5: Fisher’s exact test
- Correlation analysis and intro to linear regression. Diagnostics: Normal probability plots, Kolmogorov-Smirnov tests
- Linear regression. Diagnostics: Normal probability plots, Kolmogorov-Smirnov tests, Levene’s test for equality of variances, examine residual plots. Testing regression models and making predictions with regression
- Critique 3
- Exam 3 Week 12

Unit 4: A review of Concepts and Introduction to R Statistical Software

- Program R tutorials with familiar data sets
- Critique 4
- Papers due
- Presentations
- Cumulative Final Exam May 1<sup>st</sup> at 3:30 pm, see my website for the final exam schedule