

## **BIOL2060: Statistics for Biologists**

Lab: [time & location]

Class: [time & location]

Instructor: Dr. Shaun Turney

Office hours: [time & location] or by appointment

Course description: This course covers basic knowledge and skills for describing data and testing hypotheses, with an emphasis on application to biology research and everyday life. The three main units of the course are: (1) descriptive statistics, (2) probability and distributions, and (3) hypothesis testing.

Learning outcomes:

The aim of this course is for you to develop the basics of statistical literacy that will be valuable for a professional career as a biologist or health sciences professional. Many of the skills of statistical literacy are also valuable for life as an informed citizen.

By the end of this course, you will be able to:

1. Describe the principles, relating to probability and distributions, that underly basic statistical approaches.
2. Apply data visualization and descriptive tools using R, to communicate patterns and characteristics of biological data.
3. Perform appropriate bivariate hypothesis tests using R, including interpreting and reporting statistical results.
4. Interpret and evaluate statistical analyses reported by other researchers and critically compare alternative methods of analysis.

Instruction Method:

This course is based on an active learning and flipped classroom approach. As such, you will be asked to complete textbook readings in advance of classes. For some readings, you will have the option to watch a video instead. By studying course content before class, the classroom can be an active learning space for you to grapple with difficult concepts, make links between course content and issues you care about, and to seek clarification and affirmation.

Assessments:

<b>Assessment</b>	<b>%</b>	<b>Learning outcomes</b>	<b>Due date</b>
Online quizzes	10 x 3% = 30	1,4	Each Wednesday before lecture
Participation	8	1,2,3,4	During lectures
Case study 1	8	2	[week 6]
Case study 2	10	2,3	[week 11]
Case study 3	12	2,3	[week 13]
Final case study	32	1,2,3,4	Final exam period
<i>Total</i>	<i>100</i>		

On the first and last day of class you will take a pre-course and post-course statistical literacy test. This test will not affect your final grade. The results are used only to inform the course content and teaching strategy.

In addition to the short descriptions for graded assessments below, I will provide more detailed instructions and rubrics for each assessment. I will also provide opportunities to practice, receive ungraded feedback, and see example work, wherever possible.

**Online quizzes:** Due before class and completed online. You will be presented with five multiple choice or numerical questions drawn from a question bank. After class, you will have the option of retaking the quiz (with new questions). If you retake the quiz, your new grade will be the weighted average of the pre- and post-class quizzes (where the post-class quiz is weighted twice as heavily). Your lowest two quiz grades of the semester will be dropped from your final grade. I encourage you to work with your colleagues on the quizzes but please ensure that everyone understands the answers they are submitting.

**Participation:** Based on the percent of clicker questions completed during lecture periods. You may skip up to 15% of clicker questions without penalty. This grade is based solely on completion, not on your answers themselves.

**Case studies:** Case studies 1-3 are based on data that you will select and download from the Breeding Bird Survey or Statistics Canada to analyze topics in biology and health sciences that are of interest to you.

**Case study 1:** In the first case study, you will prepare a short report on a dataset that includes basic descriptive statistics, a boxplot, a scatterplot, and figure captions.

**Case study 2:** You will prepare a short report that includes a chi-square test and an ANOVA.

**Case study 3:** You will prepare a short report that includes a linear regression, a transformation, and a non-parametric test.

**Final case study:** This will be an open-book lab exam. You will be presented with a dataset and asked to produce graphs, perform hypothesis tests, and report and interpret your results. You will also answer several questions drawn at random from the quiz question bank.

Rubric:

Wherever appropriate, your assessment will be based on criteria from the statistical literacy rubric, below. The statistical literacy rubric is modified from the VALUE rubric produced by the Association of American Colleges and Universities.

	Level 4	Level 3	Level 2	Level 1
<b>Interpretation</b> <i>Ability to explain information presented in mathematical forms (e.g., equations, graphs, diagrams, tables, words)</i>	Provides accurate explanations of information presented in mathematical forms. Makes appropriate inferences based on that information.	Provides accurate explanations of information presented in mathematical forms.	Provides somewhat accurate explanations of information presented in mathematical forms, but occasionally makes minor errors related to computation or units.	Attempts to explain information presented in mathematical forms but draws incorrect conclusions about what the information means.
<b>Representation</b> <i>Ability to convert relevant information into various mathematical forms (e.g., equations, graphs, diagrams, tables, words)</i>	Skillfully converts relevant information into an insightful mathematical portrayal in a way that contributes to a further or deeper understanding. (See resources on effective data visualization.)	Competently converts relevant information into an appropriate and desired mathematical portrayal.	Completes conversion of information but resulting mathematical portrayal is only partially appropriate or accurate.	Completes conversion of information but resulting mathematical portrayal is inappropriate or inaccurate.
<b>Calculation</b> <i>Ability to solve problems by "hand" or using computer software.</i>	Calculations attempted are essentially all successful and sufficiently comprehensive to solve the problem. Calculations are also presented clearly and concisely (including clear comments for any code).	Calculations attempted are essentially all successful and sufficiently comprehensive to solve the problem.	Calculations attempted are either unsuccessful or represent only a portion of the calculations required to comprehensively solve the problem.	Calculations are attempted but are both unsuccessful and are not comprehensive.
<b>Application/Analysis</b> <i>Ability to make judgments and draw appropriate conclusions based on the quantitative analysis of data, while recognizing the limits of this analysis</i>	Uses the quantitative analysis of data as the basis for deep and thoughtful judgements, drawing insightful, carefully qualified conclusions from this work.	Uses the quantitative analysis of data as the basis for competent judgements, drawing reasonable and appropriately qualified conclusions from this work.	Uses the quantitative analysis of data as the basis for basic judgments, drawing plausible conclusions from this work.	Uses the quantitative analysis of data as the basis for tentative, simple judgments, although is hesitant or uncertain about drawing conclusions from this work.
<b>Assumptions</b> <i>Ability to make and evaluate important assumptions in data analysis.</i>	Explicitly describes assumptions and provides compelling rationale for why each assumption is appropriate. Shows awareness that confidence in final conclusions is limited by the accuracy of the assumptions.	Explicitly describes assumptions and provides compelling rationale for why assumptions are appropriate.	Explicitly describes assumptions.	Attempts to describe assumptions.
<b>Communication</b> <i>Expressing evidence in support of the argument (in terms of what evidence is used and how it is formatted, presented, and contextualized).</i>	Uses evidence in connection with the argument or the purpose of the work, presents it in an effective format and explains it with consistently high quality.	Uses evidence in connection with the argument or purpose of the work, though data may be presented in less than completely effective format or some parts of the explication may be too detailed or not detailed enough.	Format lacks structure and is somewhat unclear. Uses evidence but does not effectively connect it to the argument or purpose of the work.	Format is unstructured and unclear. Presents an argument for which evidence is pertinent but does not provide adequate explicit numerical support.

Any work which does not meet the criteria for Level 1 will be assigned Level 0.

### Schedule:

This timeline is tentative. It may change depending on the needs and preferences of the class or due to unforeseeable events. The chapters refer to the textbook: Whitlock & Schluter. (2015). *The analysis of biological data*. 2nd edition. Roberts and Company.

Week	Unit	Reading	Class	Lab
1		Chapter 1	Introduction to statistical thinking & Pre-course assessment	
2	Descriptive statistics	Chapter 2	Displaying data	Introduction to R
3		Chapter 3	Describing data	Introduction to R
4	Probability & distributions	Chapter 4	Estimation with uncertainty	Case study 1
5		Chapter 5	Probability	Case study 1
6		Chapter 10	The normal distribution	
7	Hypothesis testing	Chapter 6	Introduction to hypothesis testing	
8		Chapter 9	Goodness-of-fit tests & contingency tests	
9		Chapter 12	Student's t-test	Case study 2
10		Chapter 13	ANOVA	Case study 2
11		Chapter 16	Correlation & regression	Case study 3
12		Chapter 17	Violations of assumptions	Case study 3
13		Chapter 19	Modern statistical methods & Post-course assessment	Practice & peer feedback for final case study

### Course policies:

**Disability and Accessibility:** I am committed to providing equitable educational opportunities to all students. I support the University in its efforts to remove attitudinal and physical barriers that may hinder or prevent students with disabilities from participating fully in University life. If you perceive any potential barriers to your participation in this course, please discuss this with me as soon as possible so that we can explore appropriate modifications to the course. Please also reach out to the Student Accessibility Services (<https://accessibility.students.yorku.ca/>) if you have not already done so.

**Late Policy:** Assessments are due at the start time of the class or lab period on the day they are due, and anything submitted after that time will receive a grade of zero. However, if you realize in advance (up to 48 hours in advance) that you will have difficulty completing the assessment by the due date, let me know right away. Depending on the assessment, I may be

able to adjust your due date on an individual basis. Late submissions are also permitted with a valid excuse (illness, family emergency, etc.). For the final lab exam, these excuses must be supported by documentation.

**Change-of-grade requests:** If you feel that there is a mistake or misjudgement in your grade, you may request a change of grade from the person who graded your work (myself or your TA). I ask that this request must be made within two weeks of when you receive the grade. For assessments with a rubric, you must clearly explain how the grade you received does not align with the rubric.

**Communication:** I welcome you to communicate with me if you have questions or comments. You have two ways to communicate with me: (1) Come to my office hours. (2) Email me. My email address is [email address]. In the subject line, please write a brief, descriptive subject and include the course code (e.g., "BIOL2060: Question about p-values"). Please check first if your question is answered in this course outline. You may also comment or ask questions anonymously in the online suggestion box.

#### York University Policies:

All students are expected to familiarize themselves with the following information, available on the Senate Committee on Academic Standards, Curriculum & Pedagogy webpage:

<https://teachingcommons.yorku.ca/resources/teaching-strategies/senate-policies-on-teaching-learning/>

- Senate Policy on Academic Honesty and the Academic Integrity Website
- Ethics Review Process for research involving human participants
- Course requirement accommodation for students with disabilities, including physical, medical, systemic, learning and psychiatric disabilities
- Student Conduct Standards
- Religious Observance Accommodation

#### Land acknowledgement:

We recognize that many Indigenous nations have longstanding relationships with the territories upon which York University campuses are located that precede the establishment of York University. York University acknowledges its presence on the traditional territory of many Indigenous Nations. The area known as Tkaronto has been care taken by the Anishinabek Nation, the Haudenosaunee Confederacy, the Huron-Wendat, and the Métis. It is now home to many Indigenous Peoples. We acknowledge the current treaty holders, the Mississaugas of the Credit First Nation. This territory is subject of the Dish with One Spoon Wampum Belt Covenant, an agreement to peaceably share and care for the Great Lakes region.

#### Resources:

If you're struggling academically or personally, you are not alone and there are resources available to help you. Please reach out to one of the resources listed below. If you would like support contacting a resource or are struggling in this course, I encourage and welcome you to contact me.

[List of York University and Toronto resources]