

Department of Biology Course Outline

SC/BIOL 2060 3.00 Statistics for Biologists Winter 2020

Course Description

Statistical problem solving for biologists. Basic theory for the analysis of parametric and non-parametric data. Includes a tutorial period for discussion and solving of statistical problems. Two lecture hours, one tutorial period per week. One term. Three credits.

Prerequisites

Prerequisites: LE/CSE 1520 3.00, or LE/CSE 1530 3.00, or LE/CSE 1540 3.00, or LE/EECS 1520 3.00, or LE/EECS 1530 3.00, or LE/EECS 1540 3.00; SC/MATH 1014 3.00 or SC/MATH 1505 6.00 or both SC/MATH 1013 3.00 and SC/MATH 1025 3.00 or equivalents.

Course Credit Exclusions: SC/BIOL 3090 3.00, AP/ECON 2500 3.00, AP/ECON 3210 3.00, AP/ECON 3480 3.00, AP/ECON 3500 3.00, ES/ENVS 2010 6.00, AP/SC/GEOG 2420 3.00, HH/KINE 2050 3.00, HH/KINE 3150 3.00, SC/MATH 1131 3.00, SC/MATH 2560 3.00, SC/MATH 2565 3.00, SC/MATH 2570 3.00, AP/POLS 3300 6.00, HH/PSYC 2020 6.00, HH/PSYC 2021 3.00, AP/SOCI 3030 6.00.

Course Instructors and Contact Information

Instructors:

1. First half: Dr Mark Vicari, Room 151A Farquharson Building
 - Email: mvicari@yorku.ca. Please include BIOL 2060 in the subject line.
 - Office Hours: see Moodle
2. Second half: Dr. Roberto Quinlan, Room 211 Lumbers Building
 - Email: rquinlan@yorku.ca. Please include BIOL 2060 in the subject line
 - Office Hours: see Moodle

Schedule

Lectures: Mondays 10:30-11:30 in CLH G; Wednesdays 10:30-11:30 in VH A

Tutorials: Fridays 14:30-17:30 in ACW 109.

The tutorials will usually be 1-2 hrs and will be devoted to a number of tasks including:

- 1) Taking up problem sets assigned throughout the course.
- 2) Learning to use the statistical computing software R, and use the Data Analysis add-in in Microsoft Excel.
- 3) Midterm tests will be written during the tutorial period.
- 4) Dealing with individual problems/questions of students

Evaluation

Midterm tests (2)	50% total; higher grade = 30%; lower grade = 20%
Midterm 1: Friday Jan 31 Midterm 2: Friday March 06	- Half of the material on test 2 will be from Dr. Vicari; the other half will be from Dr. Quinlan
Assignments (2)	10% total (5% each)
Final Exam	40%
	- one 8.5" x 11" paper, written/printed on both sides, allowed; bring calculator - 60% of the material will be from after midterm 2; 20% will be from before midterm 1; 20% from between midterms 1 and 2

Important Dates

Midterm test 1: Friday **Jan 31**

Midterm test 2: Friday **March 6**

Last date to drop course without receiving a withdrawal note on your transcript: **Friday March 13**

Final Exam: to be held during the **winter examination period, April 7-25**. Exact date, time and location TBA by the registrar's office. Students should not book plane tickets, vacations etc. during this period before the date of the exam is known.

NOTE: for additional important dates such as holidays, refer to the "Important Dates" section of the Registrar's Website at <https://registrar.yorku.ca/enrol/dates>

Resources

Textbook: M.C. Whitlock and D. Schluter, 2015. *The Analysis of Biological Data*, 2nd edition. W.H. Freeman & Co., New York. (buy it and begin reading!).

- We will largely follow the text from the beginning up to and including at least chapter 17. But see below for explicit details of which chapters and sections.
- Note that if you have a copy of the 1st edition of this book, it may suffice, but it is your responsibility to ensure that all the material in the 2nd edition that we cover, is indeed covered in the 1st edition

Website: The course will be managed through a Moodle site. Please log in at:

<https://moodle.yorku.ca/moodle/>

Learning Outcomes

Statistics is an extremely important field for biology, and many other disciplines.

By the end of this course students should be able to:

- 1) Provide a summary of categorical and numeric data using graphical methods and statistics
- 2) Apply the most powerful hypothesis test(s) to data from a range of biological experiments involving categorical or numeric data.
- 3) Test the assumptions of various hypothesis tests
- 4) Interpret the results of the hypothesis tests carried out
- 5) Carry out the hypothesis tests both by "hand" and using the statistical computer program called R.

Course Content

TENTATIVE COURSE OUTLINE (material may change due to unforeseen circumstances)

1) INTRODUCTION TO STATISTICS (read chapter 1)

What is statistics?
Populations and samples
Random sampling
Types of data - categorical versus numeric
Explanatory versus Response variables
Frequency and probability distributions

2) DISPLAYING DATA (read chapter 2)

Plotting frequency distributions
Bar graphs, histograms
Contingency tables
Scatterplots for two variables

3) DESCRIBING DATA (read chapter 3)

Sample mean and sample median
Variance and standard deviation
(computational formula)
Quartiles and box plots
Cumulative frequency distribution
Proportions

4) Estimation with uncertainty (read chapter 4)

Estimating a population parameter
Sampling distribution of the estimates
e.g. mean
Standard error
Confidence intervals

5) Probability (read chapter 5 sections **5.1 through 5.9** inclusive)

Probability of events
Mutually exclusive events
Probability distributions
Addition and multiplication rules
Independent events
Probability trees
Conditional probability / Bayes' Theorem
Pseudoreplication (read pgs 115-116)

6) Hypothesis testing (Chapter 6 & 7)

Null (H_0) versus Alternative (H_a) hypotheses
One versus two-sided tests
Examples
Handedness and Chlorophyll
P-value
Type I and Type II errors
Analysing proportions and hypothesis tests using the Binomial distribution
OMIT THE MATERIAL ON CALCULATING CONFIDENCE INTERVALS FOR PROPORTIONS ON PAGES (189-191).

7) Goodness-of-Fit and Contingency tests (Chapters 8 & 9)

χ^2 goodness-of-fit tests
assumptions
examples
Fitting data to probability distributions
Contingency tests
G-statistic

OMIT SECTION 9.2 ON ESTIMATING ASSOCIATION IN 2X2 TABLES: ODDS RATIOS

8) The normal distribution (Chapter 10)

Ignore normal approximation for the binomial distribution (section 10.7)

The standard normal distribution and probabilities

Normal distribution of sample means

Central limit theorem

9) Student's t-test (Chapter 11 & 12)

the t-distribution

confidence intervals

one- and two-sample t-tests

assumptions

paired t-test

F-test of equal variances

OMIT SECTION 11.5 ON CONFIDENCE LIMITS FOR VARIANCE AND STANDARD DEVIATION

10) Violations of assumptions, transformation and non parametric tests (Chapter 13)

Detecting deviations from normality read section, but won't carry out Shapiro Wilk test for normality.

Transforming data to meet normality assumption

Non-parametric alternatives to t-tests

Ignore chapter 14.

11) Analysis of Variance (Chapters 15)

Single factor ANOVA

Planned versus unplanned comparisons

Fixed versus random effects

(Ignore Nonparametric alternatives pg. 471, but you should know of their existence and when to use them).

12) Correlation and Regression (Chapter 16 and 17)

Chpt 16 only sections 16.1 (but ignore confidence interval material)

include 16.2, 16.3, 16.4

Chpt 17 only sections 17.1 (ignore confidence interval)

include 17.3 (ignore ANOVA approach).

Correlation coefficient

Linear regression

Estimation of least squares line

Hypothesis test of slope

Assumptions and transformations

13) Recent advances in statistics

Experiential Education and E-Learning

This course uses the statistical computing packages *Excel* (including the data analysis add-in) and *R*.

Course Policies

Missed midterm test policy: There will be no make-up for the midterm tests in this course. Students who miss a test must have legitimate medical documentation describing their illness. If the medical documentation is deemed to be legitimate the percent value of the one midterm that was written will be weighted at 25%; the weight final exam will be increased by 25% (to 65%). A student who misses both midterms (with legitimate documentation) will be required to write a final exam that covers the entire term with all portions of the course weighted equally.

Penalty for late submission of assignments: 33% per day

Email etiquette

Subject line: please begin with "BIOL 2060" followed by a brief, but reasonably detailed, indication of the subject of your email (e.g., "question about lecture 3", etc.)

Body of the email: remember to include your name and student number at the end of every email.

Response time: please allow 2 working days.

Religious observance days

Should the dates for a test pose a conflict with a religious observance day for your particular religion, you must notify the appropriate instructor **at least 3 weeks before the date of the test**. In the event of a religious observance conflict with the final exam, students must complete an **Examination**

Accommodation Agreement Form, available at:

<https://secure.students.yorku.ca/pdf/religious-accommodation-agreement-final-examinations.pdf>

and submit it to the instructor **at least 3 weeks before the date of the exam**.

Some Advice on How to Succeed in This Course

- 1) Acquire a copy of the textbook and use it. You are responsible for all chapters in the textbook indicated and all material in those chapters unless certain pages/sections are explicitly excluded by the instructor.
- 2) Attend all lectures and tutorials – if you miss a class make certain you contact another student, find out what was covered and obtain their notes. It is YOUR responsibility to find out from other students what was covered in your absence.
- 3) Do all the problem sets. Do as many problems/questions as you can.
- 4) Use the statistical program and software taught during the course. It will be an important tool in this course, and, more importantly, you will use it extensively in future years in your other undergraduate courses.
- 5) Make certain you keep up, or you will be lost VERY SOON.

Students who feel that there are extenuating circumstances that may interfere with their ability to successfully complete the course requirements are encouraged to discuss the matter with the Course Director as soon as possible.

University Policies

Important Course Information for Students copied from the Senate Committee on Academic Standards, Curriculum & Pedagogy:

- All students are expected to familiarize themselves with the following information, available on the Senate Committee on Academic Standards, Curriculum & Pedagogy webpage (see Reports, Initiatives, Documents)

<https://secretariat-policies.info.yorku.ca/policies/academic-honesty-senate-policy-on/>

- 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

Academic Standards: Third Party Repository Sites

Numerous students in Faculty of Science courses have been charged with academic misconduct when materials they uploaded to third party repository sites (e.g. Course Hero, One Class, etc.) were taken and used by unknown students in later offerings of the course. The Faculty's Committee on Examinations and Academic Standards (CEAS) found in these cases that the burden of proof in a charge of aiding and abetting had been met, since the uploading students had been found in all cases to be wilfully blind to the reasonable likelihood of supporting plagiarism in this manner. Accordingly, to avoid this risk, students are urged not to upload their work to these sites. Whenever a student submits work obtained through Course Hero or One Class, the submitting student will be charged with plagiarism and the uploading student will be charged with aiding and abetting.

Note also that exams, tests, and other assignments are the copyrighted works of the professor assigning them, whether copyright is overtly claimed or not (i.e. whether the © is used or not). Scanning these documents constitutes copying, which is a breach of Canadian copyright law, and the breach is aggravated when scans are shared or uploaded to third party repository sites.

There is also an academic integrity website with comprehensive information about academic honesty and how to find resources at York to help improve students' research and writing skills, and cope with University life. Students are expected to review the materials on the Academic Integrity website at - http://www.yorku.ca/spark/academic_integrity/index.html

Access/Disability

York University is committed to principles of respect, inclusion and equality of all persons with disabilities across campus. The University provides services for students with disabilities (including physical, medical, learning and psychiatric disabilities) needing accommodation related to teaching and evaluation methods/materials. These services are made available to students in all Faculties and programs at York University.

Students in need of these services are asked to register with disability services as early as possible to ensure that appropriate academic accommodation can be provided with advance notice. You are encouraged to schedule a time early in the term to meet with each professor to discuss your accommodation needs. Please note that registering with disabilities services and discussing your needs with your professors is necessary to avoid any impediment to receiving the necessary academic accommodations to meet your needs.

Additional information is available at the following websites:

Counselling & Development Services - <https://counselling.students.yorku.ca>

Counselling & Disability Services at Glendon – <https://www.glendon.yorku.ca/counselling/>

York Accessibility Hub - <https://accessibilityhub.info.yorku.ca>

Ethics Review Process

York students are subject to the York University *Policy for the Ethics Review Process for Research Involving Human Participants*. In particular, students proposing to undertake research involving human participants (e.g., interviewing the director of a company or government agency, having students complete a questionnaire, etc.) are required to submit an *Application for Ethical Approval of Research Involving Human Participants* at least one month before you plan to begin the research. If you are in doubt as to whether this requirement applies to you, contact your Course Director immediately.

Religious Observance Accommodation

York University is committed to respecting the religious beliefs and practices of all members of the community, and making accommodations for observances of special significance to adherents. Should any of the dates specified in this syllabus for an in-class test or examination pose such a conflict for you, contact the Course Director within the first three weeks of class. Similarly, should an assignment to be completed in a lab, practicum placement, workshop, etc., scheduled later in the term pose such a conflict, contact the Course director immediately. Please note that to arrange an alternative date or time for an examination scheduled in the formal examination periods (December and April/May), students must complete an Examination Accommodation Form, which can be obtained from Student Client Services, Student Services Centre or online at <https://secure.students.yorku.ca/pdf/religious-accommodation-agreement-final-examinations.pdf>

Student Conduct in Academic Situations

Students and instructors are expected to maintain a professional relationship characterized by courtesy and mutual respect. Moreover, it is the responsibility of the instructor to maintain an appropriate academic atmosphere in the classroom and other academic settings, and the responsibility of the student to cooperate in that endeavour. Further, the instructor is the best person to decide, in the first instance, whether such an atmosphere is present in the class. The policy and procedures governing disruptive and/or harassing behaviour by students in academic situations is available at - <http://secretariat-policies.info.yorku.ca/policies/disruptive-andor-harassing-behaviour-in-academic-situations-senate-policy/>