

BIOL202 - 001
Introduction to Biostatistics (3)
2021 WT1

Lecture Instructor and Laboratory Coordinator:

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Office Hours (Zoom): Fridays 9:30 – 11:00AM, or by appointment arranged via email.

Lecture times (Zoom): Mon / Wed / Fri 12:00 – 12:50.

Lecture Teaching Assistant: Maggie Minkus, marguerite.minkus@ubc.ca

Academic calendar entry:

BIOL202 (3 credits) (Introduction to Biostatistics)

Data analysis methods for biologists including sampling and experimental design, visualizing and describing data, probability, hypothesis testing, comparisons of proportions and means, correlation and regression analysis, analysis of variance, non-parametric, permutation-based tests, and the central roles that statistical analyses and reproducibility play in scientific research. R and R Markdown are used to manage and visualize data, to conduct statistical analyses, and to communicate findings using literate programming. [3-2-0]

Pre-requisite: Math 100 and Second Year Standing

Course overview:

The lectures first build on [Open Science training](#) that Biology students receive in first year. Primary research articles are used to highlight aspects of the scientific method that can go awry and diminish the reliability and reproducibility of research outcomes. The lectures then introduce students to descriptive statistics, data visualization, the concepts of sampling and estimation, hypothesis testing, and experimental design. The remainder of the lectures are dedicated to teaching: inferential statistics, parametric and non-parametric statistical methods, choosing the appropriate statistical test given the study design, how to conduct the calculations using formulae provided, the assumptions associated with statistical tests, and how to evaluate those assumptions. Throughout, students are taught how to interpret and communicate the results of statistical analyses. Within the labs, students gain experience: implementing statistical analyses using the open-source statistical software R, ensuring a reproducible workflow through proper file and data management, and using R Markdown for literate programming. By the end of the term, students should be able to produce a lab report in R Markdown that includes both inputs (i.e. R code and data) and outputs (tables and figures).

Learning Outcomes:

Lecture Part I: The fundamentals of the scientific method and reproducible research workflows

Upon successful completion of this portion of the course, students will be able to:

1. Describe examples of questionable research practices and contrast these with best practices in research workflows
2. Identify common pitfalls in biological research workflows, and how these impact reliability of research outcomes
3. Identify features of primary research articles that promote reproducibility and those that hinder reproducibility

Lecture Part II: Sampling, Describing and Visualizing data

Upon successful completion of this portion of the course, students will be able to:

1. Understand sampling and estimation, and the need for statistics
2. Identify common sources of bias in sampling, and understand the goals of random sampling
3. Distinguish categorical and numerical variables
4. Choose the best methods for describing a variable
5. Choose the best way to visualize individual variables and associations between two variables
6. Calculate descriptive statistics and know which descriptors to use given features of the data
7. Compare and contrast observational and experimental studies

Lecture Part III: Inferential Statistics

Upon successful completion of this portion of the course, students will be able to:

1. Understand probability theory and probability distributions
2. Define mutually exclusive events, independent events, dependent events
3. Calculate probabilities of independent and dependent events
4. Formulate effectively worded hypotheses
5. Understand the process of hypothesis testing
6. Define false positive (Type I) and false negative (Type II) statistical errors
7. Understand the concept of statistical power, and describe factors that influence it
8. Understand the fundamentals of experimental design, and how to reduce bias and sampling error
9. Choose the appropriate statistical test given the study design and goals, and understand their respective assumptions
10. Understand the difference between parametric and non-parametric tests
11. Understand data transformations and their purpose
12. Find and report critical values of a test statistic for a given statistical analysis
13. Conduct the calculations for statistical tests using formulae
14. Understand confidence intervals and how to communicate them

15. Effectively communicate the results of statistical analyses

Lab Part I: Implementing a reproducible workflow

Upon successful completion of this portion of the course, students will be able to:

1. Demonstrate competency in implementing a computationally reproducible workflow using R, RStudio, and R Markdown
2. Manage files and data according to best practices
3. Create appropriately formatted data files
3. Use R Markdown for literate programming, ensuring transparent and thorough documentation of data processing, analysis, and presentation

Lab Part II: Data description and visualization, and statistical analyses

Upon successful completion of this portion of the course, students will be able to:

1. Use R to summarize, describe, and visualize numerical and categorical variables
2. Use R to conduct statistical analyses, including implementing appropriate tests of assumptions
3. Generate reports in R Markdown that include inputs (data and code) and outputs (tables and figures)

Course Format:

Lectures: Lectures periods will include synchronous and occasional asynchronous instruction via Zoom, combined with interactive online learning activities such as polling questions, and question & answer sessions. Lectures will be recorded and posted on Canvas for optional, asynchronous viewing. Skeleton lecture slides will be posted on Canvas prior to the lectures. These will summarize the core concepts to be covered in lecture; they will not be exhaustive. Some topics from the text will be covered minimally in lectures. Nevertheless, students are responsible for all the topics covered in the assigned sections of the text.

Labs: Lab sessions are hosted synchronously online. The course lab webpage hosts tutorials that provide step-by-step instruction on the use of the open-source software program “R” within the RStudio IDE for conducting statistical analyses. TAs will deliver a short intro / instructional piece using Zoom at the beginning of each lab session, and these will be recorded and made available for asynchronous viewing. TAs will remain on Zoom for the duration of the lab period (80 minutes) to address questions from students. Although students are permitted to work through the online tutorial material on their own time, and need not “attend” the online lab session, they are encouraged to attend. Online quizzes, submitted assignments, and a final “take home” test provide for student assessment of learning.

Copyright Disclaimer:

Diagrams and figures included in lecture presentations adhere to Copyright Guidelines for UBC Faculty, Staff and Students <http://copyright.ubc.ca/requirements/copyright-guidelines/> and UBC Fair Dealing Requirements for Faculty and Staff <http://copyright.ubc.ca/requirements/fair-dealing/>. Some of these figures and images are subject to copyright and will not be posted to **Canvas**. All material uploaded to **Canvas** that contain diagrams and figures are used with permission of the publisher; are in the public domain; are licensed by Creative Commons; meet the permitted terms of use of UBC's library license agreements for electronic items; and/or adhere to the UBC Fair Dealing Requirements for Faculty and Staff. Access to the **Canvas** course site is limited to students currently registered in this course. Under no circumstance are students permitted to provide any other person with means to access this material. Anyone violating these restrictions may be subject to legal action. Permission to electronically record any course materials must be granted by the instructor. Distribution of this material to a third party is forbidden.

Laboratory Meeting times (Zoom):

Lab sessions are listed below. Lab sessions begin the week of September 13, 2021. All labs will be hosted on Zoom by their respective TAs, and meetings will have links on Canvas. Students should attend their assigned lab section.

Lab Sections listed in chronological order, with time and TAs:

Day of week	Time	TA	Lab Section
Monday	08:00 – 09:30	Stefano Mezzini	L03
Monday	08:00 – 09:30	Liam Johnson	L09
Tuesday	09:30 – 11:00	Liam Johnson	L11
Tuesday	12:30 – 14:00	Liam Johnson	L01
Tuesday	12:30 – 14:00	Maggie Minkus	L12
Wednesday	09:30 – 11:00	Maggie Minkus	L10
Thursday	09:30 – 11:00	Jannatul Ferdous	L04
Thursday	09:30 – 11:00	Carol Tomiyama	L06
Thursday	11:00 – 12:30	Carol Tomiyama	L07
Thursday	12:30 – 14:00	Jannatul Ferdous	L02
Thursday	12:30 – 14:00	Stefano Mezzini	L05
Thursday	14:00 – 15:30	Stefano Mezzini	L13
Thursday	14:30 – 17:00	Jannatul Ferdous	L08

Required Materials:

Textbook: Whitlock, M. and Schluter, D. *The analysis of biological data*. 3rd edition. 2020. Macmillan Learning. *Consult text website for additional learning resources, corrections / typographical errors: <https://whitlockschluter3e.zoology.ubc.ca./index.html>

Calculator Required in lecture and during exams. Programmable calculators are allowed.
Computer A computer or other device (e.g. iPad) with a webcam and keyboard is required.

Laboratory instructional material:

All instructional materials (tutorials) will be available at this webpage:
<https://ubco-biology.github.io/BIOL202/>

Course Evaluation:

Your final grade (a percentage) will be comprised of the following (details for each item are provided below):

Activity	Worth	Delivery and due date
Midterm	15%	Online via Canvas, Friday October 22, 2021
Online Canvas quizzes (4)	10%	Starting week of Sept. 20, 2021, roughly every 2 weeks
Reproducibility assignment	5%	Electronic submission by 12:00pm on Canvas Nov. 5, 2021
Final lecture exam	35%	Online via Canvas (Date TBD)
Lab assignments (3)	15%	See schedule below
Lab online quizzes (4)	10%	Start week of September 13, 2021
Lab test	10%	Online via Canvas, during week of November 29, 2021
Total	100%	

Final grades will be based on the evaluations listed above and the final grade will be assigned according to the standardized grading system outlined in the UBC Okanagan Calendar.

Note: Any requests for changes to final exams must be sent to the office of the Associate Dean of Students (bsasdeansoffice.ubco@ubc.ca).

Lecture Midterm (15%)

The lecture midterm will be deployed online through Canvas on Friday October 22nd, 2021, during the lecture period timeslot (12:00 – 12:50pm). The midterm will only be available during this time, and any questions that are not answered by 12:50pm will receive a zero grade. The midterm will include multiple choice and calculation questions. The midterm is “open-book”: students may use the text book (either hard-copy or eBook) and any other online resources. However, given the time limit to the test, excessive reliance on external resources is discouraged. Communication by any means with others during the test is strictly forbidden, and students will be asked to sign a pledge committing to this, and to proper academic conduct.

Online quizzes (10%)

Four online quizzes, each worth 2.5%, will be administered via Canvas throughout the term, with required completion dates occurring roughly every 2 weeks. Quizzes will include multiple choice and calculation questions. Once a quiz is started on Canvas, the student has a 24 hour window within which to complete it. At the 24-hour mark, uncompleted questions are given a zero grade. The quizzes cover topics discussed in lectures and in the course text book. Some of the questions within the text will be used.

Reproducibility assignment (5%)

For this assignment students will find three primary research articles, of their choosing, to evaluate with respect to adherence to Open Science best practices. Students will be provided a checklist to use for their evaluation. They will also provide a short description of each study, and will use R Markdown to generate their report. The assignment will be submitted via Canvas.

Lecture Final Examination (35%):

The final exam, 2 hours in duration, will be deployed online via Canvas during the regular examination period. The exam is “open-book”: students may use the text book (either hard-copy or eBook) and any other online resources. However, given the time limit to the test (2 hours), excessive reliance on external resources is discouraged. The exam will include multiple choice and calculation questions. Communication by any means with others during the exam is strictly forbidden, and students will be asked to sign a pledge committing to this, and to proper academic conduct.

Lab assignments (15%):

Three lab assignments will be administered through the term. These will involve students using R to answer questions, using the online tutorials as guides, and using R Markdown to generate their assignment document. The course web page on Canvas will host the lab assignments, and students will submit their assignments to Canvas. *Grading:* Students are to submit answers to all questions in the assignment, and these will be graded according to a rubric provided in advance.

Lab online quizzes and exercises (10%)

Four quizzes, roughly one every two weeks, will be administered through Canvas. These aim to test the students’ knowledge of basic coding and procedures within R.

Lab test (10%):

During the last week of labs (week of November 29th), a unique lab test will be deployed via Canvas for each lab section, the purpose of which is to test students on their ability to use R to effectively conduct statistical analyses. The test will cover material in the online tutorials. Starting at the beginning of the students’ respective lab session, the students will have a 24 hour window within which to start and complete the test. It is an open-book test, and students can consult any online material they wish (e.g. tutorials) when completing the test. However, students will be

asked to sign a pledge committing to not assisting or receiving assistance on the test from other students during the entire week of November 29th through December 4th, 2021.

Late or missed assignments, and missed exams:

From UBC Okanagan Academic Calendar/Policies and Regulations/Academic Concession

“Students who, because of unforeseen events, are unable to complete tests or other graded work, should normally discuss with their instructors how they can make up for missed work, according to **written guidelines given to them at the start of the course (see below)**. Instructors are not required to make allowance for any missed test or incomplete work that is not satisfactorily accounted for. If ill health is an issue, students are encouraged to seek attention from a health professional. Campus Health and Counselling will normally provide documentation only to students who have been seen previously at these offices for treatment or counselling specific to conditions associated with their academic difficulties. Students who feel that requests for consideration have not been dealt with fairly by their instructors may take their concerns first to the Head of the discipline, and if not resolved, to the Office of the Dean. Further information can be found at:

<http://www.calendar.ubc.ca/okanagan/index.cfm?tree=3,48,0,0>.

Assignments, quizzes, and exercises that are not completed / submitted by the due date will not be accepted, and will receive a grade of zero without a valid excuse. There will be no make-up assessments provided. If a midterm or lab test is missed without an acceptable excuse (e.g. physician's note), the student will receive a zero on that test. Students who miss a midterm for legitimate reasons (e.g. illness with physician's note) will, in general, **NOT** be provided a make-up midterm. Instead, the worth of the midterm will be added to the total worth of the final exam. Students who miss the lab test for legitimate reasons (e.g. illness with physician's note) will be provided a make-up lab test at a time arranged with the instructor.

Repeat Course Policy:

Students who have successfully completed a course with a lab who wish to repeat the course for a more favorable grade, or a student who wishes to repeat the failed portion of the course may do so, if, and only if, the following requirements are met:

- If the student failed the laboratory portion of the course (either because of a cumulative grade of <50% overall in the lab, OR because of a grade of <50% on the lab test), but achieved a grade of at least C (60%) in the lecture portion of the course, the student may opt to repeat only the laboratory portion.
- If the student failed the lecture portion of the course, but achieved a grade of at least C (60%) in the laboratory portion of the course, the student may opt to repeat only the lecture portion.

- The course must be taken again **within two years** of the term in which the student was originally enrolled in the course (e.g. if the course was originally taken in the Fall term of 2019, the last possible term in which the student can repeat the course is Fall of 2020).
- In situations where the weighting of the lab/lecture component changes from year to year (e.g. 30% lab, 70% lecture in one year; 40% lab, 60% lecture in another year), it will be at the discretion of the instructor teaching the course the second time to decide the weighting in the calculation of the new grade.
- The student must complete the “Repeat course” form found on the Biology web page (<http://biol.ok.ubc.ca/forms.html>) and submit it by email to biology.okanagan@ubc.ca or to the Unit Administrative Assistant (SCI 161) by the last day of the late registration period.

Please note that the university policy is that the student must register and pay for the complete course, and not just a portion of the course.

Online conduct:

Students are expected to respect classmates and instructors within online learning environments, and in the use of chat or discussion boards. Any disrespectful behaviour will not be tolerated. Should students find classmates or activities of classmates disrespectful, students are asked to notify the instructor so that the situation can be dealt with in an independent manner.

Email communication for the course:

CANVAS will be used by the instructor to communicate with the class. Students must pay close attention to *CANVAS* communications. Students should not use *CANVAS* email to contact the instructor; instead, students should use the instructor’s UBC email address (on first page), and include the subject heading "BIOL202". Students should refrain from emailing teaching assistants frequently, and should use office hours as much as possible.

Piazza: This course uses the online software Piazza for facilitating discussions and questions/answers. This is the primary means by which students can get help on both lecture and lab topics. Students are encouraged to help each other troubleshoot. The instructor and TAs will monitor this discussion regularly, and will provide answers to questions in a reasonable timeframe.

Academic Integrity:

The academic enterprise is founded on honesty, civility, and integrity. As members of this enterprise, all students are expected to know, understand, and follow the codes of conduct regarding academic integrity. At the most basic level, this means submitting only original work done by you and acknowledging all sources of information or ideas and attributing them to others as required. This also means you should not cheat, copy, or mislead others about what is your work. Violations of academic integrity (i.e., misconduct) lead to the break down of the academic

enterprise, and therefore serious consequences arise and harsh sanctions are imposed. For example, incidences of plagiarism or cheating may result in a mark of zero on the assignment or exam and more serious consequences may apply if the matter is referred to the President's Advisory Committee on Student Discipline. Careful records are kept in order to monitor and prevent recurrences.

A more detailed description of academic integrity, including the policies and procedures, may be found at: <http://okanagan.students.ubc.ca/calendar/index.cfm?tree=3,54,111,0>

If you have any questions about how academic integrity applies to this course, please consult with your professor.

Disability Assistance:

If you require disability-related accommodations to meet the course objectives, please contact the Coordinator of Disability Resources located in the Student Development and Advising area in the University Centre building. For more information about Disability Resources or academic accommodations, please visit the website at: <https://students.ok.ubc.ca/academic-success/disability-resources/>

Equity, Human Rights, Discrimination and Harassment:

UBC Okanagan is a place where every student, staff and faculty member should be able to study and work in an environment that is free from human rights-based discrimination and harassment. Under UBC's Policy 3 on Discrimination and Harassment, UBC prohibits discrimination and harassment on the basis of the following grounds: age, ancestry, colour, family status, marital status, physical or mental disability, place of origin, political belief, race, religion, sex, sexual orientation or unrelated criminal conviction. If you require assistance related to an issue of equity, discrimination or harassment, please contact:

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Tel 250 807 9291, Website <https://equity.ok.ubc.ca/>, Email equity.ubco@ubc.ca