

Syllabus: Biostatistics (BIOL 322) 3 credits, Winter 2022

Updated: 2022-02-05

This course examines statistical methods for the biological sciences; experimental design; data description; binomial, Poisson and Normal distributions; statistical inference; hypothesis testing; chi-square; one and two sample tests of the mean; analysis of variance including 2-way and nested ANOVAs; correlation; regression; and analogous non-parametric techniques. Lectures and laboratory. NOTE: Students who have received credit for COMM 215, ECON 222, GEOG 362, MAST 333 , PSYC 316, SOCI 213 or STAT 250 may not take this course for credit.

In the event of further extraordinary circumstances and pursuant to the [Academic Regulations](#), the University may modify the delivery, content, structure, forum, location and/or evaluation scheme. In the event of such extraordinary circumstances, students will be informed of the changes. I will highlight any changes to the syllabus since posting the original course outline in **bold red text**.

Course time

Lectures: 8:45 AM – 10:00 AM Eastern Standard Time, Wednesday and Friday. **Room: HB 130, Loyola Campus**

Tutorials: 1:15 PM – 4:00 PM or 4:15 PM – 7:00 PM , either Thursday or Friday (if you cannot make your assigned tutorial for one week, contact the TAs to arrange to attend the other tutorial). **Room: CC 203, Loyola Campus**

Course instructors

Professor: Dr. Eric Pedersen, Assistant Professor, Department of Biology

The best way to contact me: Via message on Moodle.

Email: eric.pedersen@concordia.ca. If you email, make sure to include the course number and your student ID in the subject line. Note that I do receive a large volume of email, so it is more likely that I will see a message on Moodle.

I will try to get back to you as quickly as possible. However, it may take up to 48 hours to get back to you, so please plan accordingly.

Office hours: immediately after class (10:00 AM - 10:45 AM Wednesday and Friday), or by appointment. Office hours will be held via Zoom for the first two weeks, and otherwise will be at my office: SP 401-05 (4th floor SP building, right out of the elevators). I will also be available 20 minutes prior to the start of each class, either on Zoom or in person.

Teaching assistants:

To be announced

All TAs are available to meet to answer your questions regarding tutorials and course material both during the tutorial period and throughout the rest of the term. You can either email your TA your questions directly, or set up virtual or in-person appointments.

Outline:

Learning objectives

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

1. understand and explain key concepts of basic statistics: measurement, samples, populations, statistics, distributions, uncertainty, and statistical models;
2. Understand different types of data, and summarize, visualize, and describe patterns in data;
3. apply and interpret different measures of scientific uncertainty, including confidence intervals and significance tests;
4. use the R language to fit simple statistical methods and simulate new data from simple probability distributions to evaluate statistical methods;
5. understand the role of assumptions in building statistical models, how to construct more complex models from simpler parts, and how to evaluate how well simple models fit their assumptions;
6. recognize and correct common statistical misunderstandings;
7. explain basic statistical ideas clearly in writing, and understand how to apply statistical approaches to real-world problems.

Course format

Lectures for this course will take place Wednesday and Friday, 8:45 AM - 10:00 AM. Lectures, office hours, tutorials, and class discussion will take place in person. All lectures will be live in person and will focus on discussing and explaining statistical concepts, and demonstrating them using computer code. I will also be broadcasting lectures via Zoom in case you are not feeling well and are unable to make it to campus. These lectures will be recorded, but recordings will only be made available by request with a valid excuse for missing class. I expect students to participate in lectures by answering live questions and discussion.

Tutorials will take place on Thursdays and Fridays, and are designed to give you practical experience with working with data and using statistical analyses that you have learned about in lecture. Tutorials will involve working through a series of practical exercises, and handing in a tutorial report for each week. You will be using the R statistical programming language for these exercises, and your report should be written in R code; you will receive instruction on how to use R for this. You will be able to work in groups for the tutorial, but you are expected to write your report on your own and in your own words. Each tutorial will have an assigned TA who will go through the exercises for the week and will be available to discuss the tutorial material with.

Moodle:

Assignments, quizzes, tutorials, and tests will be submitted via the Moodle online platform, using the Moodle course page. *It is your responsibility to verify that your work has been properly uploaded to Moodle by the due date. Not verifying that your work was properly uploaded is not a legitimate excuse for missing the due date.*

Evaluation

Your grade for this class will depend on five components: participation in the pre- and post-course knowledge assessment, weekly quizzes, weekly tutorial reports, assignments, and exams. All written assessments may be submitted in either English or French.

Pre- and post-course knowledge assessment

I will post a short (20 question) multiple-choice assessment to Moodle at the start of the course, and the same quiz at the end of the course. You will be able to work through the assessment any time in the two weeks that the assessment is posted, but you will have 30 minutes to answer from whenever time you start taking the assessment. The final due date for each assessment will be Sunday two weeks after it is posted. These are designed to help me understand what background knowledge you have coming in to the course, and to assess what you've learned from the material after the course. *You will not be graded on how you perform on these assessments*, but you will receive 2% participation marks for completing *both* assessments. As this information is very important to me, I do expect you to make a good-faith attempt to answer the assessment; as such, evidence of answering the questions as quickly as possible or at random will result in you losing these participation marks.

Answering active learning questions during class

I will be posting multiple-choice questions during each lecture to help you think about the material. While you will not be graded on whether you get these questions correct, you will get a 2% participation mark for completing all of the questions (this mark will be adjusted based on the fraction of questions you participated in). You will need to purchase a subscription to the iClicker REEF service to answer these questions; subscriptions are available from the Concordia Bookstore.

Weekly quizzes

At the end of each week, I will post a short (4-8 question) multiple choice quiz on Moodle on the material that I will cover that week. You will have 15 minutes to complete each quiz, and two attempts per quiz; I will base your mark off the average of the two attempts, and each quiz is worth 1% of your total mark. You can attempt the quizzes any time after they are posted before the due date. Quizzes 1 to 5 will be due the day before the midterm, and quizzes 6 to 11 will be due before the final exam. **However, I strongly recommend you try to keep up with the quizzes as they are posted**, as they are designed to help you identify concepts or problems that you are having trouble understanding, and taking them will help you study the material. You will be able to review your quiz answers after you have completed it. Also, as you have multiple weeks to work on these quizzes, there will not be any extensions or excused absences for not submitting a quiz.

Tutorial reports

Each tutorial will have an associated report that you will submit following the tutorial. Tutorial reports must be submitted as a text file written in the R programming language, answering the questions posed in that week's tutorial. The script file must be able to be successfully run by the TAs, and the outcome of running the script should produce the correct answers to the tutorial. Further, the script file must include comments explaining your answer, and answering any written questions required by the tutorial questions. We will explain how to produce these script files during the tutorial period. We encourage you to work in groups during the tutorial period, but your report *must be solely your own work, and written in your own words*. Each report will be worth 1% of your total grade. **All tutorial reports must be submitted via**

Moodle and are due the next business day (that is: end of the day Friday for students in Thursday tutorials, end of the day Monday for students in Friday tutorials). You are not required to attend tutorials, but tutorial reports are mandatory. There will not be any extensions on tutorial reports. However, you can miss up to two tutorial reports for any reason without negatively affecting your grade (you are not required to notify the professor TA of your reasons for missing); your tutorial mark will be based on the average of the submitted reports.

Assignments

There will be three written assignments due throughout the class. These assignments will be written reports, and will include written answers, R code, and figures or graphics generated from that code. The assignments will be due **at 12 PM on Feb. 7th, Mar. 21th, and Apr. 19**, and should be submitted via Moodle as PDF files. Assignments will be posted three weeks prior to the due date. These assignments are designed to evaluate your ability to understand, explain, and interpret statistical ideas, and will be graded both on the clarity of your writing and the accuracy of your answers. Each assignment is worth 10% of your total mark. If you require an extension, you must contact the instructor *before the assignment due date* with the reason for the extension. Otherwise, the following grading penalties will be applied to late reports: -5% for assignments submitted past the deadline but on the due date, -10% for each day late after the deadline, to a maximum penalty of .

Exams

There will be a midterm worth 15% and a cumulative final exam worth 30%. However, if you achieve a higher mark on the final than on the midterm, your midterm will only count for 7.5%, and your final will count for 7.5% more. The midterm will take place during the regular class period on **February 16th**. You will have 1.25 hours to write the exam. The date for the final exam will be posted when the spring final exams schedule is released.

For each exam, you will be provided with a formula sheet, and you can bring in **1 double-sided page** of your own notes for reference. These notes can include diagrams, definitions, and concepts, but must be hand-written. These notes will be checked and signed by an invigilator to ensure they comply with these requirements.

If you miss the midterm for a valid reason, and inform the instructor in advance of the exam, the weight for the midterm will be transferred to the final exam.

Grade distribution

Item	Grade
Participation in pre- and post-course knowledge assessment	2%
Participation in class via active learning questions	2%
Tutorials (11, 1% each)	11%
Weekly quizzes (10, 1% each)	10%
Assignments (3, 10% each)	30%
Midterm	15%
Final exam	30%

Grading scheme:

A+: ≥ 90 , A: 85-89.9, A-: 80-84.9, B+: 77-79.9, B: 73-76.9, B-: 70-72.9, C+: 67-69.9, C: 63-66.9, C-: 60-62.9, D+: 57-59.9, D: 53-56.9, D: 50-52.9, F: <50

Course material

Lectures and course notes

Slides from lectures will be posted to the Moodle page, as will any detailed notes on important comments. Note that the posted lecture slides do not constitute complete notes for the class; you will need to keep your own notes during lectures.

If you cannot attend lectures in person on a given day, you will be able to join via Zoom. The class link is <https://concordia-ca.zoom.us/j/82828097944?pwd%3DM0hmVUVoUmI4by8yRzltRVNMeGthUT09> (meeting ID: 828 2809 7944, Passcode: 831159). However, you are still expected to participate using the Reef polling software and in class discussions if you are attending via Zoom. I will record lectures but these recordings will only be accessible via request with a valid reason for missing the lecture.

Textbook

The recommended textbook for this course is **The Analysis of Biological Data by Whitlock & Schluter**, 3rd edition, W.H. Freeman & Company. There is also data and resources for each chapter listed here: <https://whitlockschluter3e.zoology.ubc.ca>. The textbook is not required, but it is strongly recommended. You can purchase or rent the textbook through the University Bookstore.

To answer interactive questions during class, you will also need an active subscription to the IClicker REEF polling service. You can purchase this from the Concordia Bookstore.

You might also find these books to be useful additional references:

- **Learning Statistics with R version 0.6 by Danielle Navarro:** <https://learningstatisticswithr.com/>. It is written with undergraduate psychology students in mind, but the basic statistical ideas are the same, and Dr. Navarro's book is a clear and thoughtful introduction to modern statistical thinking. It is also an additional reference to help you learn how to use R for the class.
- **OpenIntro Statistics:** <https://www.openintro.org/book/os/>: A useful introduction to statistical thinking, including key ideas such as how to simulate data to understand methods, and the role of probability in statistics. It does not focus on biological examples, but the basic ideas are the same. Freely available as a pdf, or \$20 for a paperback copy.
- **The Art of Statistics: Learning from Data, by David Spiegelhalter:** This book is an excellent conceptual companion to this course. Dr. Spiegelhalter focuses on the key conceptual ideas you need to understand at the introductory level. He does not focus on the formulas, but instead on the major insights needed to grasp the concepts we talk about in class.

R statistical software

R is a programming language designed to facilitate statistical analyses. You are expected to use R for the tutorials and for the assignments, and I will be using R code to demonstrate statistical ideas during the lectures. You are not expected to have previous experience with R; we will teach you what you need to know to use the software for this class. However, you should have the software installed before the first tutorial on the second week of classes. I will post a detailed installation guide in the first week of classes. You can download R for your preferred operating system at this website: <https://mirror.rcg.sfu.ca/mirror/CRAN/>. I also strongly suggest you install Rstudio (<https://rstudio.com/products/rstudio/download/>) which is a free tool that makes it substantially easier to use R and to organize your work. I will be using Rstudio for demonstrating code during class.

If you do not have a computer that can install R (for instance, if you only have access to a tablet or a Chromebook) you can also run all of the R code for this class at this website: <https://rdrr.io/snippets/>. If

you do use this service, however, make sure to save your work frequently as text files; `rdr` does not save your work for you!

Schedule of lecture materials (order of topics is tentative and may change)

Date	Week	Topic	Associated chapter
Jan. 7	1	Class intro and what statistics is	
Jan. 12	2	Introduction to the R statistical language	
Jan. 14	2	Key ideas about data: data types, models, data statistics	Ch. 1
Jan. 19	3	Populations and samples, distributions, estimates from samples	Ch. 1
Jan. 19		<i>Deadline to withdraw with full tuition refund (DNE) from Winter courses</i>	
Jan. 21	3	Summarizing data: moments and quantiles	Ch.3
Jan. 26	4	Modelling relationships between variables: linear regression and correlation	Ch. 17, section 17.1
Jan. 28	4	Graphing data 1: visualizing data	Ch. 2
Feb. 2	5	Graphing data 2: principles of good visualization	Ch. 2
Feb. 4	5	Probability basics: events, simple, joint, and conditional probability, statistical independence	Ch. 5
Feb. 9	6	Probability part 2: distributions and moments	Ch. 5
Feb. 11	6	Experimental and observational design	Ch. 14: 14.1-14.4
Feb. 16	7	Midterm: all material to Feb. 11	
Feb. 18	7	Sampling distributions, and the binomial, normal, and Chi-squared distributions	Ch. 4
Feb. 23	8	Where does the Normal distribution come from? The central limit theorem	Ch. 10
Feb. 25	8	Hypothesis testing: test statistics, p-values, and Chi-squared tests	Ch. 6
Feb 28-Mar 4		Reading week: no classes	
Mar. 9	9	Hypothesis testing: Z-tests, type-I/type-II errors and one vs. two-tailed tests	Ch.6
Mar. 11	9	Confidence intervals part I: known variance	Ch. 4
Mar. 16	10	Confidence intervals part II: unknown variance and the t-distribution	Ch. 11
Mar. 18	10	Models for grouped data 1: differences between two groups	Ch. 12
Mar. 23	11	Linear regression as a model and the importance of assumptions	Ch. 17
Mar. 25	11	Testing models - goodness of fit	Ch. 13
Mar. 25		<i>Deadline for academic withdrawal (DISC) for winter courses</i>	
Apr. 1	12	How good are our predictions anyway?: Mean squared error, R^2 , and prediction intervals	
Mar. 30	12	Models for grouped data 2: differences between multiple groups and the ANOVA	Ch. 15
Apr. 6	13	Modeling non-normal data: estimating models with maximum likelihood	Ch. 20
Apr. 8	13	Bayesian methods and models, hierarchical models	
Apr. 13	14	Class review	

Schedule of tutorials and assignments:

Week	Tutorial topic	Material due
1	Review how to set up R, Rstudio: video demo only	Nothing due
2	1. Introduction to R	pre-class concept assessment (<i>Thurs. Jan. 20 at 11:59 PM</i>)
3	2. Sampling data and data distributions	Tutorial #1 (T1) report*
4	3. Summarizing data and regression	T2 report*
5	4. Graphing and visualizing data	T3 report*
6	5. Probability	T4 report*, assignment 1 (<i>Monday Feb. 7 at 12 PM</i>)
7	6. Experimental and sampling design	Quizzes 1 to 4 (<i>due before the midterm</i>), No report due for T5
8	7. Sampling distributions	T6 report*
9	8. Hypothesis testing and p-values	T7 report*
10	9. Confidence intervals	T8 report*,
11	10. Comparing groups and slopes	T9* assignment 2 (<i>Monday March 21 at 12 PM</i>)
12	11. Testing assumptions and model predictions	T10*,
13	12. ANOVA and maximum likelihood	T11*,
14	No tutorial	T12*, assignment 3 (<i>Tuesday, April 19 at 12 PM</i>), quizzes 5 to 10 , post-class concept assessment (<i>quizzes and post-class assessment due the day before the final exam at midnight</i>)

*Note that all tutorial reports are due 1 business day after your tutorial (Friday for Thursday tutorials, the following Monday for Friday tutorials) at 7 PM.

Behaviour

All individuals participating in courses are expected to be professional and constructive throughout the course, including in their communications.

Concordia students are subject to the [Code of Rights and Responsibilities](#) which applies both when students are physically and virtually engaged in any University activity, including classes, seminars, meetings, etc. Students engaged in University activities must respect this Code when engaging with any members of the Concordia community, including faculty, staff, and students, whether such interactions are verbal or in writing, face to face or online/virtual. Failing to comply with the Code may result in charges and sanctions, as outlined in the Code.

IP

Content belonging to instructors shared in online courses, including, but not limited to, online lectures, course notes, and video recordings of classes remain the intellectual property of the faculty member. It may not be distributed, published or broadcast, in whole or in part, without the express permission of the faculty member. Students are also forbidden to use their own means of recording any elements of an online class or lecture without express permission of the instructor. Any unauthorized sharing of course content may constitute a breach of the [Academic Code of Conduct](#) and/or the [Code of Rights and Responsibilities](#). As specified in the [Policy on Intellectual Property](#), the University does not claim any ownership of or interest in any student IP. All university members retain copyright over their work.

Ethical behaviour

Plagiarism:

The most common offense under the Academic Code of Conduct is plagiarism, which the Code defines as “the presentation of the work of another person as one’s own or without proper acknowledgement.” This includes material copied word for word from books, journals, Internet sites, professor’s course notes, etc. It refers to material that is paraphrased but closely resembles the original source. It also includes for example the work of a fellow student, an answer on a quiz, data for a lab report, a paper or assignment completed by another student. It might be a paper purchased from any source. Plagiarism does not refer to words alone –it can refer to copying images, graphs, tables and ideas. “Presentation” is not limited to written work. It includes oral presentations, computer assignments and artistic works. Finally, if you translate the work of another person into any other language and do not cite the source, this is also plagiarism.

In Simple Words: Do not copy, paraphrase or translate anything from anywhere without saying where you obtained it.

For some of your assignments, I will be using the software Ouriginal. It uses text matching technology as a method to uphold the University’s high academic integrity standards to detect any potential plagiarism. Ouriginal is integrated into Moodle. For the assignments set up to use Ouriginal, the software will review your paper when you upload it to Moodle. To learn more about Ouriginal’s privacy policy please review its [Privacy Policy](#).

Other student resources:

Accessibility statement

I will strive to make learning experience as accessible and inclusive as possible. If you have accessibility needs that require academic accommodations, please meet with an advisor from the Access Centre for Students with Disabilities (ACSD) as soon as possible to set up an accommodation plan. I welcome meeting with all students to discuss their [accessibility needs](#).

Statement on Digital Access and Equality

Digital devices (like laptops and cell phones) are becoming increasingly important to success in university. In this course, you will need digital devices to access readings, complete and submit written assignments and exams, and discuss with other students. I recognize that some students are unable to afford the cost of purchasing digital devices and that other students rely on older, more problem-prone devices that frequently break down or become unusable. I also recognize that those technology problems can be a significant source of stress for students. Given those challenges, I encourage students to be aware of the many technology-related resources that Concordia University provides, including:

- Free Office software and data storage (Active Concordia students have access to Office 365 Education - a collection of services that allows you to collaborate and share your schoolwork): <https://www.concordia.ca/it/services/office-365-education.html>
- Access to free support with issues related to Concordia technology (e.g., email, wifi, printing, device setup, etc.): <https://www.concordia.ca/it/support.html>
- Laptops that students can borrow from the Concordia Library: <https://library.concordia.ca/help/technology/laptops.php>

If you experience a technology-related problem that interferes with your work in this course that cannot be resolved through the above resources, please contact me. This will enable me to assist you in accessing

support. However, please note that you are expected to save backed up versions of your work (Dropbox, OneDrive, or Google Drive work very well and if you need help in learning how to use these, come to my office hours). Thus, requests for accommodation on late or missed assignments due to a crashing computer (or similar) will not be considered. Additional Campus Resources

The resources listed below (and many others) are in place to help you succeed at Concordia. Everyone faces challenges at some point, and often a new environment or difficult and stressful situations (i.e., university) mean we may need additional help. I encourage you to look into the various resources available at Concordia. If you need assistance and cannot find the appropriate resources, please reach out to me, your academic advisor, or another trusted campus advisor.

Resources for health, wellbeing, and student success

- Student Resources (overview): <http://stc.concordia.ca/>
- New Student Program: <http://newstudent.concordia.ca/>
- Health Services: <https://www.concordia.ca/students/health.html>
- Counselling and Psychological Services: <http://cdev.concordia.ca/>
- Sexual Assault Resource Center: <https://www.concordia.ca/students/sexual-assault.html>
- Indigenous Student Resources: <https://www.concordia.ca/about/indigenous/resources.html>
- International Student Resources: <https://www.concordia.ca/students/international.html>
- Financial Aid and Awards: <http://faao.concordia.ca/main/>

Resources related to academic success and integrity

- Academic Integrity Website: <http://www.concordia.ca/students/academic-integrity.html>
- Student Advocacy Office: <https://www.concordia.ca/offices/advocacy.html>
- Student Success Centre: <http://www.concordia.ca/students/success.html>
- Student Writing Centre: <http://www.concordia.ca/students/success/learning-support/writing-assistance.html>
- Library and Citation Style Guides: <http://library.concordia.ca/help/howto/citations.html>

Basic Needs

Any student who faces challenges securing their food or housing and believes this may affect their performance in the course is urged to contact the Dean of Students Office or Concordia Student Union for support, and/or access the following resources (which include free and reduced meals available daily on both the downtown and Loyola campus):

- Affordable Food Resources at Concordia and in Montreal: <https://www.concordia.ca/students/health/topics/nutrition/affordable-food-resourcesinmontreal.html>
- Concordia Off-Campus Housing and Job Support: <https://www.concordia.ca/students/international/sessions-workshops/housing-support.html>
- Concordia Housing and Job Bank (HOJO): <https://www.csu.qc.ca/services/housing-and-job-bank-hojo/>