General Course Information

Course: **BIOL343**
Course title: **Advanced Data Analysis for Biologists**
Prerequisite: BIOL 243/3.0
Semester and year: Fall terms 2023/24
Number of credits: 3
Learning hours: 120 (36 Lecture, 20 Tutorial, 64 Private study)
Modality: On campus, in-person

Course description

Advanced topics in using R for data management, exploratory data analysis, data visualization, and statistical analysis using the general linear model, with particular focus on statistical literacy and biological examples from both laboratory and field research.

The main topics to be covered in this course are data management & visualization and the practical application of general linear models to biological data using R statistical software environment. This course builds on the foundation provided in BIOL243 (and equivalent courses) to give students considerable practical experience in data analysis and presentation. Students who are successful in BIOL343 should be well prepared for the sorts of data analysis required in field courses, honours theses and graduate research.

Proposed lecture and tutorial topics
week 1   Intro to statistical thinking, R and data management (using dplyr)
week 2   Intro to data visualization (using ggplot and R Notebooks)
week 3   Statistical inference: the population, the sample & the sampling distribution
week 4   Comparing samples and intro to linear models
week 5   Regression and diagnosing assumptions
week 6   Multiple regression and model selection
week 7   Polynomial regression, likelihood and information theory
week 8   Simple and factorial analysis of variance
week 9   Making up data to design better experiments
week 10   Analysis of covariance and model II regression
week 11   Logistic regression and generalized linear models
week 12   Mixed-effects linear models

Course learning outcomes

Biol343 teaches students how to collect, manage, visualize, analyze and interpret biological data using R software, with particular emphasis on the super-useful linear model. Most of the lectures and assignments deal with the practical application of data analyses rather than the underlying mathematical theory. As part of this "toolbox" approach, we emphasize in-person, active learning in lecture, tutorials and through weekly assignments. In lectures, you actively write R code for data wrangling, visualization and analysis, while making lots of mistakes and learning how to diagnose and correct them. In tutorials, you will work with a team of expert TAs and the professor to tackle assignments that challenge biological hypotheses with real data, and you will learn how to create effective data visualizations and interpret and talk about analytical results.
By the end of this course, you will be able to
- Manage, wrangle and apply quality-control to large datasets

- Produce beautiful graphical displays of data that illuminate biological hypotheses
- Distinguish the population, the sample and the sampling distribution and know why this is important
- Identify when data violate the assumptions of statistical analyses and know how to remedy this
- Write R code that is clear, concise and produces reproducible analyses of data
- Interpret graphical and statistical analyses in relation to predictions from biological hypotheses
- Exploit the broad scope and flexibility of the linear model for analyzing biological data
- Evaluate competing statistical models that seek to explain variation in nature
- Amaze friends and relatives with your in-depth knowledge of the tidyverse
- Independently solve analytical problems and know where to go to find useful strategies to tackle thorny problems

Learning hours

Teaching method		Average hours per week	Number of weeks	Total hours
In-class hours	Lecture	3	12	36
	Seminar			
	Laboratory			
	Tutorial	2	10	20
	Practicum			
	Group learning			
	Individual instruction			
Other	Online activity			
	Off-campus activity			
	Private study	8.3	12	64
Total hours on task				120

Important university dates

Please visit the [Faculty of Arts and Sciences Sessional Dates website](#) for all academic deadlines.

Inclusion

Land acknowledgement

We acknowledge that Queen's University occupies traditional Anishinaabe and Haudenosaunee territory. To acknowledge this traditional territory is to recognize its longer history, one predating the establishment of the earliest European colonies. It is also to acknowledge this territory's significance for the Indigenous Peoples who lived, and continue to live, upon it and whose practices and spiritualties are tied to the land and continue to develop in relationship to the territory and its other inhabitants today. Indigenous communities in Kingston/Katarokwi continue to reflect the area's Anishinaabe and Haudenosaunee roots. There is also a significant Métis community and First Peoples from other Nations across Turtle Island present here today.

Equity, diversity & inclusivity statement

Queen's University recognizes that the values of equity and diversity are vital to and in harmony with its educational mission and standards of excellence. It acknowledges that direct, indirect, and systemic discrimination exists within our institutional structures, policies, and practices and in our community. These take many forms and work to differentially advantage and disadvantage persons across social identities such

as race, ethnicity, disability, gender identity, sexual orientation and socioeconomic status. In this class we will work to promote an anti-discriminatory, anti-racist and accountable environment where everyone feels welcome. Every member of this class is asked to show respect for every other member.

Building a classroom community

University is a place to share, question, and challenge ideas. Each student brings a different set of lived experiences. You can help to create a safer, more respectful classroom community for learners by following these guidelines:
- Make a personal commitment to learn about, understand, and support your peers.
- Assume the best of others and expect the best of them.
- Recognize and value the experiences, abilities, and knowledge each person brings to the course.
- Acknowledge the impact of oppression on other people's lives and make sure your words and tone are respectful and inclusive.
- Encourage others to develop and share their ideas.
- Pay close attention to what your peers say/write before you respond. Think through and re-read what you have written before you post online or send your comments to others.
- Be open to having your ideas challenged and challenge others with the intent of facilitating growth.
- Look for opportunities to agree with one another, building on and intentionally referencing peers' thoughts and ideas; disagree with ideas without making personal attacks, demeaning, or embarrassing others.

Fostering accessibility

All of us have a shared responsibility for fostering accessibility and promoting meaningful inclusion of those with disabilities. The [Accessibility Hub](#) at Queen's University's Human Rights & Equity Office offer a host of [tutorials](#) that provide us all with practical tips for:
- creating accessible documents, e.g., to submit to your teaching team or share with peers in peer feedback activities/in a presentation,
- emails, e.g., while communicating with group members or your teaching team, and
- meeting practices (e.g., in tutorials/labs/seminars or virtual meetings.

Name/pronoun

If, for whatever reason, you wish to change how your name appears in onQ and/or on class lists, please follow these steps. You may also use this process to add your pronouns to the appearance of your name.

1. Log into SOLUS.
2. Click on Personal Information tab.
3. Click on the Names tab
4. Click on the Add New Name tab
5. Choose Preferred from the Name Type drop down menu
6. Enter the name you would like to appear in onQ and/or on class lists.
7. Click Save.

Please allow 24 to 48 hours for your name to be registered within the system. If you have further questions or concerns, please contact ITS at Queen's University.

Course Materials & Technologies

Required course textbook

Motulsky H 2016 Essential Biostatistics. A Nonmathematical Approach. Oxford University Press

Readings combined with lectures will cover all statistical fundamentals, including frequency distributions, skewness, measures of central tendency, nominal, ordinal, interval measurements, summary measures of variation, probability theory, normal distribution, sampling theory, confidence intervals, tests of significance (null hypothesis, t-test, one-tail vs. two-tail tests), analyses of proportions and categories, analyses for group means, correlation, regression and linear models. There will be two midterm exams (worth 14% each) to evaluate understanding of these essential statistical concepts.

Educational technologies, help, privacy, and accessibility

This course makes use of the following programs, R and R Studio for specific educational use/purposes.

Privacy: Be aware that your independent use of the R and R Studio used in this course*, beyond what is required,* is subject to their terms of use and privacy policy. You are encouraged to review the applicable privacy statements.

Accessibility: Queen's University is committed to developing courses that are accessible. For further information on accessibility compliance of R Studio please consult this link: https://support.posit.co/hc/en-us/articles/360044226673-RStudio-Accessibility-Features

Notice of recording

The teaching team will not record lectures or tutorials in this course.

Copyright of course material

Course materials created by the course instructor, including all slides, presentations, handouts, tests, exams, and other similar course materials, are the intellectual property of the instructor. It is a departure from academic integrity to distribute, publicly post, sell or otherwise disseminate an instructor's course materials or to provide an instructor's course materials to anyone else for distribution, posting, sale or other means of dissemination, without the instructor's express consent. A student who engages in such conduct may be subject to penalty for a departure from academic integrity and may also face adverse legal consequences for infringement of intellectual property rights.

Communication

Questions about the course and contacting the teaching team

Question scan be asked of the professor after any lecture or during tutorials and office hours. Questions can also be posted on the OnQ discussion forum for this course. The teaching team can be contacted via email: biol343@queensu.ca

Queen's email

The university communicates with students via Queen's email. Please check your email regularly to ensure you do not miss important information related to your course.

Course feedback

At various points during the course, you may be asked to take part in a variety of feedback activities, such as surveys and questionnaires. This feedback enables the teaching team to improve the course. All surveys are anonymous and are directly related to activities, assessments, and other course material.

Assessments

Component	Weight (%)	Date
Weekly assignments (9 x 8%)	72	About weekly
Two in-class midterm exams (2 x 14%)	28	The Friday lecture period in weeks 4 and 8

Assessment flexibility & assignment submission policy

Assignments: Falling behind on the assignments will greatly compromise student success and the learning objectives of this course. Because assignments are rapidly graded and handed back to students within two days of the due date, there is no scope to have late assignments evaluated. So, assignments must be handed in on-time and late reports will not be accepted. For those students with a valid academic consideration (see below), the marks for a missed assignment will be distributed among the marks for the other assignments. We emphasize, however, that each assignment builds upon the previous assignment, so students are strongly advised to complete missed assignments before tackling the next assignment.

Midterm exams: There will be two midterm exams held during the Friday lecture period in weeks 4 and 8. Each will consist of about 15 short-answer questions and is worth 14% of your final grade. If you require academic an academic accommodation for these exams please read carefully the section on Accommodations below and make sure you are registered with QSAS and the Ventus system. If you miss a midterm exam with a valid academic consideration (see below), then you will write a make-up exam that will be held 630–730pm on the Monday after the midterm was scheduled.

Proctored exams

There is no final exam in this course.

Policy for review of graded work

Requests for assignment regrading may be made to biol343@queensu.ca 48 hours after you have received the marked copy of your assignment, but no more than 10 days later. Be sure to read your assessment feedback carefully before you submit a review of graded work. To request that your assignment be reviewed, please include the following in your email:
- Your name, student number, and TA's name.
- The original copy of your marked assignment, attached.
- Your reason for the request:
  - The specific aspects of your assignment that you believe were not sufficiently awarded, referring to the categories of the rubric.
  - Why you believe that your assignment meets the criteria for a higher mark for each of the categories of the rubric that you indicated above. Please make explicit reference to the detailed descriptions of each category provided in the rubric.

Should we find an error where marks were not assigned when they should have been or were missed in adding up the total score or were added up incorrectly resulting in a higher score than earned, the grade will

be changed so that it is accurate. Grades would only increase or decrease if there was evidence of an error in marking, not simply because the regrader interprets or applies the rubric slightly differently than the original grader.

Final grade calculation

Assignments and exams will be given numeric grades, and the total mark for the course will be converted to letter grades following the Queen's University Faculty of Arts and Science Grade Conversion Scale.

Polices

Class attendance

Your presence and participation in class contributes to the knowledge and skills that you will develop throughout this course. I expect that you attend class regularly, participate in class conversations and learning activities. These types of activities provide active engagement, promote a deeper understanding of the course content, and contribute to your success in this course.

Academic support

All undergraduate students face new learning and writing challenges as they progress through university: essays and reports become more complex; effectively incorporating research into writing becomes more important; the types of assignments become more diverse; managing your time and developing the skills you need to read and think critically gets more challenging. I encourage students to contact Student Academic Success Services (SASS). SASS offers many different ways to receive support:
- Free online or in-person appointments to get personalized support on writing and academic skills from expert staff and trained peers.
- Workshops and drop-in programs. SASS' Events Calendar lists events coming soon.
- Online resources that provide strategies for academic skills and writing development at university.

If English is not your first language, SASS has specific resources for English as Additional Language students, including weekly programs and EAL academic skills appointments. You can meet on an ongoing basis with an EAL consultant to work on your academic writing, speaking, listening, and reading skills.

Accommodations for disabilities

Queen's University is committed to working with students with disabilities to remove barriers to their academic goals. Queen's Student Accessibility Services (QSAS), students with disabilities, instructors, and faculty staff work together to provide and implement academic accommodations designed to allow students with disabilities equitable access to all course material (including in-class as well as exams). If you are a student currently experiencing barriers to your academics due to disability related reasons, and you would like to understand whether academic accommodations could support the removal of those barriers, please visit the QSAS website to learn more about academic accommodations or start the registration process with QSAS by clicking *Access Ventus* button at **Ventus | Accessibility Services | Queen's (queensu.ca)**

VENTUS is an online portal that connects students, instructors, Queen's Student Accessibility Services, the Exam's Office and other support services in the process to request, assess, and implement academic accommodations.
To learn more go to: https://www.queensu.ca/ventus-support/students/visual-guide-ventus-students

This course follows the principles of universal design. Because each of the nine assignments in this course takes about 4-6 hours to complete and we are giving students 6 days to complete each assignment,

everyone has more than enough time to complete each assignment, and there are no time-based accommodations for the assignments.

However, the two midterm exams will occur during 50-minute lecture slots and are time-limited. So, the Exams Office will make arrangements for students with QSAS-registered accommodations. To be accommodated for the midterms you must be registered with the Ventus system.

Academic consideration for students in extenuating circumstances

Academic Consideration is a process for the University community to provide a compassionate response to assist students experiencing unforeseen, short-term extenuating circumstances that may impact or impede a student's ability to complete their academics. This may include but is not limited to,

- Short term physical or mental illness or injury (e.g. stomach flu, anxiety/depression, mononucleosis, concussion, broken bones, surgery, medical treatments)
- Traumatic event/confidential (e.g. bereavement, serious injury, illness or required treatment for a significant other/family member or a traumatic event such as divorce, sexual assault, social injustice)
- Requirements by law or public health authorities (e.g. court dates, jury duty, requirements to isolate after exposure to a cantagion)
- Significant event (e.g. varsity athletic event, distinguished event, serving in the reserve forces, Queen's U field course)
- A religious observance

Queen's University is committed to providing academic consideration to students experiencing extenuating circumstances. For more information, please see the Senate Policy on Academic Consideration for Students in Extenuating Circumstances.

Each Faculty has developed a protocol to provide a consistent and equitable approach in dealing with requests for academic consideration for students facing extenuating circumstances. For more information, undergraduate students in the Faculty of Arts and Sciences should consult the Faculty's webpage on Academic Consideration in Extenuating Circumstances and submit a request via the Academic Consideration Request Portal. Students in other Faculties and Schools who are enrolled in this course should refer to the protocol for their home Faculty.

Students are encouraged to submit requests as soon as the need becomes apparent and to contact biol343@queensu.ca as soon as possible once academic consideration has been granted. Any delay in contact may limit the options available for academic consideration.

For more information on the Academic Consideration process, what is and is not an extenuating circumstance, and to submit an Academic Consideration request, please see the Faculty of Arts and Science's Academic Consideration website. ASO courses include links to information on Academic Consideration on your Course Homepage in onQ.

As explained above, the marks for a missed assignment will be distributed among the remaining assignments (e.g. if you miss one assignment the remaining assignments are now worth 9% each).

If you miss a midterm exam with a valid academic consideration, then you will write a make-up exam that will be held 630–730pm on the Monday after the midterm was scheduled.

Note about travel: We cannot provide academic consideration for personal travel. Please check the dates in the course schedule and avoid making any travel (or other) plans that will prevent you from participating in any activities or completing any assessments.

Queen's policy statement on academic integrity

Queen's University is dedicated to creating a scholarly community free to explore a range of ideas, to build and advance knowledge, and to share the ideas and knowledge that emerge from a range of intellectual pursuits. Queen's students, faculty, administrators and staff therefore all have responsibilities for supporting and upholding the fundamental values of academic integrity. Academic integrity is constituted by the five core fundamental values of honesty, trust, fairness, respect and responsibility and by the quality of courage. These values and qualities are central to the building, nurturing and sustaining of an academic community in which all members of the community will thrive. Adherence to the values expressed through academic integrity forms a foundation for the "freedom of inquiry and exchange of ideas" essential to the intellectual life of the University.

The following statements from "The Fundamental Values of Academic Integrity" (2nd edition), developed by the International Center for Academic Integrity (ICAI), contextualize these values and qualities:
* Honesty: Academic communities of integrity advance the quest for truth and knowledge through intellectual and personal honesty in learning, teaching, research, and service.
* Trust: Academic communities of integrity both foster and rely upon climates of mutual trust. Climates of trust encourage and support the free exchange of ideas which in turn allows scholarly inquiry to reach its fullest potential.
* Fairness: Academic communities of integrity establish clear and transparent expectations, standards, and practices to support fairness in the interactions of students, faculty, and administrators.
* Respect: Academic communities of integrity value the interactive, cooperative, participatory nature of learning. They honour, value, and consider diverse opinions and ideas.
* Responsibility: Academic communities of integrity rest upon foundations of personal accountability coupled with the willingness of individuals and groups to lead by example, uphold mutually agreed-upon standards, and take action when they encounter wrongdoing.
* Courage: To develop and sustain communities of integrity, it takes more than simply believing in the fundamental values. Translating the values from talking points into action -- standing up for them in the face of pressure and adversity — requires determination, commitment, and courage.

Students are responsible for familiarizing themselves with and adhering to the Senate **regulations** concerning academic integrity, along with **Faculty or School** specific information. Departures from academic integrity include, but are not limited to, plagiarism, use of unauthorized materials, facilitation, forgery and falsification. Actions which contravene the regulation on academic integrity carry sanctions that can range from a warning, to loss of grades on an assignment, to failure of a course, to requirement to withdraw from the university.

The use of generative artificial intelligence

Using generative AI writing tools such as ChatGPT in your submitted work is not permitted in this class. This type of use constitutes a Departure from Academic Integrity.

Queen's Student Academic Success Services (SASS) offers a self-directed, online academic integrity module which we encourage all students to take which will help with:
* Understanding the nature of the academic integrity departure
* Understanding the expectations of and role of sources in scholarly writing

- Integrating sources into your writing (paraphrasing, quoting, summarizing)
- Understanding when and how to cite your sources
- Managing your time effectively to avoid the need for shortcuts
- Taking effective notes to ensure accuracy of source material and correct attribution