

The University of Western Ontario
Department of Biology
BIOLOGY 4259F
Research Hypothesis Testing
Fall 2024

Course Information

Lecture: 2 hours

Lab: 3 hours

Instructor

Dr. Ben Rubin

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Pre-requisites

Biology 2244A/B or Statistical Sciences 2244A/B; and completion of at least 1.5 Biology courses at the 3000-level or above.

Required Materials

Laptop: Bring your own to lectures and labs.

Software (free):

- R version 4.4.1 (June 2024) (<https://cran.r-project.org/>)
- RStudio Desktop v2022.07.01 (<https://posit.co/download/rstudio-desktop/>)

*If you have an earlier version of R and RStudio on your laptop, I recommend that you uninstall R, RStudio, and all libraries, and then install the most recent versions. You may also use R Studio Cloud, which is hosted online.

Books:

- Hector, A. 2021. The New Statistics with R: An Introduction for Biologists. 2nd edition. Oxford University Press, Oxford, UK. Electronic access via the library.
- Beckerman, A.P., D.Z. Childs, O.L. Petchey. 2017. Getting Started with R: An Introduction for Biologists. 2nd edition. Oxford University Press, Oxford, UK. Electronic access via the library.

Description

This course aims to help you become an informed user and consumer of statistics. Statistical methods allow us to answer questions and learn about the world around us from data. As a biologist, you might apply analysis of variance to learn about the effects of different diseases on plant growth, linear regression to explore the impacts of climate change on species diversity, or logistic regression to understand the factors affecting an animal's presence in the landscape.

In introductory courses, you may have been taught these methods as if they were recipes to follow. My goal is to help you understand these techniques, and more complex procedures, more deeply so that you can choose an appropriate analysis for your study and report your results clearly. Our discussions will focus on understanding the assumptions underlying the methods we study and developing good practices of statistics that you can take forward to new problems.

Learning Outcomes

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

1. Explain the assumptions of the methods studied in class.
2. Decide whether a specified method is appropriate to analyze data from a given study.
3. Implement the methods studied in class in R and interpret the results.
4. Report the results of your analysis in language appropriate for a publication in biology.

Assessment

Your course grade will be calculated based on the following elements:

Lecture attendance (20 of 23 required for full marks)	5%
Reading reports (12 of 14 required for full marks)	5%
Writing assignments (top 3 of 4) ¹	30%
Summary and critique of statistical analysis and reporting in a scientific paper ¹²	20%
Data analysis assignments (top 9 of 11)	40%

¹ This course is designated as an “essay course”; therefore, to satisfy the Senate requirement, students must demonstrate “some minimal competence in essay writing” by submitting written work totalling at least 2,500 words. Three of four writing assignments and the Summary and critique of statistical analysis and reporting in a scientific paper meet the 2,500-word requirement, but less writing does not. Therefore, these assessments are essential to the learning objectives and must be completed to pass the course.

² This assignment is designated by the instructor as exempt from requests for academic accommodation without documentation (see General information about missed coursework, below).

Brief description of each element:

Reading report – for each reading assignment you will be asked to state the three to five main points and to rate your own understanding of each point on a scale from 1 to 10. These are due Monday mornings at 8:30 AM. Grading scheme: full credit if submitted, no credit if not submitted

Writing assignments – essays of 500 to 600 words that evaluate the important principles of how statistical inference is conducted and reported. Due dates are on tentative schedule at the end of this course outline.

Summary and critique of statistical analysis and reporting in a scientific paper – essay of 1,000 to 1,200 words that describes and critiques the use of statistical analysis as described in a biological research article of your choosing. The due date will be shortly after we cover the relevant technique in class. There will be a sign-up process near the beginning of the term so that all students have some choice of topic and due date.

Data analysis assignments – The assignments are to be completed using R Studio to apply the techniques of lecture and lab. Due dates are on tentative schedule at the end of this course outline.

Seminar leading – During each seminar meeting, we will discuss a paper about the use of statistical analysis in biology. One or two students will be assigned to lead each discussion. There will be a sign-up process near the beginning of the term so that all students have some choice of topic and due date.

General information about missed coursework

Students must familiarize themselves with the *University Policy on Academic Consideration – Undergraduate Students in First Entry Programs* posted on the Academic Calendar: https://www.uwo.ca/univsec/pdf/academic_policies/appeals/academic_consideration_Sep24.pdf,

This policy does not apply to requests for Academic Consideration submitted for **attempted or completed work**, whether online or in person.

The policy also does not apply to students experiencing longer-term impacts on their academic responsibilities. These students should consult [Accessible Education](#).

For procedures on how to submit Academic Consideration requests, please see the information posted on the Office of the Registrar's webpage:

https://registrar.uwo.ca/academics/academic_considerations/

All requests for Academic Consideration must be made within 48 hours after the assessment date or submission deadline.

All Academic Consideration requests must include supporting documentation; however, recognizing that formal documentation may not be available in some extenuating circumstances, the policy allows students to make one Academic Consideration request **without supporting documentation** in this course. However, the Summary and critique of statistical analysis and reporting in a scientific paper is designated by the instructor as excluded from this policy and all other course elements will be handled through flexible completion requirements rather than through academic accommodation. If you are experiencing longer-term impacts on your academic responsibilities which cause you to miss more than the allowed number of assessments, please consult [Accessible Education](#).

Evaluation Scheme for Missed Assessments

If the **Summary and critique of statistical analysis and reporting in a scientific paper** is missed, you must submit an Academic Consideration request with supporting documentation within 48 hours of the due date. If the request is granted, accommodation will be an extension of up to one week.

If **any other assessments** are missed assessments all requests for Academic Consideration will be denied. Denials may be appealed to your Faculty's Dean's Office:

https://uwo.ca/univsec/pdf/academic_policies/appeals/appealsundergrad.pdf Accommodation of longer-term impacts is available through [Accessible Education](#). If accommodation is granted based on appeal or by Accessible Education, it will be by re-weighting a portion of the grade to the summary and critique of statistical analysis and reporting in a scientific paper.

Religious Accommodation

When conflicts with a religious holiday that requires an absence from the University or prohibits certain activities, students should request an accommodation for their absence in writing to the course instructor and/or the Academic Advising office of their Faculty of Registration. This notice should be made as early as possible but not later than two weeks prior to the writing or the examination (or one week prior to the writing of the test).

Please visit the Diversity Calendars posted on our university's EDID website for the recognized religious holidays:

<https://www.edi.uwo.ca>.

Accommodation Policies

Students with disabilities are encouraged to contact Accessible Education, which provides recommendations for accommodation based on medical documentation or psychological and cognitive testing. The policy on Academic Accommodation for Students with Disabilities can be found at:

https://www.uwo.ca/univsec/pdf/academic_policies/appeals/Academic_Accommodation_disabilities.pdf.

Academic Policies

The website for Registrar Services is <https://www.registrar.uwo.ca/>.

In accordance with policy,

https://www.uwo.ca/univsec/pdf/policies_procedures/section1/mapp113.pdf,

the centrally administered e-mail account provided to students will be considered the individual's official university e-mail address. It is the responsibility of the account holder to ensure that e-mail received from the University at their official university address is attended to in a timely manner.

Scholastic offences are taken seriously and students are directed to read the appropriate policy, specifically, the definition of what constitutes a Scholastic Offence, at the following Web site:

https://www.uwo.ca/univsec/pdf/academic_policies/appeals/scholastic_discipline_undergrad.pdf.

All required papers may be subject to submission for textual similarity review to the commercial plagiarism detection software under license to the University for the detection of plagiarism. All papers submitted for such checking will be included as source documents in the reference database for the purpose of detecting plagiarism of papers subsequently submitted to the system. Use of the service is subject to the licensing agreement, currently between The University of Western Ontario and Turnitin.com (<http://www.turnitin.com>).

Support Services

Please visit the Science & Basic Medical Sciences Academic Advising webpage for information on adding/dropping courses, academic considerations for absences, appeals, exam conflicts, and many other academic-related matters: <https://www.uwo.ca/sci/counselling/>.

Students who are in emotional/mental distress should refer to Mental Health@Western (<https://uwo.ca/health/>) for a complete list of options about how to obtain help.

Western is committed to reducing incidents of gender-based and sexual violence and providing compassionate support to anyone who has gone through these traumatic events. If you have experienced sexual or gender-based violence (either recently or in the past), you will find information about support services for survivors, including emergency contacts at

https://www.uwo.ca/health/student_support/survivor_support/get-help.html.

To connect with a case manager or set up an appointment, please contact support@uwo.ca.

Please contact the course instructor if you require lecture or printed material in an alternate format or if any other arrangements can make this course more accessible to you. You may also wish to contact Accessible Education at

http://academicsupport.uwo.ca/accessible_education/index.html

if you have any questions regarding accommodations.

Learning-skills counsellors at Learning Development and Success (<https://learning.uwo.ca>) are ready to help you improve your learning skills. They offer presentations on strategies for improving time management, multiple-choice exam preparation/writing, textbook reading, and more. Individual support is offered throughout the Fall/Winter terms in the drop-in Learning Help Centre, and year-round through individual counselling.

Additional student-run support services are offered by the USC, <https://westernusc.ca/services/>.

Tentative Course Schedule: Lecture and lab

Week	Lecture topic	Lecture readings	Lab topic	Lab readings	Assignments due
Sept 9, 11	Introduction; Statistical estimation	None	Intro to R, R Studio, R Markdown	Beckerman: Chs. 1, 2	None
Sept 16, 18	Statistical models	Hector: Chs. 5, 6	Data management	Beckerman: Ch.3	Analysis #1
Sept 23, 25	Regression	Hector: Chs. 7, 8	Graphing	Beckerman: Ch. 4	Writing #1: Sept 24 Analysis #2
Oct 2	M: no class W: Model inference	Hector: Chs. 9, 10	Regression	None	Analysis #3
Oct 7, 9	ANOVA	Hector: Chs. 11, 12	ANOVA	None	Analysis #4
Reading week					
Oct 21, 23	ANCOVA	Hector: Ch. 13	ANCOVA	None	Analysis #5
Oct 28, 30	Model selection & linear model complexities	Hector: Ch. 14	Multiple regression and model comparison	None	Writing #2: Oct 29 Analysis #6
Nov 4, 6	GLM for binary data	Hector: Chs. 15, 18	GLM for binary data	None	Analysis #7
Nov 11, 13	GLM for count data	Hector: Ch. 16	GLM for count data	None	Analysis #8
Nov 18, 20	GLM for binomial data	Hector: Ch. 16	GLM for binomial data	None	Analysis #9
Nov 25, 27	GAM	TBA	GAM	None	Writing #3: Nov 26 Analysis #10
Dec 2, 4	GLMM	TBA	GLMM	None	Writing #4 & Analysis #11