School of Biological Sciences

UNIVERSITY OF CANTERBURY
Te Whare Wānanga o Waitaha
CHRISTCHURCH NEW ZEALAND

Ngā Whakamārama | Course Outline 2023

BIOL309
Experimental Design & Data Analysis for Biologists

0.125 EFTS 15 Points
Semester 2

Whakamahuki | Course Description:
This course provides a detailed understanding of how the interpretation and analysis of data depends on the way the data were collected. It covers various aspects of experimental design, a variety of statistical methods to analyse data, basic programming in R, and places a heavy emphasis on interpreting the results of analysis. It is intended for anyone who would like to know more about designing robust research, analysing datasets of various kinds, or who wishes to better identify the misleading use of statistics in the media or in research. The experimental design component is particularly suited for anyone who plans to do postgraduate research in any theme of biological sciences, or who would like to pursue a career in any field where it is useful to identify patterns in data.

Kairuruku Akoranga | Course Coordinator:
Helen Warburton, Julius von Haast room 315, Ph:03 369 5212,
helen.warburton@canterbury.ac.nz
Contact me (easiest by email) with any issues about the course generally. I will typically reply within 48 hours on weekdays. If you haven't heard back by then, then please feel free to hassle me again.

Pūkenga | Teachers
Professor Ian Dickie, Julius von Haast 320, ian.dickie@canterbury.ac.nz

Aromatawai | Assessment

Lab sign out	10% (1% for 10 labs)
Lab quizzes	5 × 6% = 30%
Mid-semester test	20%
Final exam	40%

The mid-semester test will run for one hour.
At the end of each lab, you will get signed out which will gain you 1% (total 10% for the course, lowest value dropped). If you miss a lab due to illness, bring your completed lab notes to the next lab session.
The lab assessments will be based on the lab material (primarily focusing on the material since the previous assessment). They can be done either at the end of the lab or in your own time, but they must be completed by midnight on the Friday of that week. They will be conducted in Learn, and occur every 2-3 weeks. Note that you

must get a minimum of 40% weighted average in the lab sign out + quizzes AND a minimum of 40% weighted average on the test + exam to pass the course.

Tuhinga | Texts and Readings:

This course will not directly follow any text book, and the lab manual has detailed explanations for much of the material. However, if you'd like a book to help with your study or for reference:

Crawley, M.J. (2015) Statistics: An Introduction using R. (2nd Ed.) Wiley & Sons, Chichester.

is available from the University Bookshop and UC library, is user-friendly and gives a good overview of the material covered in the course. You should be aware, however, that no book is good at explaining everything that might be helpful to a statistically-minded biologist; additional references may be recommended and put on restricted loan in the library or on Learn.

Other potential references

Quinn, G. P. & Keough, M. J. (2002). Experimental Design and Data Analysis for Biologists. Cambridge University Press, Cambridge.

Additional resources will be made available during the course on Learn.

Prerequisites

Successful completion of BIOL209 is a pre-requisite for BIOL309, as the concepts covered here lead on directly from those developed in the previous semester. BIOL309 is essential for all students who intend to pursue postgraduate studies or go on to a career in any branch of biological research.

Goal of the Course

The aim of BIOL309 is to build on the concepts developed in BIOL209 to provide training in the use of advanced statistical techniques and in the design and analysis of biological experiments. The biological focus applies both to the choice of relevant methods and the specific examples discussed. The examples will cover a wide range of biology, from biochemistry to ecology, although you should not expect every topic to be illustrated with an example from your specific area of interest in biology. Note that one goal of the course is to prepare students for postgraduate research programmes and jobs in research organisations, and this affects the choice of course content and style.

The course covers data analysis, and emphasises how familiar tests such as analysis of variance and linear regression can be extended to provide a flexible suite of techniques, which can be applied to a variety of situations. This knowledge will be applied to the design of experiments, covering concepts such as replication, power and repeated measures. An experiment can be designed properly only on the basis of knowledge of the statistical test that will eventually be required. This emphasis on the need to consider data analysis as an integral part of the experimental design process means that topics will build on one another in sequence. You need to understand each topic in order to understand the next, and if you fall behind in understanding, some systematic catching up will be necessary. If you have problems with concepts, please ask for clarification from the lecturer involved or the lab demonstrators as soon as possible. Don't let your problems compound by falling even further behind in the course.

Hua Akoranga | Intended Learning Outcomes and Aromatawai | Associated Assessment

As a student in the course, I will develop the ability to:

1. Identify potential analysis approaches, and apply a wide range of statistical tests (including linear models, non-parametric tests, and generalised linear models) to answer scientific questions (*assessment tasks: Lab assessments, Mid-semester test, Final exam*). (Graduate attribute: Employability, innovation and enterprise)
2. View statistical methods as an inter-related set of tools that can be applied to different situations, and to be able to defend your choice of analysis for a given problem.
3. Design robust experiments and research using observational data, and interpret the results of analysis in light of experimental design (*assessment tasks: Lab assessments, Mid-semester test, Final exam*). (Graduate attribute: Employability, innovation and enterprise);
4. Carry out analyses and basic programming in the R statistical package (*assessment task: Lab assessments*). (Graduate attribute: Employability, innovation and enterprise)
5. Interpret data with an understanding of how certain we can be about what we know, and how hidden variables may cloud our judgement or give a false impression of causation (*assessment tasks: Lab assessments, Mid-semester test, Final exam*). (Graduate attribute: Employability, innovation and enterprise).

Pūkenga Ngaio | Transferable Skills

As a student in this course, I will develop the following skills*:*

- The ability to phrase statistically rigorous, biologically interesting hypotheses.
- The ability to identify the best experimental design to test specific questions.
- Proficiency with a diverse array of statistical tests and data manipulations in the R programming environment.
- The ability to interpret statistical results presented in scientific papers.
- The ability to communicate the biological meaning of statistical tests.

Summary of the Course Content

Some topics covered by this course are:

- Very brief revision of ANOVA, Regression
- Multifactor ANOVA, Multiple regressions
- General linear models and dummy variables
- Assumptions of parametric tests and dealing with data that don't meet them
- Designing biological studies (experimental design, nested and split plot designs)
- Generalised linear models using Poisson and Binomial errors
- Compositional data / multivariate approaches: diversity, clustering, ordination
- Monte-Carlo Methods

Timetable

http://www.canterbury.ac.nz/theuni/timetable/

Akoranga | Lectures/labs

Week	Month	Date	Lecture No.	Lecture Topics	Labs
1	July	17	1	Brief revision of Analysis of Variance and regression.	Home-based activity
		20	2		
2		24	3	Extension of ANOVA and regression into multifactor ANOVA and multiple regression.	Jul 25
		27	4	Balanced vs. unbalanced designs	
3		31	5	Assumptions of parametric tests.	Aug 1*
	Aug	3	6	What to do if the assumptions aren't met (transformations and non-parametric tests).	
4		7	7	General linear models & ANCOVA	Aug 8
		10	8	Model simplification	
5		14	9	Introduction to experimental design	Aug 15*
		17	10	Blocking	
6		21	11	Nested designs **Mid-term test this week**	Aug 22
		24	12	Split-plot designs	
Term Break: 28 August-10 September					
7	Sept	111	13	Repeated measures designs	Sept 12*
		15	14	Review of experimental designs	
8		18	15	Mixed effects models	Sept 19
		21	16	Generalized linear models	
9		25	17	Modelling count data (Poisson errors)	Sept 26*
		28	18	Modelling proportion data (Binomial errors)	
10	Oct	2	19	Compositional data: describing diversity, extrapolation	Oct 3
		5	20	Measurement of compositional similarity and clustering	
11		9	21	Ordination: PCA, NMMDS	Oct 10
		12	22	Statistical tests of composition: NPMANOVA, Procrustes rotation	
12		16	23	Monte-Carlo methods I	Oct 17*
		20	24	Monte-Carlo methods II and wrap up.	

*** = there will be a lab assessment that week**

Mid-term test will take place during week 6 (the week beginning 21 August, but check with timetable closer to the time for specifics)

Feedback from previous Course Survey

Student ratings (out of 5)	**2021**
The materials provided helped me to understand what was required to succeed in this course.	**4.51**
The organisation of this course helped me learn.	**4.49**
I found the workload was appropriate to the level of the course.	**4.36**
I found the assessments appropriate for the course.	**4.36**
Where I sought feedback on my assessments, I found it helpful.	**4.49**

Helpful features

1. Lecture slides were informative and easy to follow, along with a good explanation of each slide.
2. The 309 lab manual has been extremely useful in understanding the course content.
3. Very good organisation of the course, small frequent quizzes and labs with recap sessions at the end helped a lot!
4. The lecture content order seemed good.
5. A lot less stressful than the assessments for 209, I really appreciated the types of assessments being changed to smaller but more frequent assignments. Helped me learn more as I was less
stressed.
6. The online lab tests were good, they sound a lot better than a big lab exam, and they helped me learn the lecture material throughout the term rather than waiting for exam time
7. The nature of the internal tests seemed fair as it would've been very difficult to memorise all the R coding, especially as it comes later with continual use.

What to change? (Action/response indicated in bold)

The lectures where well organised but the lecture slides online had important parts of it deliberately left blank. This makes it a bit harder to go back through notes and reinforce learning.
This is deliberate, because research shows that if you make notes and write things down (rather than just listening or reading), you retain the information better. However, writing too much down during a lecture can prevent you from having any time to stop and think. As a compromise, we give much of the long text and figures in the powerpoints, but leave blank the key words for you to write them down yourself to help you remember them.

But the labs we worth so few % and had tasks that were either extremely simple or extremely difficult no in between. I think it would perhaps be better to have a series of labs over the course to learn information as you go, or two weekly quizzes worth 5% or maybe even less just because they really help you learn as you go.
We already have approximately two-weekly tests worth 5%, so not sure how to address this. Lab tests have some easy questions so that hopefully nobody gets zero, and then progressively more difficult questions. The R code to answer them always comes from a previous lab.

RULES, REGULATIONS, AND WHAT TO DO WHEN THINGS GO WRONG

[updated March 2023]

If in doubt: ASK! The course coordinator is happy to answer questions. All staff involved in the course are available for advice on specific issues.

What do I do if I have to miss a test/exam or if my performance was impaired?
In Biological Sciences, we require a satisfactory level of achievement in both the theoretical aspects of the discipline and in practical activities. **This means you must attend all class activities (labs, tutorials, fieldtrips)** and submit all items of assessment unless you have a very good reason not to (e.g. medical reasons) and if this has been approved by your course coordinator.

If you feel that **illness, injury, bereavement or other extenuating circumstances beyond your control** prevented you from completing a **test/exam** worth 10% or more of the total course assessment, or if these circumstances affected your performance in such assessments, you should apply for Special Consideration. Applications for Special Consideration should be submitted via the Special Consideration website http://www.canterbury.ac.nz/study/special-consideration/ *within five working days* of the assessment or its due date. You should also notify the course coordinator. If you apply for Special Consideration because of medical reasons, you should visit a doctor within a reasonable timeframe (application form available on the website above or from the Student Health Centre).

The Special Consideration provisions are intended to assist students who have covered the work of a course but have been prevented by illness or other critical circumstances from demonstrating their mastery of the material or skills at the time of a text/exam – **they do not excuse you from doing the test/exam** within a reasonable time agreed with the course coordinator.

What do I do if I have to miss a quiz or assignment or if I need an extension?
You cannot apply for Special Consideration if you miss an assessment that is not a test/exam, such as a quiz, lab report, essay, literature review or other assignment, or if the test/exam is worth less than 10% or more of the total course assessment. If this happens or if you need an extension because of **illness, injury, bereavement or other extenuating circumstances beyond your control**, please contact the course coordinator and arrange an alternate activity and/or submission date. You should also do this if you have to miss a laboratory, tutorial or field trip.

What are other valid reasons to miss an assessment or mandatory course activity?
The Special Considerations policy (https://www.canterbury.ac.nz/about/governance/ucpolicy/student/special-consideration-procedures-and-guidelines/) outlines only a few kinds of activities that UC considers valid reasons for missing an assessment or mandatory course activity other than those outlined above. These include **involvement in international or national representative sport or cultural groups.** Holiday trips, birthday parties, weddings, work-related commitments etc. are not given special status in this University policy. Please contact your course coordinator to ask for an alternate activity and/or submission date if you are eligible.

Special Consideration for late discontinuation of a course
Students prevented by **extenuating circumstances** from completing the course after the final date for withdrawing, may apply for Special Consideration for late discontinuation of the course. Applications must be submitted via http://www.canterbury.ac.nz/study/special-consideration/ no later than five working days after the examination period has finished.

Academic Integrity
It is the responsibility of each student to be familiar with the definitions, policies and procedures concerning academic misconduct/dishonest behaviour. Instances of academic misconduct will be dealt with in a serious and appropriate manner. Students should refer to: https://www.canterbury.ac.nz/about/ako/academic-quality/academic-integrity/

Plagiarism
It is essential that you are aware that plagiarism is considered a very serious offence by the academic community, the University and the School of Biological Sciences. Plagiarism is defined as taking content from another work or author and presenting it, without attribution, as if it is your own work. Content here includes text (sentences or major parts of sentences), display items (graphs and tables), and overall structure (the detailed sequence of ideas). Plagiarism includes:

- re-use of previous assignments (even if each individual sentence has been rephrased to say the same thing in different words, if the overall structure is re-used).
- copying of another student's work (with or without their consent).
- the unreferenced use of published material or material from the internet, e.g. cutting and pasting of paragraphs or pages into an essay.
- the generation of text using artificial intelligence technology without disclosure and when it is not intended to be part of an assignment.

For most pieces of in-term assessment you will be given information concerning the use of direct and indirect quotes from previously published work. If you have any doubt about the appropriate use of published material, please speak with an academic staff member. If you are unsure what plagiarism is, seek advice.

It is a School policy that courses will likely that you submit work electronically for subsequent analysis of originality using *Turnitin*. Students agree that by taking courses in BIOL, assessments may be submitted to Turnitin.com for textual similarity review. All submitted papers will be included as source documents in the Turnitin.com reference database solely for the purpose of detecting plagiarism of such papers. Use of the Turnitin.com service is subject to the Terms and Conditions of Use as posted on the Turnitin.com site.

Where do I hand in assignments and then collect them once marked?
All assignments should be submitted as directed by the course coordinator. Typically, this will be electronically via Learn for on-line grading and for analysis in *Turnitin*. If a hard copy is requested, assignments should be placed in the designated collection boxes in the foyer of the 2nd floor of the School of Biological Sciences (Julius von Haast building, at the top of the stairs). All assignments must be accompanied by a cover sheet signed by you stating that the submitted work is not plagiarised. Cover sheets are available on top of the collection boxes, or you can download one from the Biology website (http://www.canterbury.ac.nz/media/documents/science-documents/assignment-coversheet.pdf).

Marked assignments will be returned through Learn or, if in hard copy, can be collected from the School of Biological Sciences reception, unless directed otherwise by the course coordinator. Teaching staff will endeavour to return work as soon as possible, and should contact you if there are likely to be any delays that will prevent return within the maximum 4-week timeframe.

What if I can't get it finished in time?
Reports and assignments should be handed in on time. Extensions may be granted if you have a valid reason (see above). **If you require an extension, you should request one from the course coordinator** (or the lecturer responsible for marking the work), with as much notice as possible. Please do this BEFORE the deadline for the assignment. **If you have been given an extension and you have been asked to submit a hard-copy of your work, you should hand the work DIRECTLY to the course coordinator** (do not put it in the drop box as it may not be cleared after the due date).
If an extension has not been granted:

- work handed in within 1 hour of the deadline: penalty of up to 5 percentage points of the mark for the assignment (e.g., a mark of 75% might be reduced to 70%).
- work handed in 1 – 24 hours after the deadline: penalty of 10 percentage points of the mark for the assignment (e.g., a mark of 75% is reduced to 65%).
- work handed in 1 – 7 days after the deadline: penalty of 15 percentage points of the mark for the assignment (e.g., a mark of 75% is reduced to 60%).
- work handed in more than 7 days after the deadline will not be marked or earn credit.

What if I have written more than the word or page limit?
If there is a word limit on an assignment, it is usually there to stop you doing too much work and to encourage you to write succinctly. You can be up to 10% over without too much worry, but if the length increases beyond that your mark may suffer due to failure to follow the requirements. If you find yourself way over the word limit talk to the lecturer concerned about how to get your assignment to an acceptable length. Unless specifically advised that there is flexibility, you must adhere to the word limit indicated.

What if I fail part of the course?
In Biological Sciences, we require a satisfactory level of achievement in both the theoretical aspects of the discipline and in practical activities. This means you must attend all class activities and submit all items of assessment unless you have a very good reason not to (e.g. medical reasons). **A student must attain an average score of at least 40% for in-course assessments (e.g. assignments, reports, quizzes) and an average score of at least 40% in the exam and/or tests, AND score at least 50% overall for the course, to be awarded a passing grade. See the course outlines for clarification of the assessment items included in each category and ask the coordinator if you are still unsure.**

What's the best way to give feedback?
We welcome constructive feedback at all times – help us to make this a valuable course for you. We endeavour to remain approachable at all times. If you would rather give feedback anonymously, please use the online course survey or talk to lab demonstrators, or your class rep (who will all report back to the staff-student liaison committee that includes a representative from each of the undergraduate classes). Class representatives will be selected from each class at the start of course.

What's the best way to complain?

If you feel you have not been fairly treated during this course, please raise the issue with the lecturer or course coordinator in the first instance. Other avenues include your class rep., who can raise issues anonymously, or the UCSA education coordinator.

Grading

A+	90% or above
A	85 – 90
A-	80 – 84
B+	75 – 79
B	70 – 74
B-	65 – 69
C+	60 – 64
C	55 – 59
C-	50 – 54

A restricted pass (R) **may** be awarded to those who are close to a pass (i.e. an overall score of 48-49.9%) AND who have achieved at least a 40% overall score in both in-course assessment and tests/exams. If an R grade is awarded you gain credit for the course but **cannot continue into papers that require this course as a pre-requisite**. NB. The R grade is only available at 100 and 200 level - it cannot be awarded for third year papers.

Failing grades: D 40-49 E 0–39