



STAT*2230 Biostatistics for Integrative Biology

Winter 2020

Section(s): C01

Department of Integrative Biology

Credit Weight: 0.50

Version 1.00 - November 21, 2019

1 Course Details

1.1 Calendar Description

This course introduces students to the design, completion and interpretation of research projects, including identifying categories of research questions, types of data, data gathering methods, efficient graphic and numeric methods to summarize data, standard statistical analyses involving parameter estimation and hypothesis tests and interpreting results in the context of research goals. Statistical concepts underlying practical aspects of biological research will be emphasized. Computer-intensive laboratory sessions will focus on practical data organization, visualization, statistical analysis using software, and interpretation and communication of statistical results.

Pre-Requisites:

BIOL*1070

Restrictions:

BIOL*2250, STAT*2040, STAT*2060, STAT*2080, STAT*2120, STAT*2250. Restricted to students in the BSC majors in BIOD, MFB, WBC, WLB, and ZOO, and BSES majors in ECOL and ECOL:C.

1.2 Timetable

Lecture: Monday, Wednesday, Friday, 8:30-9:20, ALEX 100

Labs: STAT*2230*0101, Thursday, 12:30-2:20, SSC 1305

STAT*2230*0102, Thursday, 10:30-12:20; SSC 1305

STAT*2230*0103, Thursday 2:30-4:20; SSC 1306

STAT*2230*0104, Friday, 11:30-1:20; SSC 1305

STAT*2230*0105, Friday, 2:30-4:20; SSC 1305

1.3 Final Exam

Exam time and location is subject to change. Please see WebAdvisor for the latest information.

2 Instructional Support

2.1 Instructional Support Team

Instructor: Julie Horrocks
Email: jhorrock@uoguelph.ca
Office Hours: TBD

Instructor: Karl Cottenie
Email: cottenie@uoguelph.ca
Office Hours: TBD

3 Learning Resources

3.1 Required Resources

Top Hat (Software)

To facilitate discussion and to enhance your learning in and out of class, we will be using educational software called Top Hat. Top Hat allows you to answer questions and engage in discussion using your smartphone, tablet or laptop. You will need to purchase the Top Hat app. Instructions for purchasing, downloading and setting up the Top Hat software will be provided by e-mail/Courselink

R Statistical Software (Software)

- We will be using the software package RStudio to analyze data in labs. R is freely available. If you wish to download a copy for your personal computer, it is a two-step process:
 - First, you must download R (the programming language) at <http://cran.r-project.org>.
 - Second, you must download RStudio (the visual interface) at <https://www.rstudio.com/products/rstudio/download/>. To open the program, always click on the RStudio icon and not the R icon.
- Guide to using R: Dalgaard, P. 2008. Introductory Statistics with R, Second Edition. New York, Springer.
- PDFs of Dalgaard (2008) are available for free download through the University of Guelph library.

3.2 Recommended Resources

Statistics for the Life Sciences (Textbook)

- Samuels, M.L., J. A. Witmer, and A. A. Schaffner. 2016. Statistics for the Life Sciences, Fifth Edition. New York, Pearson.

The Analysis of Biological Data (Textbook)

- Whitlock, M. C., and D. Schluter. 2015. The Analysis of Biological Data, Second Edition. MacMillan Learning.

You will be able to use these books as well as your own notes during the open-book midterm and final exam

Statistics Learning Centre (Other)

Located in the Learning Commons on the third floor of the library, the Mathematics and Statistics Learning Centre is a drop-in centre where you'll find a team of tutors that can help you understand and solve course-work problems. The Learning Centre is open Monday 9:30-3:30, Tuesday 10:00-4:00, Wednesday 9:30-3:30, Thursday 10:00-4:00 and Friday 9:30-2:30. You will find the tutors sitting at the end of the room near the sign that says "Statistics". Approach them with your questions at any time!

4 Learning Outcomes

This course is designed to give students experience and confidence in the design and

analysis of data within realistic biological research contexts. Students will gain basic practical experience in displaying, summarizing, analyzing and interpreting biological data in applied research contexts using standard statistical methods.

4.1 Course Learning Outcomes

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

1. Understand the statistical concepts of bias, variability, and sampling distributions
 2. Select the appropriate statistical method for a given data set
 3. Evaluate the quality of data collected from observational and experimental studies
 4. Make and interpret visual summaries of data
 5. Use statistical computer software to explore and analyze data
 6. Understand statistical language as used in the primary biological literature
 7. Interpret statistical results and communicate them to other biologists
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5 Teaching and Learning Activities

5.1 General Information

- Lectures:

For your convenience, drafts of slides will be posted on Courselink prior to lecture. However, please note that these drafts can differ from the final, corrected versions of the slides, which will be posted on Courselink after lecture.

We will ask you to confer with your neighbours during lecture to discuss TopHat questions. We do this because research shows that students who work with their neighbours to answer questions in class score better on exams than students who do not interact with their peers.

- Labs:

Labs will be run by TAs who will introduce the lab assignment, lead discussion, and give pointers on using R. While we do not take attendance at labs, we strongly encourage you to attend.

Be sure to save the work you do in the lab (data files, output, word processing) and mail it to yourself before you leave. Alternatively, you can save your work on a memory key.

5.2 Important Dates

Jan. 6	First day of classes
Jan. 13	First lab
Feb. 14	Midterm (in class)
Feb. 17-21	Reading week
Apr. 3	Last day of classes
TBD	Final Exam. Location: TBD

5.3 TENTATIVE schedule of lectures and labs. Chapter numbers refer to Samuels et al. 2016, 5th edition.

Monday	Wednesday	Thursday	Friday
January 6 (KC/JH) Why do you need statistics? Sources of variability No Lab	Jan 8 (KC) Type of evidence Sampling (Chapter 1) No Lab	No lab	January 10 (KC) Type of evidence Sampling (Chapter 1) No Lab
January 13 (KC) Description of samples (Chapter 2) Lab 1: Intro to R	Jan 15 (KC) Description of samples (Chapter 2) Lab 1: Intro to R	Lab 1: Intro to R	January 17 (KC) Description of samples (Chapter 2) Lab 1: Intro to R
Jan 20 (JH) Normal distribution (Chapter 4) Lab 2: Sampling, Description of samples	Jan 22 (JH) Confidence Intervals (Chapter 6) Lab 2: Sampling, Description of samples	Lab 2: Sampling, Description of samples	January 24 (JH) Confidence Intervals (Chapter 6) Lab 2: Sampling, Description of samples
Jan 27 (JH) Bias and precision One-sample hypothesis tests (Chapter 6) Lab 3: Confidence Intervals	Jan 29 (JH) Bias and precision One-sample hypothesis tests (Chapter 6) Lab 3: Confidence Intervals	Lab 3: Confidence Intervals	Jan 31 (JH) Bias and precision One-sample hypothesis tests (Chapter 6) Lab 3: Confidence Intervals
February 3 (KC)	Feb 5 (KC)		February 7 (KC)

Experimental design I Comparison of two independent samples (Chapter 7) Lab 4: One-sample hypothesis tests	Experimental design I Comparison of two independent samples (Chapter 7) Lab 4: One-sample hypothesis tests	Lab 4: One-sample hypothesis tests	Comparison of paired samples (Chapter 8) Lab 4: One-sample hypothesis tests
Feb 10 (KC) Review No Lab	Feb 12 (KC) Review No Lab	No Lab	Feb 14 Midterm No Lab
Feb 17 BREAK	Feb 19 BREAK	Feb 20 BREAK	Feb 21 BREAK
February 24 (JH) Chi-square goodness of fit (Chapter 9) Lab 5: Experimental design; Comparison of independent and paired samples	Feb 26 (JH) Chi-square goodness of fit (Chapter 9) Lab 5: Experimental design; Comparison of independent and paired samples	Lab 5: Experimental design; Comparison of independent and paired samples	Feb 28 (JH) Contingency tables (Chapter 10) Lab 5: Experimental design; Comparison of independent and paired samples
March 2 (KC) Experimental design II Lab 6: Chi-square tests	Mar 4 (KC) Experimental design II, One-way ANOVA Lab 6: Chi-square tests	Lab 6: Chi-square tests	March 6 (KC) One-way ANOVA (Chapter 11) Lab 6: Chi-square tests
March 9 (JH) Multiple comparisons (Chapter 11) Lab 7: One-way ANOVA	Mar 11 (JH) ANOVA w/blocks (Chapter 11) Lab 7: One-way ANOVA	Lab 7: One-way ANOVA	March 15 (JH) ANOVA w/blocks (Chapter 11) Lab 7: One-way ANOVA
March 16 (KC) Two-way ANOVA (Chapter 11) Lab 8: Multiple comparisons; ANOVA	Mar 18 (KC) Two-way ANOVA (Chapter 11) Lab 8: Multiple comparisons; ANOVA	Lab 8: Multiple comparisons; ANOVA	March 20 (JH) Linear regression and correlation (Chapter 12) Lab 8: Multiple

with blocks	with blocks	with blocks	comparisons; ANOVA with blocks
March 23 (JH) Linear regression and correlation (Chapter 12) Lab 9: Linear Regression and Correlation	Mar 25 (JH) Linear regression and correlation (Chapter 12) Lab 9: Linear Regression and Correlation	Lab 9: Linear Regression and Correlation	Mar 27 (JH) Linear regression and correlation (Chapter 12) Lab 9: Linear Regression and Correlation
Mar 30 (KC) Case studies	Apr 1 (KC) Case studies		April 3 (KC /JH) Review

6 Assessments

6.1 Marking Schemes & Distributions

Name	Scheme A (%)
Lab Assignments	25
Midterm Exam	30
Top Hat Questions	5
Final Exam	40
Total	100

6.2 Assessment Details

Lab Assignments (25%)

Date: Labs due MONDAYS at noon on: Jan 20,27, Feb 3,10, Mar 2,9,16,23,30

Learning Outcome: 1, 2, 3, 4, 5, 6, 7

- The assignments are designed to give you experience in data management, experimental design, graphical methods, and statistical analysis using R, as well as reinforce concepts presented in lectures. The assignments and any required data sets will be posted on CourseLink. The first lab will not be graded. There will, therefore, be 8 graded assignments in total, but your lowest assignment grade will be dropped. **Late assignments will not be accepted!!!!**
- Because of limited computers, students will work together in pairs. Discussion often leads to better understanding and so we encourage group thinking. However, we urge you to not divide up the work. You will get the best value if you work together to increase your comprehension and not to do less work. Statistical analysis, data exploration, and the learning of statistical software only comes with experience. Each student must hand in a separate complete assignment, and no part of this should be copied from another student. Academic dishonesty, such as plagiarism (including copying all or part of an assignment) and impersonation is grounds for loss of course credit and dismissal. More information on the subject of academic misconduct can be found at the following website:
http://www.uoguelph.ca/undergrad_calendar/c08/c08-amisconduct.shtml
- You will be submitting completed assignments online using a grading

software called **Crowdmark**. You will receive online submission instructions via your University of Guelph e-mail address for each assignment. It is your responsibility to check for this e-mail and to contact Dr. Cottenie if you do not receive the e-mail for a particular assignment. More details regarding this process will be provided on each assignment. Marked assignments will be returned via e-mail. We will do our best to return the assignments one-week after the due date.

- You are responsible for answering all of the questions on each assignment because these will help prepare you for the course exams. **However, only some of each assignment will be graded each week.** You will not know in advance which questions will be subject to grading. Solutions for each assignment will be posted on the course. It is up to you to check the answer sheet to evaluate your performance on the unmarked questions.

Midterm Exam (30%)

Date: Fri, Feb 14

Learning Outcome: 1, 3, 4, 7

- The midterm will generally address the following topics:
 - Numerical and mechanical skills
 - Your ability to critically evaluate the quality of data (e.g., data collection, experimental method) or of the experimental design and analyses
 - The legitimate interpretation of results in a biological context.

Top Hat Questions (5%)

Date: All semester beginning Mon Jan 13th

Learning Outcome: 1, 2, 3, 4, 7

- 5% of your final grade will be based on your graded responses as well as on your participation in Top Hat questions in class.
- We will practice using Top Hat in lecture on January 8-10, 2020
- We will begin graded Top Hat questions on January 13, 2020.
- Your lowest 3 grades for Top Hat questions will be deleted from your grade calculation so that you will not be penalized for illness or other occasional absences from class.

Final Exam (40%)

Date: TBD, TBD

Learning Outcome: 1, 2, 3, 4, 5, 7

- The final exam will generally address the following topics:
 - Numerical and mechanical skills
 - Your ability to critically evaluate the quality of data (e.g., data collection, experimental method) or of the experimental design and analyses
 - The legitimate interpretation of results in a biological context.
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7 Course Statements

7.1 Academic Accommodation of Religious Obligations

If you are unable to complete a course requirement due to religious obligations, please let the instructor know within the first two weeks of class. See the academic calendar for more information:

<https://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-accomrelig.shtml>

7.2 Consideration

Consideration may be granted at the instructors discretion. Please note that consideration for medical, compassionate or university-related conflicts (e.g., varsity sports) may require additional discussion with your program counsellor. Consideration is generally more likely when the student proactively advises the instructor of issues well in advance of deadlines.

<http://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-ac.shtml>

7.3 Course Evaluations

- Because this course is co-taught by the departments of Math-Stats and Integrative Biology, we encourage you to provide evaluations of the course and instructors separately to each department.
- The Integrative Biology evaluation can be performed on-line through the CCS course evaluation website: https://courseeval.uoguelph.ca/CEVAL_LOGIN.php
- The Mathematics and Statistics evaluation can be performed on-line through the CCS course evaluation website:
https://courseeval.uoguelph.ca/CEVAL_LOGIN.php

7.4 Student Responsibilities

You should plan on spending a minimum of ten hours per week working on this course, in addition to time spent in lectures and tutorials. This time includes reading the required

sections of the textbook, reviewing and/or rewriting lecture notes, preparing questions on any material with which you need help, doing practice problems, and working on your lab assignments. The Instructors and TAs will offer as much assistance as possible. However, remember that this is your learning experience, and you will get as much out of this class as you put into it.

8 Department of Integrative Biology Statements

8.1 Academic Advisors

If you are concerned about any aspect of your academic program:

- Make an appointment with a program counsellor in your degree program. [B.Sc. Academic Advising](#) or [Program Counsellors](#)

8.2 Academic Support

If you are struggling to succeed academically:

- Learning Commons: There are numerous academic resources offered by the Learning Commons including, Supported Learning Groups for a variety of courses, workshops related to time management, taking multiple choice exams, and general study skills. You can also set up individualized appointments with a learning specialist. <http://www.learningcommons.uoguelph.ca/>
- Science Commons: Located in the library, the Science Commons provides support for physics, mathematic/statistics, and chemistry. Details on their hours of operations can be found at: <http://www.lib.uoguelph.ca/get-assistance/studying/chemistry-physics-help> and <http://www.lib.uoguelph.ca/get-assistance/studying/math-stats-help>

8.3 Wellness

If you are struggling with personal or health issues:

- Counselling services offers individualized appointments to help students work through personal struggles that may be impacting their academic performance. <https://www.uoguelph.ca/counselling/>
- Student Health Services is located on campus and is available to provide medical attention. <https://www.uoguelph.ca/studenthealthservices/clinic>
- For support related to stress and anxiety, besides Health Services and Counselling Services, Kathy Somers runs training workshops and one-on-one

sessions related to stress management and high performance situations.
<http://www.selfregulationskills.ca/>

9 University Statements

9.1 Email Communication

As per university regulations, all students are required to check their e-mail account regularly: e-mail is the official route of communication between the University and its students.

9.2 When You Cannot Meet a Course Requirement

When you find yourself unable to meet an in-course requirement because of illness or compassionate reasons please advise the course instructor (or designated person, such as a teaching assistant) in writing, with your name, id#, and e-mail contact. The grounds for Academic Consideration are detailed in the Undergraduate and Graduate Calendars.

Undergraduate Calendar - Academic Consideration and Appeals

<https://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-ac.shtml>

Graduate Calendar - Grounds for Academic Consideration

<https://www.uoguelph.ca/registrar/calendars/graduate/current/genreg/index.shtml>

Associate Diploma Calendar - Academic Consideration, Appeals and Petitions

<https://www.uoguelph.ca/registrar/calendars/diploma/current/index.shtml>

9.3 Drop Date

Students will have until the last day of classes to drop courses without academic penalty. The deadline to drop two-semester courses will be the last day of classes in the second semester. This applies to all students (undergraduate, graduate and diploma) except for Doctor of Veterinary Medicine and Associate Diploma in Veterinary Technology (conventional and alternative delivery) students. The regulations and procedures for course registration are available in their respective Academic Calendars.

Undergraduate Calendar - Dropping Courses

<https://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-drop.shtml>

Graduate Calendar - Registration Changes

<https://www.uoguelph.ca/registrar/calendars/graduate/current/genreg/genreg-reg-regchg.shtml>

Associate Diploma Calendar - Dropping Courses

<https://www.uoguelph.ca/registrar/calendars/diploma/current/c08/c08-drop.shtml>

9.4 Copies of Out-of-class Assignments

Keep paper and/or other reliable back-up copies of all out-of-class assignments: you may be asked to resubmit work at any time.

9.5 Accessibility

The University promotes the full participation of students who experience disabilities in their academic programs. To that end, the provision of academic accommodation is a shared responsibility between the University and the student.

When accommodations are needed, the student is required to first register with Student Accessibility Services (SAS). Documentation to substantiate the existence of a disability is required; however, interim accommodations may be possible while that process is underway.

Accommodations are available for both permanent and temporary disabilities. It should be noted that common illnesses such as a cold or the flu do not constitute a disability.

Use of the SAS Exam Centre requires students to book their exams at least 7 days in advance and not later than the 40th Class Day.

For Guelph students, information can be found on the SAS website
<https://www.uoguelph.ca/sas>

For Ridgetown students, information can be found on the Ridgetown SAS website
<https://www.ridgetownc.com/services/accessibilityservices.cfm>

9.6 Academic Integrity

The University of Guelph is committed to upholding the highest standards of academic integrity, and it is the responsibility of all members of the University community—faculty, staff, and students—to be aware of what constitutes academic misconduct and to do as much as possible to prevent academic offences from occurring. University of Guelph students have the responsibility of abiding by the University's policy on academic misconduct regardless of their location of study; faculty, staff, and students have the responsibility of supporting an environment that encourages academic integrity. Students need to remain aware that instructors have access to and the right to use electronic and other means of detection.

Please note: Whether or not a student intended to commit academic misconduct is not relevant for a finding of guilt. Hurried or careless submission of assignments does not excuse students from responsibility for verifying the academic integrity of their work before submitting it. Students who are in any doubt as to whether an action on their part could be construed as an academic offence should consult with a faculty member or faculty advisor.

Undergraduate Calendar - Academic Misconduct
<https://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-amisconduct.shtml>

Graduate Calendar - Academic Misconduct

<https://www.uoguelph.ca/registrar/calendars/graduate/current/genreg/index.shtml>

9.7 Recording of Materials

Presentations that are made in relation to course work - including lectures - cannot be recorded or copied without the permission of the presenter, whether the instructor, a student, or guest lecturer. Material recorded with permission is restricted to use for that course unless further permission is granted.

9.8 Resources

The Academic Calendars are the source of information about the University of Guelph's procedures, policies, and regulations that apply to undergraduate, graduate, and diploma programs.

Academic Calendars

<https://www.uoguelph.ca/academics/calendars>
