THE UNIVERSITY OF BRITISH COLUMBIA

Biology UBC
Vancouver, BC, CANADA

UBC's Point Grey Campus is located on the unceded, traditional and ancestral territory of the xʷməθkʷəy̓əm (Musqueam).

This syllabus is a general representation of the course as previously offered and is subject to change.

BIOL 300 – Fundamentals of Biostatistics

General Course Syllabus

Course description: Biol 300 is a course designed to introduce biology students to thinking about and doing data analysis using statistics.

Course format: 3 lecture hours per week with a 2-hour tutorial. The tutorial focuses on learning the R programming language.
Credits: 3
Prerequisites: One of BIOL 121, SCIE 001
Accepted corequisites: One of MATH 100, MATH 101, MATH 103, MATH 105, MATH 121, SCIE 001
Instructor(s) and Contact: Vikram Baliga (vikram.baliga@ubc.ca); Kaitlyn Gaynor (kaitlyn.gaynor@ubc.ca); Darren Irwin (darren.irwin@ubc.ca); Michael Whitlock (michael.whitlock@ubc.ca)

Course learning objectives:
Learning objectives for the course include:

- Design scientific studies appropriately and perform statistical analysis on collected data using the R programming language.
- Evaluate and critique whether other people have done statistics correctly.
- Apply statistical thinking to real-world questions to make and communicate evidence-based decisions in both personal and professional contexts.

By the end of the course, students should be familiar with the following topics:

Part A: Introduction to Statistics

- Statistics and samples (random sampling, population vs. sample, types of variables, frequency distributions).

- Displaying data (tables, bar graphs, histograms, contingency tables, mosaic plots, cumulative frequency distributions, scatter plots, principles of effective display).
- Describing data (mean, median, mode, standard deviation, quartiles, proportions).
- Estimating with uncertainty (sampling error, parameters vs. estimates, sampling distributions of estimates, standard error, confidence intervals).
- Probability (probability definitions, Venn diagrams, probability distributions, addition and multiplication rules, independent vs. dependent events, probability trees, conditional probability, Bayes' theorem).
- Hypothesis testing (null vs. alternative hypotheses, Type I and Type II errors, one-side vs. two-sided tests).

Part B: Proportions and Frequencies

- Analyzing proportions (binomial distribution and test, Agresti-Coull confidence interval).
- Fitting probability models to frequency data (random models: proportion, binomial, Poisson; Chi-squared goodness-of-fit test).
- Contingency analysis (Chi-squared contingency test, Fisher's exact test).

Part C: Comparing Numerical Values

- Normal distributions (standard normal distribution, normal distribution of sample means, central limit theorem, normal approximation of the binomial distribution).
- Inference for a normal population (t-distribution, confidence interval for the mean, one-sample t-test, estimating SD and variance of a normal population).
- Comparing two means (paired t-test, two-sample t-test, comparing variances).
- Handling violations of assumptions (deviations from normality, when to ignore violations, transformations, nonparametric tests: sign text, Wilcoxon signed-rank test, Mann-Whitney U-test).
- Designing experiments (reducing bias, reducing sampling error).
- Comparing means of more than two groups (ANOVA, planned vs. unplanned comparisons, fixed vs. random effects).

Part D: Regression and Correlation

- Correlation between numerical variables (correlation coefficient, testing null hypothesis of zero correlation, Spearman's rank correlation).
- Regression (linear regression, confidence intervals, testing hypothesis of zero slope, regression toward the mean, nonlinear regression).

Part E: Advanced Methods

- Computer-intensive methods (simulation, randomization, bootstrapping).
- Likelihood (maximum likelihood estimation, log-likelihood ratio test).

Textbook and additional resources:

The following resources are recommended:

- The Analysis of Biological Data, by Whitlock and Schluter (3rd edition).

Grading Scheme:

Note: the grading scheme may vary by term and instructor.

Assessment	Weight
Final exam	50%
Midterm exam	30%
Homework assignments	10%
Lab reports	10%

DETAILS ON ASSESSMENTS:

All exams are hand-written and occur during the lecture (for the midterm) or the formal examination period (for the final exam). Students are permitted to use a basic or scientific calculator (not programming) during exams. Performance on the exams is expected to reflect the student's own work, not that of other people or services. University policy dictates stern penalties for those who copy the work of others or allow their own work to be copied. On assignments, it is acceptable to work in groups, but it is not acceptable for a student to copy another's work, to allow their work to be copied, or to copy answers provided by a Large Language Model (or AI service).

Schedule of topics (may vary by term and instructor):

Week	Topic
1	Statistics and samples
2	Displaying data & describing data
3	Estimating with uncertainty & probability
4	Probability & Hypothesis testing
5	Proportions
6	Frequency data & Contingency analysis
7	Normal distribution & One-sample tests

8	Review for Midterm & Midterm exam
9	Two-sample tests & Violations of assumptions
10	Experimental design & ANOVA
11	ANOVA
12	Correlation & Regression
13	Regression & Advanced Methods
14	Advanced Methods & Review for Final Exam

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University Policies:

UBC provides resources to support student learning and to maintain healthy lifestyles but recognizes that sometimes crises arise and so there are additional resources to access including those for survivors of sexual violence.

UBC values respect for the person and ideas of all members of the academic community. Harassment and discrimination are not tolerated nor is suppression of academic freedom.

UBC provides appropriate accommodation for students with disabilities and for religious, spiritual and cultural observances.

UBC values academic honesty and students ae expected to acknowledge the ideas generated by others and to uphold the highest academic standards in all of their actions.

Details of how to access support are available on the UBC Senate website.