revised rationale: 1/15/15
revised syllabus: 1/15/15

083

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SEP 24 2014
WSU Registrar

Washington State University
MAJOR CURRICULAR CHANGE FORM - - COURSE
(Submit original signed form and ten copies to the Registrar's Office, zip 1035.)

Future Effective Date: 08/01/2015 ☑ New course ☐ Temporary course ☐ Drop service course
(effective date cannot be retroactive) ☐ There is a course fee associated with this course (see instructions)

☐ Variable credit _____ ☐ Repeat credit (cumulative maximum _____ hours)

☐ Increase credit (former credit _____) ☐ Lecture-lab ratio (former ratio _____)

☐ Number (former number _____) ☐ Prefix (former prefix _____)

☐ Crosslisting (between WSU departments) **(Must have both departmental signatures)** ☐ Cooperative listing (UI prefix and number _____)
taught by: WSU ☐ UI ☐ jointly taught ☐

☐ Conjoint listing (400/500) ☐ S, F grading

☐ Request to meet Writing in the Major [M] requirement **(Must have All-University Writing Committee Approval)**

☐ Request to meet GER in _____ **(Must have GenEd Committee Approval)** ☐ Fulfills GER lab (L) requirement

☐ Professional course **(Pharmacy & Vet Med only)** ☐ Graduate credit **(professional programs only)**

☐ Other (please list request) The Analysis of Biological Data

Biology	571	~~The Analysis of Biological Data~~ Name Change Quantitative Toolkit for Biologists
course prefix	course no.	title

3	3	0	0	Stat 512
credit	lecture hrs per week	lab hrs per week	studio hrs per week	prerequisite

Description (**20 words or less**) Hands-on experience in the exploration, analysis, and interpretation of patterns in modern biological datasets.

Instructor: Jeremiah Busch Phone number: 335-0086 Email: jwbusch@wsu.edu
Contact: Justine Rupp Phone number: 335-8649 Email: ruppj@wsu.edu
Campus Zip Code: 4236

- Please attach rationale for your request, a current and complete syllabus, and explain how this impacts other units in Pullman and other branches (if applicable).
- Secure all required signatures and provide 10 copies to the Registrar's Office.

8 Sept. 2014 — **Chair/date**
9/15/14 — **Dean/date**
General Education Com/date

Chair (if crosslisted/interdisciplinary)*
Dean (if crosslisted/interdisciplinary) *
Graduate Studies Com/date

All-University Writing Com/date
Academic Affairs Com/date
Senate/date

***If the proposed change impacts or involves collaboration with other units, use the additional signature lines provided for each impacted unit and college.**

Typically offered

083
Rec'd
1-15-15

Rationale for BIOLOGY 571: Quantitative Toolkit for Biologists

Building the skills of students

Current SBS graduate students have voiced concern that they require better training in the handling, analysis, and interpretation of biological data. These skills are absolutely essential for today's graduate students, who need to be suited to the diverse spectrum of basic biological research conducted in SBS. At its core, entering students would benefit from: 1) exploring biological datasets; 2) identifying quantitative methods appropriate for extracting meaning from complex biological datasets; and 3) applying specific quantitative methods commonly used in modern biological research. The purpose of this course is to strengthen each of these core attributes of SBS graduate students. In doing so, the course will actively engage students in the use of a statistical package (R) to answer applied questions, and will strengthen a general understanding of statistics laid down in other foundational graduate courses (e.g. STAT 512). In addition, this course should make students aware of their own educational needs with respect to statistical training; we anticipate that many students will decide to take advanced statistical classes (e.g., STAT 530) after realizing that their specific interests in biology require thorough grounding in specific statistical areas.

Similarity to other courses

This course provides a venue for students to apply statistical techniques learned in other courses (e.g., STAT 512) toward biological problems as a step toward gaining full independence as researchers. Prior completion of STAT 512 is a prerequisite for enrolling in this course. Of existing courses, BIOLOGY 572 *Quantitative Methods and Statistics in Ecology* covers the "philosophy and methods of formulating hypotheses as mathematical models and confronting them with data." In fact, all existing graduate courses involve students in the formulation of specific research questions. The goal of this course, however, is to teach graduate students the core skills of navigating complex biological datasets and properly handling, exploring, and extracting essential information from them. These skills are completely general and often not well-developed, weakening the ability of students to reach their research goals, regardless of their field of inquiry. This course will strengthen the ability of students to vertically navigate research problems from experimental design to data collection, analysis, and interpretation. These are essential skills as the modern practice of biology relies upon increasingly data-rich approaches.

Role in the graduate curriculum

This course will serve an important role in improving the quality of research conducted in SBS. Specifically, this course provides a powerful venue for a cohort-building experience that unifies the graduate student population and provides a foundation for essential quantitative skills necessary for modern biological research, regardless of the specific aims of the students involves.

Students often lack experience presenting the outcomes of research to others, which is an essential skill for a career conducting biological research. This mode of communication is absolutely essential to translate the importance of research to other scientists and the general public. In this course, students will attain a biological dataset that permits a question of direct relevance to their research interests to be answered. After discussions with the instructor, students will give a standard research presentation where they clearly state a biological question, present analytical methods and results, and make robust conclusion on the problem at hand. BIOLOGY 582 (Grant Writing) is currently offered in the fall and this spring course will provide an excellent complement for early-career graduate students.

Interactions between students

This course will meet twice weekly. During each week, the instructor(s) will lecture on a topic on the first day of instruction, which will be followed by hands-on manipulation of data on the second day of instruction. Each week between meeting, students will work on short group projects and post their answers to a wiki-page. This will allow students and faculty to share R scripts and results while collectively discussing the costs and benefits of each group's solution. The feedback between groups will improve student information literacy, problem solving abilities, and scientific communication skills.

Course catalog summary

Hands-on experience in the exploration, analysis, and interpretation of patterns in modern biological datasets.

New Course Syllabus

083
Rec'd
1-15-15

Quantitative Toolkit for Biologists

Primary Instructor: Jeremiah Busch
Secondary Instructors: Jesse Brunner, Pat Carter, Omar Cornejo, Asaph Cousins, Erica Crespi, Dave Evans, Dick Gomulkiewicz, Joanna Kelley, Elissa Schwartz, and Andrew Storfer
Alternating spring semesters (even years)
Enrollment limit = 25
3 credits, Tu-Th 2:50-4:05pm
Prerequisite: STAT 512 or instructor permission

Course Objectives

Modern research in biology demands increasingly sophisticated quantitative techniques for designing effective experiments, visualizing and analyzing large, complex datasets, and developing and implementing simulations and models to provide hypotheses and theoretical expectations for specific empirical systems. To ensure that students gain the expertise necessary to conduct independent research, this course will immerse students in multiple practices: 1) exploring biological datasets; 2) identifying quantitative methods appropriate for developing and testing biological hypotheses; and 3) applying quantitative methods commonly used in modern biological research. The purpose of this course is to strengthen each of these core skills; in doing so, the course will actively engage students through the use of a statistical package (R) to answer applied questions, strengthen the general understanding of statistics laid down in other foundational graduate courses (e.g., STAT 512) into specific biological contexts, and prepare students for additional advanced statistics classes (e.g., STAT 530).

Format of Instruction

This course will meet twice weekly. During each week, instructor(s) will present a topic on the first day of instruction, which will be followed on the second day of instruction by hands-on manipulation of data and group work. This course is team taught by multiple faculty with unique research expertise and therefore provides students with a wide breadth of exposure to the diversity of modern biological quantitative methods. Each week between meetings, students will work on short group projects and post their answers to a shared webpage. This will allow both students and instructors to share their results and collectively discuss the costs and benefits of each group's solution to problems. The feedback between groups will improve student problem solving abilities and scientific communication.

Office Hours

The primary instructor will be available each week (Friday, 1:00 PM - 3:00 PM) to directly answer student questions and aid groups in completing assignments. Secondary instructors will similarly be available for two hours a week to address student questions on topics and datasets they present. These individual hours will be determined according to instructor schedules each semester.

Major Goals

I expect students in this course to:

- learn to explore patterns in biological datasets using widely distributed software (R)
- review and apply statistical techniques to test a wide spectrum of biological hypotheses
- gain experience in formulating experiments commonly used in biological research

- learn the fundamentals of developing mathematical models and simulations for biological problems
- develop skills necessary to present quantitative results to a general biology audience

Student Learning Assessment

Students in this course will be assessed with two types of assignments:

- **Group study of biological datasets (67% of grade)**

Throughout the course, instructor(s) will present topics which are broken into 10 modules. Some modules will take longer than a week to cover. The instructor(s) will present biological datasets meant to challenge students in the handling and interpretation of data. These datasets will be posted to the course website and students will work together on assignments to identify solutions to the biological problem at hand. Solutions will be shared on a course webpage, facilitating interactions between groups and the instructor to identify best research practices.

- **Oral research presentation (33% of grade)**

Students will identify a biological problem central to their graduate research interests. A biological dataset will be obtained from online data repositories, the primary advisor, or other sources, and the student will explore the datasets to address fundamental biological hypotheses. After consultation with the instructor(s), students will present their research in the format of a talk at national scientific meetings. Talks will be 15 minutes long and will consist of a clearly stated biological problem, quantitative approaches to test hypotheses, results, and conclusions.

Student Learning Outcomes

	At the end of the course, students will be able to:	**Course assignment that advances learning goal:**	**This objective will be evaluated primarily by:**
Depth, Breadth and Integration of Learning	Integrate knowledge from diverse and broad fields and apply this knowledge to the practice of data-intensive biological research. Understand how to best approach testing of biological hypotheses.	Group assignments that actively involve students in the exploration and analysis of complex biological datasets. Research talks in which aims, research methods, and conclusions are clearly formulated.	Instructor and student evaluations of each group's approach to answering problems addressed in diverse biological datasets. The depth and clarity of oral communication skills will be scored by the instructors.
Critical and Creative Thinking	Critically evaluate the structure of biological data, review statistical concepts, and identify analytical methods for extracting key biological insights.	In-class interrogation of datasets will teach students the connections between data types, their distributions, and the interpretation of	Group discussion of datasets and unified work toward extracting information from these data. Assignments provide a formal mode for the

		appropriate test statistics.	class to identify best research practices.
Communication	Present research results dynamically in the format of a standard scientific presentation. Critique the structure and validity of logical arguments.	A 15 minute research presentation covering the identification of a biological problem, its analysis, and data interpretation. Evaluating efficacy of peer scientific presentations	Oral presentation of final research results that further student's graduate research goals. Group discussion of presentation strengths and weaknesses
Information Literacy	Gain independence in distilling the complexity of biological data into its essential attributes. Strengthen the ability to clearly connect biological questions to experimental designs and analytical techniques.	Modeling instructor's approaches to each unique biological dataset in class, and repeated framing of clear hypotheses. Group assignments wherein students debate on the merits of alternative approaches and identify best practices.	In-class exploration of biological datasets. Weekly group assignments shared with the entire class and evaluated by instructors.

Grading and Attendance Policy

Achievement of high grades (e.g. A or A-) in this course is contingent upon achieving more than 90% of total points on group assignments and the oral research presentation. Students are expected to attend all classes and actively participate in discussions of the material during lecture. After two unexcused absences, a student's grade will be penalized by 5% for each additional lecture missed.

Point %	Grade
>92%	A
90-92%	A-
87-89%	B+
83-86%	B
80-82%	B-
77-79%	C+
73-76%	C
70-72%	C-
67-69%	D+
63-66%	D
<63%	F

Academic Integrity

WSU is an institution that upholds the highest standards of academic integrity. Students working on group projects are expected to contribute equally to their assignments, and are expected to hand in original work. To ensure clear attribution of credit regarding intellectual ideas, students are expected to properly cite sources of information in group projects and their oral research presentations. Plagiarism or copying is considering cheating (for definitions of plagiarism, see the SBS webpage: http://sbs.wsu.edu/index2.html). It is strongly suggested that you read and understand these definitions.

Students with Disabilities

Reasonable accommodations are available for students with a documented disability. If you have a disability and need accommodations to fully participate in this class, please either visit or call the Access Center (Washington Building 217, 509-335-3417) to schedule an appointment. All accommodations MUST be approved through the Access Center. For more information contact a Disability Specialist (webpage: http://accesscenter.wsu.edu; email: Access.Center@wsu.edu).

Campus Safety

WSU is committed to enhancing the safety of the students, faculty, staff, and visitors. It is highly recommended that you review the Campus Safety Plan (http://safetyplan.wsu.edu/) and visit the Office of Emergency Management web site (http://oem.wsu.edu/) for a comprehensive listing of university policies, procedures, statistics, and information related to campus safety, emergency management, and the health and welfare of the campus community.

Module	Instructor(s)	Weeks
1: Handling biological datasets	**Brunner, Crespi**	**1-2**

The format and structure of biological datasets

Reviewing linear algebra to understand how R "thinks"
Load a dataset in R
Summarize data in tables, graphs
Group project: Describing variation in blood pressure and heart rate in college students

2: Review: basic probability	**Busch**	**3**

Probability
Parameters and outcomes
Binomial distribution
Group project: Probabilities of sampling alleles at a single locus in a small population

3: Review: biological distributions and statistics	**Cousins, Kelley**	**4-5**

Common distributions in biology
Sampling, estimation and confidence intervals
Plotting means and data for two treatments
A simple test statistic
P-values
Biological vs. statistical significance

Group project: Revisiting heart rate data and examining the distributions of species

4: Likelihood **Busch** **6**

Parameters and data in biological systems
Least-squares and likelihood approaches
The likelihood function
Maximum likelihood
Group project: Inferring rates of hybridization between species using genetic data

5: A primer on experimental design **Crespi, Storfer** **7-8**

Uncontrolled situations
An example of a survey with two correlated variables
Formulating testable hypotheses
Testing hypotheses
Isolating treatment effects
Covariates
Replication
Sample size and power
Group project: Students design experiments to test hypotheses in their own study systems

6: Linear mixed models **Carter** **9**

Review of simple linear models
ANOVA
Regression
An introduction to mixed models
The "Animal Model" in quantitative genetics
Group project: Building a linear mixed model and interpreting analytical outcomes

7: Reducing complex data **Carter** **10**

Types of multivariate biological data
The genetic variance-covariance matrix (G)
Eigenvalues and eigenvectors as descriptors of genetic variation
Group project: Estimating a G matrix using the Animal Model

8: Stable isotopes and their analysis **Evans** **11**

Global nutrient cycles
Stable isotope enrichment
Variability in isotope composition
Group project: Understanding variation in isotope signatures

9: Simulating biological processes **Gomulkiewicz, Cornejo** **12-13**

Tools for simple coding in R
Randomness (process-based vs individual-based simulation models)
Visualizing power and error
Revisiting a "simple" process from last time
Student oral research presentations

10: Approximations **Gomulkiewicz** **14-15**

Taylor (and other) series
The delta method
Solving simple algebraic equations
What to do when a solution is not self-evident
Student oral research presentations

Rubric for grading of assignments

Group study of biological datasets (applies to all group projects, which have the same value)

Students will work in small teams (3-5 students each) and will produce a report based upon their collective activities answering the questions distributed by the instructor(s). All members of a group are expected to contribute equally to the presentation and will receive the same grade on a given assignment.

Statement of the biological questions associated with dataset	10%
Clear description of analytical approach used to address question	25%
Quality of tables and figures	25%
Correct usage and interpretation of statistical techniques	25%
Overall synthesis of how methods answer the research question	15%

Oral research presentation

Students will work on their own to develop a research talk in the format of a standard scientific presentation. To improve their ability to give clear research talks, students will receive peer criticism of their oral research presentation, but their grade will be based entirely on the criticisms of instructors.

Organization of content and clarity	20%
Clear statement of the biological problem(s)	15%
Effective engagement of audience	15%
Technical expertise and sophistication of approach	30%
Quality of conclusions, inferential limitations, and insights	20%

WSU.Curriculum

From: Wherland, Scot
Sent: Thursday, January 15, 2015 8:29 AM
To: Davis, William B; Edwards, Charles Gould; Evans, Marc A.; Johnson-Shull, Lisa Ann; Kwon, Paul; Lambeth, Suzanne Terese; Manzo-Robledo, Francisco; Neider, Xyanthe Nicole; Vyhnanek, Lou; Wack, Mary
Subject: 083 Catalog Agenda #083 [printed and attached 1/15]
Attachments: BIOLOGY 571 Syllabus-3.docx; BIOLOGY 571 Justification V3.docx; BIOLOGY 571 Justification V3.pdf; BIOLOGY 571 Syllabus-3.pdf

Here is the new syllabus for Biology 571 in response to turf issues with Stat. The syllabus has been rewritten, the title has changed, and there is a new prerequisite of Stat 512.

Scot Wherland Voice: 509.335.3360
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Department of Chemistry Office: Fulmer 151
Washington State University Email: scot_wherland@wsu.edu
Pullman, WA 99164-4630

-----Original Message-----
From: Patrick A. Carter [mailto:pacarter@wsu.edu]
Sent: Monday, December 08, 2014 3:36 PM
To: Wherland, Scot; Evans, Marc A.
Subject: Biol 571 materials

Hi Scott and Marc,
Attached are the new (and hopefully improved!) syllabus and justification for Biology 571.
I have provided each as both Word and pdf files in case you prefer one over the other.
Please note that the course title has changed and that we are requiring a pre-req of Stat 512 now.

Please let me know if you have any questions or concerns with this version, and thank you for working with us on this.
Pat

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