

INVESTIGATIVE BIOLOGY LABORATORY (BioG 1500) SYLLABUS

This course is designed to provide lab experience with emphasis on the processes of scientific investigation and to promote collaboration, communication, and literacy in science. The goal of this lab course is to teach skills, especially critical thinking and problem-solving, that students can apply in research laboratories during their time at Cornell and after graduation. These skills go far beyond learning how to use particular laboratory equipment.

The course introduces students to a laboratory research environment, teamwork, hypothesis formation, experimental design, statistics, and ethics in research. Students practice many forms of science communication, from presentations to paper writing and scientific poster preparation. The course modules follow the “crawl, walk, run” approach to develop the capacity of students to solve increasingly challenging problems with greater independence. Lab topics include genetics, evolution, microbiology, ecology, biochemistry, and molecular biology. First, the students fill their scientific “tool box” to design and carry out experiments and then use that tool box to conduct student-driven investigations. The course uses three modules to cater to the different interests in biology: a) the antibiotic resistance research module targets those who are interested in a pre-med track, b) the module in algal population growth for biofuel production caters to biological engineers and ecologists, while c) the human microsatellite DNA module is in the interest of those who would like to gain skills in genetics and molecular biology research. The expectation is that students finish the course as well-rounded scientists, equipped with all the skills needed in real research environments.

The course employs a number of student-centered pedagogies including case studies, formative assessment using a web-based response system (poll everywhere), problem-based learning, reflection, debate, role playing, presentations, hands on activities, peer-teaching, peer-review, and inquiry-based learning.

By the end of the course, students will be able to:

1. Design hypothesis-based experiments, choose appropriate statistical test(s), analyze data, and interpret results.
2. Demonstrate mastery of modern lab techniques and scientific methods that can be applied across biological systems and scales.
3. Find relevant scientific information using appropriate library tools, and to communicate effectively using both written and oral formats.
4. Think through a scientific process with peers and understand the ethics, benefits and challenges of collaborative work.
5. Use discovery science to explore patterns in nature, and understand the importance of accuracy and precision.
6. Apply fundamental biological information to increasingly novel and complex situations.

HOW TO REACH US

607-255-2031

www.InvestigativeBiology.cornell.edu

biolabs@cornell.edu

| | |
|---|--------------------|
| Mark A. Sarvary, Director of Laboratories | 1140 Comstock Hall |
| Irena Horvatt, Course and Media Coordinator | 1130 Comstock Hall |
| KC Ryan, Laboratory Coordinator | 1132 Comstock Hall |
| Educational Postdoctoral Associates | 1128 Comstock Hall |
| Lab Instructors (TAs) | 1122 Comstock Hall |

All rooms are located on the first floor of Comstock Hall. The Administrative office is in 1130, and laboratories are located in 1104, 1108, 1112, 1116 and 1120. Students attend one 50-minute lecture and participate in one three-hour laboratory per week.

Weekly Lecture: Tuesday 9:05-9:55 am. Room: Call Auditorium, 116 Kennedy Hall.

Weekly Lab: See your roster for the section time and lab room.

FOUR IMPORTANT THINGS YOU WILL NEED IN THIS COURSE

1. *Investigative Biology - a Laboratory Text* (Sarvary, Fall 2018) – **available at the Cornell Store**
2. *Biology For a Changing World*, 2nd edition (Shuster et al., 2014) – **e-book available online**
Provides custom-made chapters and pages via electronic access. Purchase the access directly from the publisher: <http://tinyurl.com/F18ebook>. If you are not sure whether or not you will stay in the course, sign up for the 21-day temporary access before you purchase the book.
3. *Poll Everywhere* classroom response system – **free and available online at polleverywhere.com**
Poll Everywhere produces a tool that allows you to interact with your professor(s) through your own mobile devices. The intended goal is to improve student engagement in the classroom through the use of interactive learning. During each lecture you will use Poll Everywhere to answer multiple-choice and short answer questions based on the assigned readings and your understanding of the lecture. **You must log in with your NetID every time!** If you are not logged in, your answers will not count toward your grade!

How to register:

- Go to: <http://tinyurl.com/F18poll>
- You will be asked to provide your name and Cornell email address (other email addresses will not be accepted in the course). Create a unique password.
- If you plan on using your cell phone to text the responses, you must enter and certify your cell phone number in your profile (www.polleverywhere.com/profile/edit) to ensure that you receive credit for responding.
- Check if you are connected to BIOG1500 under settings/voter registration. Follow the instructions for “Register as a Participant” to check if your account is connected to the course. It may prompt you to enter Dr. Sarvary’s email address: mas245@cornell.edu.
- If you have any questions, please visit the Poll Everywhere User Guide (www.polleverywhere.com/guide).
- Your information is protected and Poll Everywhere will never share emails or phone number with any third party.

Answering poll questions:

- Questions will appear on www.pollev.com/BioG1500.
- Make sure you are **signed in** before answering the questions. This will ensure that you receive credit for responding. Signing in is your responsibility. For take home questions, you must be signed in on the web browser that you are using to answer the questions. Without signing in, you will not receive any credit for your answers.

Without completing the steps above, Dr. Sarvary will not be able to see your responses.

4. “R” is a free statistical software that will be needed for data analysis and graphing throughout the semester.
 - You can download this software for your PC or Mac from www.r-project.org. Choose one of the US Mirrors. Please also download R-studio from www.rstudio.com/ide/download.
 - Create a folder on your computer called “RBioG1500”, where you may wish to store all the datasets used in BioG 1500.
 - Download this software to your laptop that you can bring to lab when needed.

HOW TO SUCCEED IN THIS COURSE:

Participate in the lecture dialogues: The content knowledge required for the laboratory sessions will be discussed during the lectures. Questions prior to (and during) the lectures will test whether you completed the assigned readings and test whether you acquired the needed information to complete the laboratory exercises. You should complete the assigned reading (posted scientific papers, the e-book, and the Lab Manual) prior to lecture. During each lecture you will answer multiple choice and short answer questions. Choosing the correct answer will earn you full credit; choosing an incorrect answer will not earn any credit. Approximately 20% of the in-lecture polling scores will be dropped, in case you cannot attend a lecture or your device was not working.

Unless poll questions are assigned as homework, answering them outside of the lecture hall (pretending to be in lecture) is considered academic dishonesty and results in the loss of ALL lecture participation points. No exceptions.

Gain useful lab skills: Your success in the lab course depends on your preparation for each new lab. A thorough reading of the relevant lab chapter, e-book reading, and attending and actively engaging in lecture should adequately prepare you for each lab session. This is a lab course; therefore lab attendance is mandatory. Please arrive on time so you can actively participate in the lab. If you require special accommodations, or need to miss a lab, providing officially recognized documentation to Irena Horvatt in the course administrative office (1130 Comstock Hall) is suggested. This will aid you not only in obtaining those accommodations, but also will enable our course staff to better assist you. In cases where two or more labs have been missed, course withdrawal is suggested.

Take advantage of the course learning tools: *Questions to prepare you for each module*, and questions to test your knowledge are in the lab manual. Meet your lab instructor during office hours to discuss the answers to these questions. Worksheets and *apply your skills questions* are designed to help you solve problems related to a lab topic or help you learn a particular skill in science, such as searching for scholarly literature. Some of them will be completed in lab, others outside of lab. Use these questions as smart learning tools! Many of these questions will appear on the practical exams. *Instructional videos* and *Tutorials* were developed or sought out by our staff to help you gain certain lab skills.

Be on time and don't procrastinate: Some assignments are due at the beginning of your lab section; while the paper writing assignments are due at 5pm on Friday. Please consult the calendar at the end of the syllabus. *The lab instructor cannot change deadlines.* If you have a valid reason to receive an extension without penalty, please contact Dr. Sarvary. If you cannot finish your assignment by the deadline, you can submit a late assignment. Late assignments carry a 30% reduction of grade per day: for example if you turn in your assignment within 24 hours after its deadline, you cannot receive more than 70% of the maximum score. If you are 24-48 hours late, your maximum score can be 50%. None of the assignments can be more than 48 hours late. Late submissions will also result in late return of the graded assignments. Some assignments (i.e. peer-review, poll questions, etc.) cannot be turned in late.

Don't be shy, speak up! We are here for you! Do not wait until the end of the course to raise problems/issues. Come and talk to us! If you are experiencing undue personal or academic stress at any time during the semester or need to talk with someone about a personal problem or situation, please seek support as soon as possible.

Monitor your assignments and the posted grades on Blackboard. Please look at answer keys as soon as they are posted, and your graded exam as soon as they are returned to you! "*Errare humanum est*", but if you notice a grading error on your graded exam, don't wait! Notify your TA within 48 hours of the receipt of the grade. Due to the fast pace nature of this course, we cannot honor re-grading requests after 48 hours. Please always provide a clear and detailed explanation of why you find an answer incorrect.

The BioG 1500 Staff is available to talk with you about stresses related to your work in this class. Additionally, we can assist you in reaching out to any one of a wide range of campus resources:

- Cornell Learning Strategies Center at 255-6310, <http://lsc.sas.cornell.edu>
- Gannett Health Services at 255-5155, www.gannett.cornell.edu
- Peer Support provided by Empathy Assistance and Referral Service at 255-EARS
- Office of Undergraduate Biology at 255-5233, biology.cornell.edu
- Student Disability Services (SDS) in 420 CCC building; phone number is 254-4545.

HOW WE WILL ASSESS YOUR KNOWLEDGE AND LABORATORY SKILLS:

We use a wide variety of assessment techniques to form a realistic picture of your understanding of the course content and the laboratory skills you gained in this course. **Lab Practical Exams:** This is a biology laboratory course; therefore your scientific skills will be tested in a laboratory setting. Two **lab practical exams** will be held in lab during regular lab time, in *lab 4* and *lab 12*. They will cover the practical skills of instrumentation, statistics, and methods in science and communication. **Lab Participation:** Your lab participation grade will be partially based on an evaluation of your **lab etiquette**, which includes your working habits, responsibility, cooperation, and preparedness. You will also need to submit 3 questions and answer them for each module. The Q&A are due by the lecture time of certain weeks (see calendar).

Communicating Science: We want to prepare you to tackle the challenges of scientific publishing, so you will go through the same writing process as scientists, who submit their papers to a scientific journal. To help improve your writing skills, your paper will go through a peer-review process. You will receive points if you submit a reviewable assignment. As a final, graded assignment, you will individually write a **complete scientific paper** on the antibiotic resistance experiment, and present a **scientific poster** on the limiting nutrient experiment.

| <u>Component</u> | <u>Percent of Grade</u> |
|---|-------------------------|
| LAB SKILLS AND CONTENT KNOWLEDGE (total 60%) | |
| Practical exam 1 | 10 |
| Practical exam 2 | 14 |
| Statistics worksheet | 3 |
| Lecture participation | 6 |
| Mid-semester Lab participation & etiquette (attendance, activity, behavior) | 3 |
| Lab participation & etiquette (attendance, activity, behavior) | 6 |
| Understanding Experimental Design & Liebig's Barrel Simbio | 4 |
| 3 Pre-lab questions and answers for each of AR, LN & DNA modules | 9 |
| LN & AR & DNA big picture reflection paragraphs | 3 |
| Transferable skills (apply skills in novel settings outside of class) | 2 |
| COMMUNICATING SCIENCE (total 40%) | |
| Critically evaluate a scholarly journal article (worksheet) | 3 |
| <u>Publishing your research:</u> | |
| Antibiotic Resistance (AR) design mini-seminars | 2 |
| Antibiotic Resistance (AR) Introduction and Methods draft | 2 |
| <i>First submission:</i> Antibiotic Resistance paper for peer-review | 2 |
| Peer review and self-review | 3 |
| <i>Back to the editor:</i> AR paper for publication | 10 |
| Peer-review rebuttal letter | 2 |
| <u>Going to a conference:</u> | |
| Limiting Nutrients (LN) virtual poster draft | 2 |
| LN Poster visuals and content | 10 |
| LN Poster oral presentation | 2 |
| LN Poster Supplementary materials | 2 |
| Total: | 100% |

Final letter grades: your final performance in the course *will not* be based on the performance of other students (e.g. no curve). The general guidelines for letter grades: 90-100%: (A+, A, A-); 80-90%: (B+, B, B-); 70-80%: (C+, C, C-); 60-70%: (D+, D, D-); below 60% is F. Exact cut-off points will not be known until the day of letter grade assignment. We do not offer extra/bonus assignments.

Incompletes: Cornell policy dictates that an incomplete be arranged only when a student has substantial passing equity in the course (e.g. all requirements for the course have been completed satisfactorily except for a term paper or final exam) and the reason for failure to complete all course requirements is convincing to the instructor and beyond the student's control. If you feel that you deserve an incomplete, you must contact Dr. Sarvary and provide legitimate documentation.

STAY CONNECTED AND BE INFORMED:

1. Course website and social media

You can find valuable course information on our website (www.InvestigativeBiology.cornell.edu). Please check back frequently for updated instructional videos on our YouTube channel, science news, blog posts, and event announcements.

Use our social media outlets to receive real-time information about the course, staff and your fellow students. Find **@Cornellbiolabs** on *Twitter, Facebook & Instagram*. Use **#CUintheLab** in your posts.

2. BLACKBOARD™ 9.1

Instructors and course staff will post course related materials to Blackboard™ 9.1 (Bb). Assignments must be submitted through Bb. You will use Bb to view course documents, to view slides of course lectures, to receive statistical codes for R, to watch online tutorials for statistics, literature searches and other topics. You can monitor your grades throughout the semester. Access to Bb 9.1 requires that you use your net ID, which is the first part of your Cornell email address, and your self-chosen password.

DISCLAIMERS:

Plagiarism: According to the Cornell University [Code of Academic Integrity](http://cuinfo.cornell.edu/Academic/AIC.html), a student shall be guilty of violating the code of academic integrity if she/he knowingly represents the work of others as her/his own [or helps another student to do so]. For additional information, refer to <http://cuinfo.cornell.edu/Academic/AIC.html>. If you are accused of plagiarism, a primary hearing is scheduled at which the evidence is considered and a decision rendered. If you are found guilty, the academic integrity officer of your college is notified.

Using pedagogical data for publications: Instructors of this course seek out new, modern pedagogical methods to improve the education of our students. Instructors may use data from exams or from poll questions in aggregate form (without identifiers of any sort) to evaluate our pedagogy. These exam question or poll question evaluations may be published in pedagogical journals. We always maintain our students' confidentiality, but students can request verbally or via email (mas245) to opt out if they have concerns. Please do not hesitate to contact the instructors if you have specific questions.

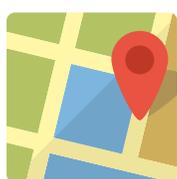
Lost and Found: Items left in the lab room may be turned in to and retrieved from the Course Coordinator Irena Horvatt in 1130 Comstock Hall. Items left in the lecture room may be retrieved from the Call Auditorium staff.

CALENDAR FOR LECTURE AND LAB ACTIVITY

| Week of | Activity | Readings and Assignments <i>E-book (BCW), Investigative Bio Lab Manual (IB)</i> |
|-----------------------------|--|---|
| Week of August 27 | | |
| Lecture 1 | Course Introduction; "Science is..." | |
| Lab 1 | Scientific Skills I: Lab safety and etiquette, Simulation modeling, Microscopy, Preliminary study data collection | <i>IB: Ch. 1.</i> / Bring Laptop |
| Week of September 3 | | |
| Lecture 2 | Scientific Investigations in Biology; Introduction to the research modules; Statistics | <i>BCW: Lecture 2</i> |
| Lab 2 | Scientific Skills II: Importing data in "R", Spectrophotometry, Full-scale study, Statistical Methods, Pipetting; Serial Dilutions | <i>IB: Ch. 1;</i> Download "R" and Bring Laptop; Complete the Serial Dilution Online Tutorial |
| Week of September 10 | | |
| Lecture 3 | Communication in Science; Science literacy I: Keyword searching; Scientific skepticism | <i>BCW: Lecture 3;</i> http://guides.library.cornell.edu/biog1500 |
| Lab 3 | Scientific Skills III: Statistics worksheet, Case study: How Scientists Think; Paper discussion, Practical review | <i>IB: Ch. 1;</i> Bring Laptop and read the assigned paper; Due: understanding experimental design simulation |
| Week of September 17 | | |
| Lecture 4 | Spontaneous Mutations and Antibiotic Resistance; Science literacy II: Citation management demonstration | <i>BCW: Lecture 4;</i> Read: <i>Evolution in Action</i> article on BB; http://guides.library.cornell.edu/Zotero_Guide |
| Lab 4 | <i>Practical exam I;</i> Antibiotic Resistance (AR) I: Treatment simulation game; Paper grading and common errors in writing | Submit the Statistics Worksheet on Blackboard |
| Week of September 24 | | |
| Lecture 5 | Darwin and Natural Selection | <i>BCW: Lecture 5;</i> DUE: 3 questions and answers on AR module on BB. |
| Lab 5 | Mid-semester evaluations; AR II: Set-up Class Project; Design AR experiment; AR paper discussion (jigsaw) | <i>IB: Ch. 2,</i> Read AR paper for discussion; |
| Week of October 1 | | |
| Lecture 6 | The responsibilities of a scientist; Responsible Conduct of Research (RCR); Science literacy III: Evaluating information | <i>BCW: Lecture 6;</i> http://guides.library.cornell.edu/fakenews |
| Lab 6 | AR III: Frequency calculation, mini-seminar on AR experimental design; Group experiment set-up | <i>IB: Ch. 2;</i> Bring AR Experimental Design Seminar Slides; Submit the Paper Discussion Worksheet; Due on Friday by 5pm: introduction & methods & references draft of AR paper |
| Week of October 8 | Week of Fall Break – No class all week | |

| | | |
|--|--|---|
| Week of October 15 | | |
| Lecture 7 | Limiting Nutrients (LN) I | BCW: Lecture 7; DUE: 3 questions and answers on LN module on BB. |
| Lab 7 | LN I: Learn about algae; Design LN Experiment; Climate Change Forum Information Gathering; AR IV: Group Data Collection and Analysis; How to explain a figure | IB: Ch. 2, Ch. 3, Bring Laptop; Submit Climate Change Forum Literature; DUE: Liebig's Barrel Simbio Simulation |
| Week of October 22 | | |
| Lecture 8 | Limiting Nutrients II | BCW: Lecture 8 |
| Lab 8 | The importance of feedback; LN II: Set up LN Experiment; Finalize Climate Change Forum Class Statement | IB: Ch. 3; Bring Laptop; DUE: AR Module reflection paragraph Due on Friday by 5pm: Submit AR Paper for Peer-Review |
| Week of October 29 | | |
| Lecture 9 | Climate Change Forum | BCW: Lecture 9 |
| Lab 9 | LN III: Poster Examples; Data Collection and Analysis; Peer-review in lab | IB: Ch. 3; Bring Laptop Due on Friday by 5pm: Submit Peer- and Self-Reviews |
| Week of November 5 | | |
| Lecture 10 | Human Microsatellite DNA (DNA) I. | BCW: Lecture 10; DUE: 3 questions and answers on DNA module on BB. |
| Lab 10 | DNA I: Student DNA Extraction; Peer-review rebuttal letter writing; Present LN results; Poster preparation | IB: Ch. 4, Bring LN Result Virtual Poster; Due on Friday by 5pm: Submit the corrected AR paper, and address the reviewers' comments |
| Week of November 12 | | |
| Lecture 11 | DNA II: Population Genetics; Post-course questions | BCW: Lecture 11; DUE: LN Module reflection paragraph |
| Lab 11 | DNA II: Student DNA Results; Gel Electrophoresis; Practical Review; Paper writing and Poster preparation; Lab Evaluation | IB: Ch. 4; Appendix 1; Appendix 2. DUE: Transferable skills: how LN and AR skills can be used in novel and more complex settings. |
| Week of November 19 Thanksgiving Break | | |
| – No class all week | | |
| Week of November 26 | | |
| Lecture 12 | Review of the semester: Ignite Talks; Evaluations | DUE: DNA module reflection paragraph |
| Lab 12 | Poster presentations; Practical exam 2 | Bring Poster to present, Submit Supplementary materials & Poster pdf on Blackboard |
| Week of December 3 | | |
| No Lecture | | Due on Tuesday, December 4 at 10am: AR Paper for Publication |

Welcome to BLOG 1500



You are here!

- * Lecture in Call Auditorium
- * Labs in Comstock Hall
- * Purchase lab manual & e-book.

Connect

- * Download required software
- * Register for Polleverywhere.com
- * Connect to course social media

Know Your Staff!

- * Check the course website for office hours
- * READ and RE:spnd to e-mails promptly



Lab # 8

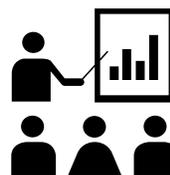
- * Antibiotic Resistance Paper due Friday 10/26 by 5:00pm.

Lab # 6

- * Mini-Seminar Paper Discussion Worksheet

Lab # 4

- * Practical Exam # 1 Statistics Worksheet



Final Paper Due

Lab # 9

- * Provide Peer & Self Review by Friday 11/2 by 5:00pm.

Lab # 10

- * Paper Submitted & Comments addressed by Friday 11/9 by 5:00pm.

Lab # 12

- * Poster Presentation, Practical Exam 2, All poster materials submitted to Blackboard



Useful Course Links:

facebook.com/CornellBiolabs
twitter.com/@CornellBiolabs
investigativebiology.cornell.edu
instagram.com/cornellbiolabs

Tuesday 12/4
@ 10am

Investigative Biology