Summer 2018

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

Dr. Mark A. Sarvary, Director of Laboratories	1140 Comstock Hall	mas245@cornell.edu
Ms. Irena Horvatt, Course and Media Coordinator	1130 Comstock Hall	ith7@cornell.edu
Ms. Martha Lyon, Laboratory Coordinator	1105 Comstock Hall	
Ms. KC Ryan, Assistant Laboratory Coordinator	1128 Comstock Hall	
Ms. Natalie Bray, Laboratory Instructor	1122 Comstock Hall	nab244@cornell.edu

The administrative office and lab rooms are located on the first floor of Comstock Hall; rooms 1130 and 1120, respectively. Students attend a lecture on Monday and participate in two laboratories on Tuesday and Thursday.

Weekly Lectures: Mondays 1:30-4:30 pm. Room: A106 Morison Room, Corson-Mudd Hall
Weekly Labs: Tuesdays and Thursdays 1:30-4:30 pm. Room: 1120 in Comstock Hall

THREE IMPORTANT THINGS YOU WILL NEED IN THIS COURSE

1. ***Investigative Biology - a Laboratory Text*** **(Sarvary, Spring 2018) – available at the Cornell Store**

2. ***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 for Poll Everywhere:
   - Go to: http://tinyurl.com/Summer18poll
   - 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.

3. ***"R"*** **is a free statistical software that will be needed for data analysis and graphing throughout the summer.**

   - 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 and the Lab Manual) prior to lecture. During each lecture you will answer multiple choice and short answer questions using Poll Everywhere. 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, 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 need to miss a lab, you must contact Irena Horvatt in the course administrative office (1130 Comstock Hall) before the day you miss the lab. A valid reason (sickness, religious holidays, or conflicts with other academic activities) will be required. In cases where 2 or more labs have been missed, course withdrawal is suggested.

Take advantage of the course learning tools: a) "*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; b) "*worksheets and test-your-knowledge 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: In general, assignments are due in lab, at the beginning of the lab section. 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 40%. 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 summer 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 look at your graded exams 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 during *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.

Science Communication: 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 or present a poster at a conference. You will individually write a **complete scientific paper** on the antibiotic resistance experiment. To help improve your paper, your lab instructor and your peers will review your submission. Your research group will present a **scientific poster** on the limiting nutrient experiment. You will also practice how to present your experimental design and results in mini-seminar format.

Component	Percent of Grade
LAB SKILLS AND CONTENT KNOWLEDGE (total 60%)	
Practical exam 1	10
Practical exam 2	15
Statistics worksheet	5
Lecture participation	6
Mid-semester Lab participation & etiquette (attendance, activity, behavior)	3
End of-semester Lab participation & etiquette	5
Understanding Experimental Design & Liebig's Barrel Simbio	2
3 Pre-lab questions and answers for each of AR, LN & DNA modules	9
LN & AR & DNA big picture reflection paragraphs	3
Transfer of learning (apply skills in novel settings outside of class)	2
SCIENCE COMMUNICATION (total 40%)	
Critically evaluate a scholarly journal article (worksheet)	2
Publishing your research:	
Antibiotic Resistance (AR) design mini-seminars	2
Antibiotic Resistance (AR) Introduction and Methods draft	2
First submission: Antibiotic Resistance paper for peer-review	2
Peer review and self-review	3
Back to the editor: AR paper for publication	10
Peer-review rebuttal letter	2
Going to a conference:	
Limiting Nutrients (LN) virtual poster draft	3
LN Poster visuals and content	10
LN Poster oral presentation	2
LN Poster Appendix (supplementary materials)	2

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 cannot 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, 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.

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.

Diversity statement: Students in Investigative Biology come from a variety of backgrounds, abilities and identities. To promote learning for all, each member of this course is expected to contribute to an inclusive and respectful learning environment. If you feel that this is not happening, please contact Dr. Sarvary immediately.

CALENDAR FOR LECTURE AND LAB ACTIVITY **[Subject to change]**

	Day	Lab or Lecture Activity	Readings *Chapters in your Lab Manual (IB)/ on BB/ AND Assignments Due*
M (Lec. 1-2)	June 25	Course Introduction, Pre-course questions	
		Scientific Investigations in Biology, Introduction to our research modules	
T (Lab 1)	June 26	Scientific Skills I: "Science is…"; Lab safety and etiquette, Simulation modeling, Microscopy, Preliminary study data collection	*IB: Ch. 1.*/ BRING LAPTOP
Th (Lab 2)	June 28	Scientific Skills II: Importing data in "R", Spectrophotometry, Full-scale study, Serial Dilutions, Pipetting	*IB: Ch. 1.* DUE: DOWNLOAD "R" & BRING LAPTOP; DUE: SERIAL DILUTIONS ONLINE TUTORIAL
M (Lec 3-4)	July 2	Case study: How Scientists Think	DUE: UNDERSTANDING EXPERIMENTAL DESIGN SIMULATION
		Antibiotic Resistance	Read: *Evolution in Action article on BB;* DUE: 3 questions and answers on AR module on BB.
T (Lab 3)	July 3	Discussing Stats worksheet; Antibiotic Resistance (AR) I: Screening for resistance, Practical review: how to study for the practical exam	*IB: Ch. 2.;* BRING LAPTOP ; Read: *Make it Stick pg. 209-212 AND Tanner: Metacognition on BB;* DUE: STATISTICS WORKSHEET;
Th (Lab 4)	July 5	*Practical Exam I.*; Treatment simulation game; Design AR experiment	*IB: Ch. 2.;* BRING LAPTOP
M (Lec. 5-6)	July 9	Limiting Nutrients	*IB: Ch. 3.;* DUE: 3 questions and answers on LN module on BB.;
		Paper grading and common errors in writing; Jigsaw paper discussion; Good vs. Bad paper.	Read: AR paper posted on BB; Appendix 2.
T (Lab 5)	July 10	AR II: Frequency calculation; Mini-seminar on AR experimental design; Group experiment set-up	*IB: Ch. 2.* DUE: MINI-SEMINAR SLIDES ON AR DESIGN AND PREDICTIONS DUE: PAPER DISSECTION WORKSHEET
Th (Lab 6)	July 12	Limiting Nutrient (LN) I: Learn about algae; Design LN Experiment	*IB: Ch. 3.* / BRING LAPTOP DUE: INTRODUCTION & METHODS & REFERENCES DRAFT OF AR PAPER; Liebig's Barrel Simbio Simulation
M (Lec. 7-8)	July 16	Human Microsatellite DNA I.	*IB: Ch. 4.;* DUE: 3 questions and answers on DNA module on BB.
		Presenting and preparing posters	*IB: Appendix 2*

T (Lab 7)	July 17	AR III: Data collection; LN II.: Set up LN Experiment	*IB: Ch. 2., Ch. 3.* / BRING LAPTOP
Th (Lab 8)	July 19	Human Microsatellite DNA I: Student DNA Extraction; Primer design;	*IB: Ch. 4;* / BRING LAPTOP/ DUE: AR module reflection paragraph
M (Lec. 9-10)	July 23	Human Microsatellite DNA II.	*IB: Ch. 4.*
		The Peer-review process	DUE: AR PAPER FOR PEER-REVIEW / BRING LAPTOP/
T (Lab 9)	July 24	LN III: Data Collection; Statistical analysis; Poster preparation	*IB: Ch. 3.*/ BRING LAPTOP
Th (Lab 10)	July 26	Field ecology: applying your research skills *(field trip)*	DUE: Transfer of learning: LN and AR skills used in novel and more complex settings.
M (Lec. 11-12)	July 30	LN Poster Draft Presentation	DUE: LN RESULTS ON VIRTUAL POSTER DUE: LN module reflection paragraph
		Peer-review rebuttal letter; Paper writing and poster preparation	DUE: PEER- AND SELF-REVIEW /BRING LAPTOP
T (Lab 11)	July 31	DNA II: Student DNA Results; Gel Electrophoresis; Electropherogram; Practical review	*IB: Ch. 4.*
Th (Lab 12)	Aug 2	Poster session; Practical exam II	DUE: POSTER (Appendix + Poster pdf on BB); DUE: DNA module reflection paragraph
T	Aug. 7	9 AM: Final paper due	DUE: AR PAPER + REBUTTAL LETTER

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Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
24	June 25 Lecture 1-2: Intro, Sci. method	26 Lab 1: Sci. Skills I.	27	28 Lab 2: Sci. Skills II. DUE: Serial Dilution Tutorial	June 29	30
July 1	2 Lecture 3-4: How Scientists Think, Antibiotic Resistance (AR). DUE: Experimental Design Simbio; Read 'Evolution in Action' article on BB; 3 Q&A on AR	3 Lab 3: Statistics, AR I. Class project. DUE: Stats worksheet; Read 'Make it Stick' & 'Metacognition' article on BB	4	5 Lab 4: ***Practical Exam I.*** Design AR experiment.	6	7
8	9 Lecture 5-6: Limiting Nutrients (LN); Paper writing Read AR paper on BB; 3 Q&A on LN	10 Lab 5: AR II: Collect data, Set up experiment. DUE: Mini-Seminar On AR Design; Paper Diss. Worksheet	11	12 Lab 6: LN I: Design experiment; DUE: Intro, Methods and References of AR paper; Liebig's Barrel Simbio	13	14
15	16 Lecture 7-8: DNA I.; Science Communication. 3 Q&A on DNA	17 Lab 7: AR III: Data collection, LN II: Set-up LN experiment.	18	19 Lab 8: DNA I: Extraction, Primer design; DUE: AR module reflection	20	21
22	23 Lecture 9-10: DNA II; Peer-review process. DUE: AR Paper For Peer-Review	24 Lab 9: LN III: Data collection, Poster preparation.	25	26 Lab 10: Field ecology: applying your skills . DUE: Transfer of Learning	27	28
29	30 Lecture 11-12: LN Poster Draft presentation, Rebuttal letter writing. DUE: Peer-Review; Virtual Poster Draft; LN module reflection	31 Lab 11: DNA II: Data analysis, Gel electrophoresis; Practical Review	August 1	2 Lab 12: **Poster session** and **Practical exam II.** DUE: Printer Poster; Poster upload to BB; DNA module reflection	3	4
5	6	7 DUE: 9 AM. Final Paper				