

Let's Experiment: A Guide for Scientists Working at the Bench

Syllabus - February 2019

Course Goals and Mission Statement

Before you step into the lab to do an experiment, you have a long list of questions. So many, that it's overwhelming. A little guidance would be helpful, right?

"Let's Experiment" is a FREE 6-week online course designed to help guide you through the process of planning and executing experiments in biology. Scientists from a variety of backgrounds give concrete steps and advice to help you build a framework for how to design experiments. We use case studies to make the abstract more tangible. In science, there is often no simple right answer. However, you can develop a general approach to experimental design and understand what you are getting into before you begin.

Here is what you will learn in this course:

- The elements of a well-designed experiment, including variables, controls, sample size and replication.
- The absolute basics of experimental variability, sample size estimation, data analysis, and p-values, and how to seek help when needed.
- Insights into your own potential bias as an experimenter, how that affects reproducibility, and how to prevent it from impacting the design and execution of an experiment.
- Experimental tips and best practices on reagent authentication, keeping a good laboratory notebook, and getting an experiment to work.

And, here is what you will take away from this course:

- A detailed plan for your experiment(s) that you can discuss with a mentor.
- A colorful flowchart for how to prioritize experiments.
- A handy lab notebook template.

At the end of this course you will have a comprehensive understanding of how to think more effectively through the design of an experiment, and to be more rigorous and transparent in its execution.

Requirements

There are no prerequisites for this course.

Format

The course is composed of videos, text, relevant journal articles, forum discussion questions, and open response assessments. The majority of the instructional materials are contained within the videos and text.

This course is hosted during the defined time window **Feb 19 - Apr 2, 2019** and content will be released on a weekly basis, each Tuesday, until the course ends. We estimate you will spend 1.5 to 3 hours on the course per week. This includes time spent watching videos, reading text, doing assessments, and engaging in the forum.

“My Experimental Plan” (Assessments)

As you go through the modules, you will be prompted to apply what you’re learning to your own research through a series of self-reflective exercises. The goal of these exercises is to probe your thinking as you design an experiment for your own research. Your responses from these exercises will be accessible through a printable document titled “My Experimental Plan.”

Grading

This is a pass/fail course, and your grade will be based solely on the completion of the open response assessments. You will receive an iBiology Courses Certificate if you complete at least 50% of the assessments by April 2, 2019. Assessment fields are defined as any text input box that appears under the “Assessment” heading within the course. Each required assessment is numbered (e.g., “Q1,” “Q2,”) to help you keep track as you take the course. Each assessment field has equal weight so there will be no difference in penalty for assessment fields you leave incomplete. That being said, we highly recommend that you endeavor to complete as many assessment fields as possible in order to get the most out of the course.

If you have further questions regarding our grading policy or completion of the course, please feel free to contact us at courses@ibiology.org.

Course Schedule

Week 1

Module 1 - AN INTRODUCTION TO EXPERIMENTAL DESIGN: So you have an experiment in mind? How to get started. Includes:

- What is experimental design?
- An introduction to the case studies and their role in the course
- How to identify the right experiment to do that addresses your question
- An introduction to “My Experimental Plan” and the course assessments
- How to choose a “good” model system

Week 2

Module 2 - KEY ELEMENTS OF EXPERIMENTAL DESIGN: How to think carefully through key features of an experiment. Includes:

- The different types of variables in an experiment and why they matter
- The different types of controls in an experiment and why they matter
- What is random variation or noise?
- How to account for random variation through replication
- The different forms of replication
- A brief introduction to sample size estimation

Week 3

Module 3 - ACCOUNT FOR BIAS: How to identify your own bias as an experimenter and safeguard your experiment from that bias through rigor and transparency. Includes:

- Rigor and transparency leads to reproducibility
- What is bias and how does it affect your science?
- Randomization and blinding
- How preregistration helps reduce bias
- Think about your data and how to analyze it
- Clarifying the p-value
- What is p-hacking and how to avoid it?

Week 4

Module 4 - GEAR UP TO DO THE EXPERIMENT: Some tips and best practices on how to prepare right before doing an experiment. Includes:

- How to familiarize yourself with an experimental protocol for the first time
- How to approach validating key reagents
- Why you should care about taking good notes
- Tips and templates for lab notebooks

Week 5

Module 5 - GETTING THE EXPERIMENT TO WORK: Some tips and best practices on how to get an experiment to work. Includes:

- What is piloting and why is it important?
- How to approach troubleshooting
- How to approach optimizing
- No experiment is perfect: The need for orthogonal approaches

Week 6

- Review and make changes to “My Experimental Plan,” the document which contains your responses to all the assessments from the course. Discuss your experimental plan with a mentor.

How To Do Good Science

“Let’s Experiment” is the second course in the “How to Do Good Science” series from iBiology Courses. If you haven’t yet, we recommend that you take the first course in this series, called [“Planning Your Scientific Journey.”](#) It teaches you how to ask scientific questions and build a research plan. [“Planning Your Scientific Journey”](#) is self-paced and can be taken any time (before, during, or after the running of this course).

