

# Teaching the Scientific Method in a Large Introductory Biology Two-Semester Lab Sequence

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One of our goals in teaching Introductory Biology labs is to teach students the scientific method. After a two-semester Introductory Biology lab sequence, students should be able to formulate hypotheses, design a simple experiment, understand the concept and utility of experimental controls, analyze and interpret results, and communicate their findings. We have developed lab exercises during the first semester where we: 1) give students the experimental question and ask them to formulate a research hypothesis and a null hypothesis, 2) ask students to design positive and negative controls for an experiment given a choice of conditions, 3) teach students to construct line and bar graphs, calculate averages and standard deviations, perform t-tests and chi-square tests 4) ask students questions about their experiments that lead them toward interpretation of results, and 5) communicate findings by answering directed questions. In the second semester of the introductory biology sequence, we have developed an inquiry-based multi-week module based on metagenomic analysis of bacterial diversity using next generation sequencing technologies. In this lab module, students work on a real research question to obtain, analyze, interpret, and communicate their data using the skills that they developed during the first semester sequence. At the end of the second semester, students think about the next step that they would take to test their hypothesis or whether they would develop a new hypothesis based on their results. This two-semester sequence takes students through learning the fundamentals of experimental design and the scientific method in the first semester using a step-wise skill building learning approach, followed by tackling a real research question that requires more independent thinking and creativity in the second semester.

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