

Introductory Biology at Grinnell College: A Transition Based Upon Learning Goals

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GRINNELL COLLEGE



Problems

- We teach science very differently than we do science.
- The generally educated public is not very scientifically literate.
- The population of scientists looks dramatically different than the population of the nation.
- The facilities that support science education do not facilitate effective teaching.



Problems with Introductory Biology

- **Field and information content is exploding**
- **Course traditionally taught in a relay-style in large lecture sections with observational or ‘canned’ labs**
- **Faculty have a hard time agreeing on ‘coverage’**
- **Lots of content coverage, but students learn/retain little**
- **Students get little sense of what biologists do**



Motivation for the Transition

- **Difficulty in agreeing upon key content**
- **Frustration by lack of student learning**
- **Science division and national context**
- **Campus student learning assessment plan required departmental based learning goals**



A New Approach—Introduction to Biological Inquiry

- Research-based learning to move away from teaching biology as a collection of facts and toward teaching biology as it is actually practiced.
- Each faculty member teaches a section focused on a unique biological question that is related to her or his research interests.



A New Approach—Introduction to Biological Inquiry

- All sections teach similar skills such as using the scientific literature, designing experiments, analyzing data, and writing scientific papers.
- Instead of the more traditional three lecture classes and one three-hour lab per week, each section is taught in the “workshop” format where lecture, laboratory, and discussion are integrated.



Introduction

This one-semester course actively involves students in the entire process of science, from choosing a novel research question, making appropriate observations and/or performing experiments, and presenting the results in various formats, including a poster presentation. This approach encourages students to learn what they need to know to address their particular questions. In doing this, we hope they will begin to see that science is driven by questions and that existing facts are used to help construct answers. Learning the existing facts is not an end in itself. In addition to providing what we regard as a better introduction to our curriculum, we also hope that *Introduction to Biological Inquiry* will strengthen the bridge between our curriculum and our involvement of undergraduates in research.



Approach

Every year, seven or eight sections of the course are offered. Each section explores a particular problem that is closely associated with the professor's area of research. The sections currently offered are: **Prairie Restoration, The Language of Neurons, Building an Animal, The Sex Life of Plants, Emerging and Re-emerging Pathogens, What Does it Mean to be a Plant, Cell Fate: Calvin or Hobbes, The Effects of Climate Change on Organisms, and Biological Responses to Stress.** Each section is taught in the “workshop” format where students meet two or three times a week in large blocks of time that allow for integration of lecture, laboratory, and discussion in each class period.



Assessment

We include two types of assessment each semester the course is taught.

- The first is course-specific and is given in a pre-test/post-test format.
- The second is a survey given at the end of the course and asks the same questions of students enrolled in all sections of the course.



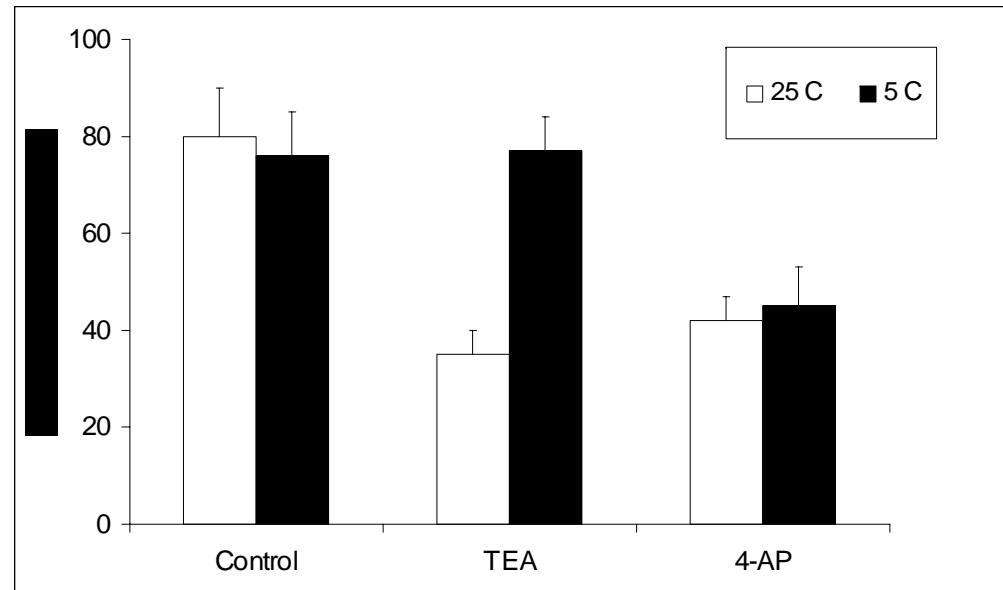
Pre-test Post-test

- On the first day of the course, students took a short written exam testing their knowledge of some factual information, data analysis, and experimental design. Similar questions were embedded on the midterm or final exams. Sample questions from one of the sections (**The Language of Neurons**) are shown below:
- **1. Factual Information:** What does the term “threshold” mean when it is applied to the nerve impulse?



Pre-test Post-test

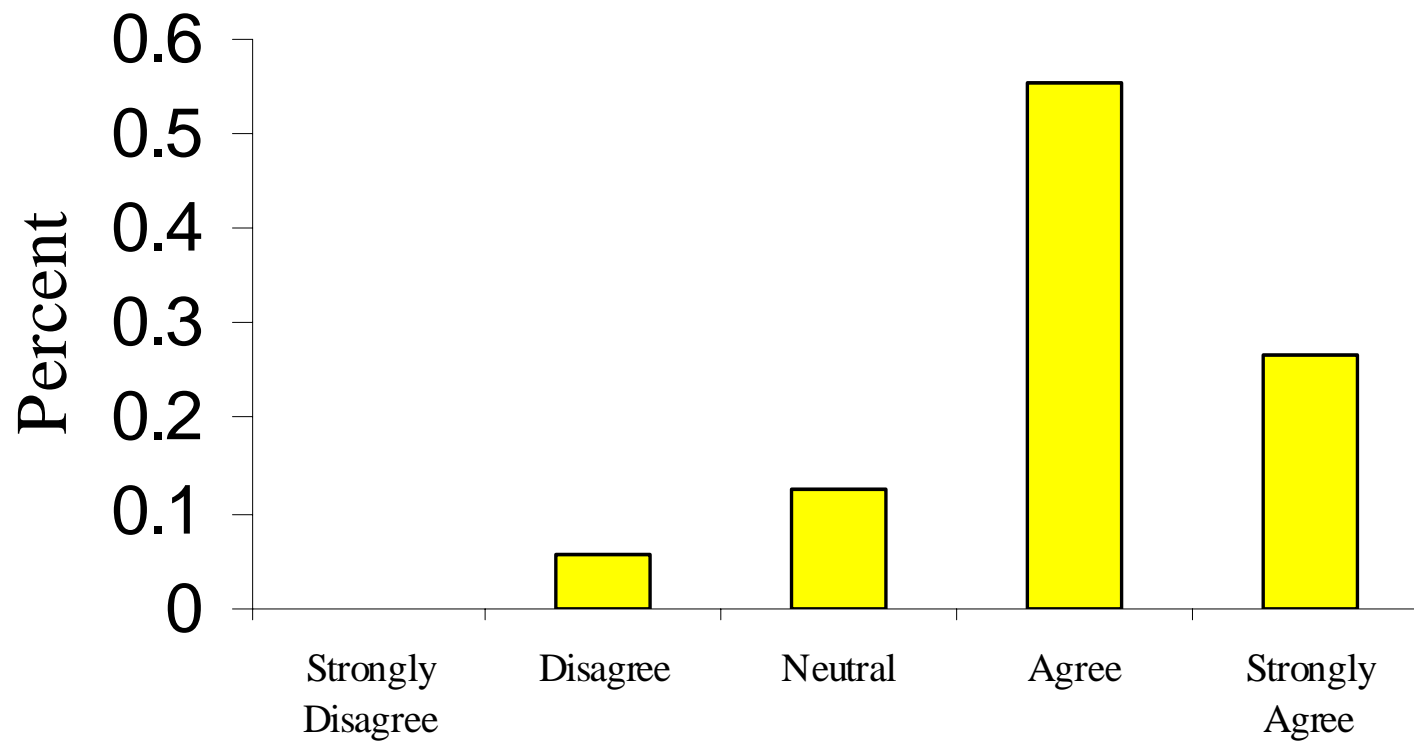
- **2. Data Analysis:**
The data to the right illustrate the results of an experiment to determine the effect of tetraethylammonium (TEA) and 4-aminopyridine (4-AP) on the resting membrane potential



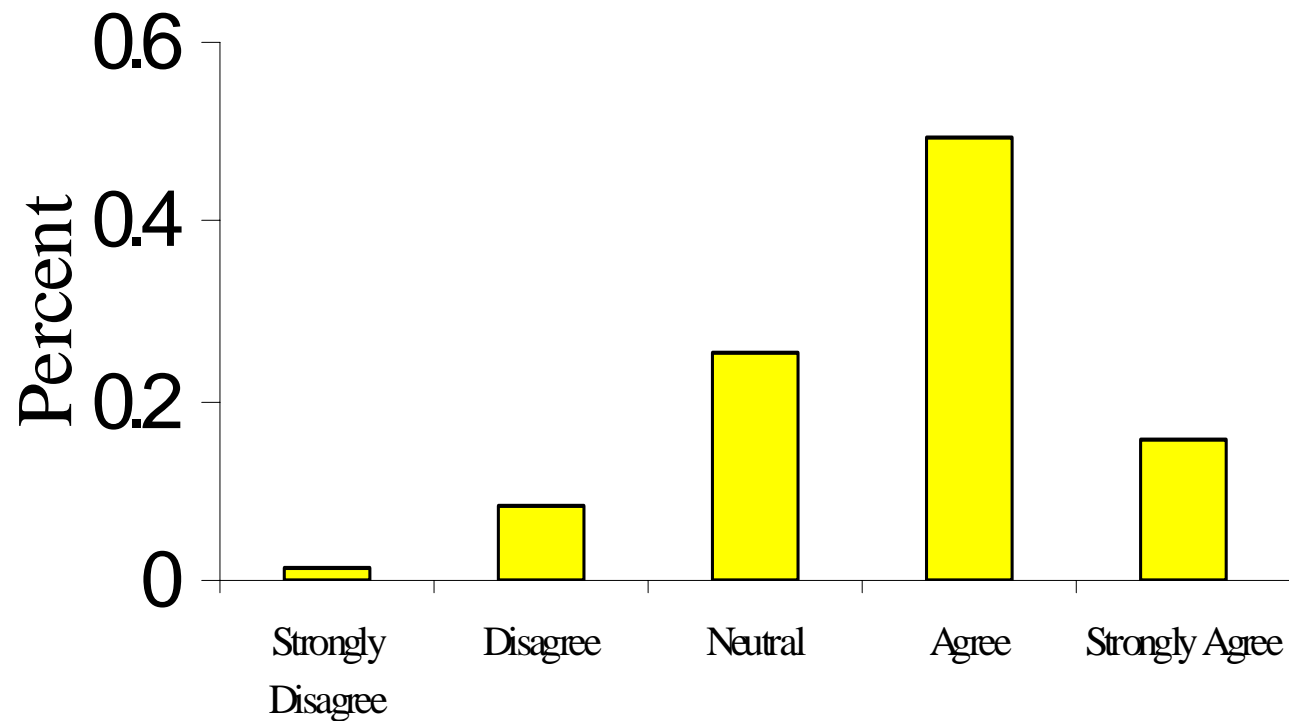
of muscle cells in the superficial extensor muscle of the crayfish. What can you conclude about the effects of TEA and 4-AP on the resting membrane potential?



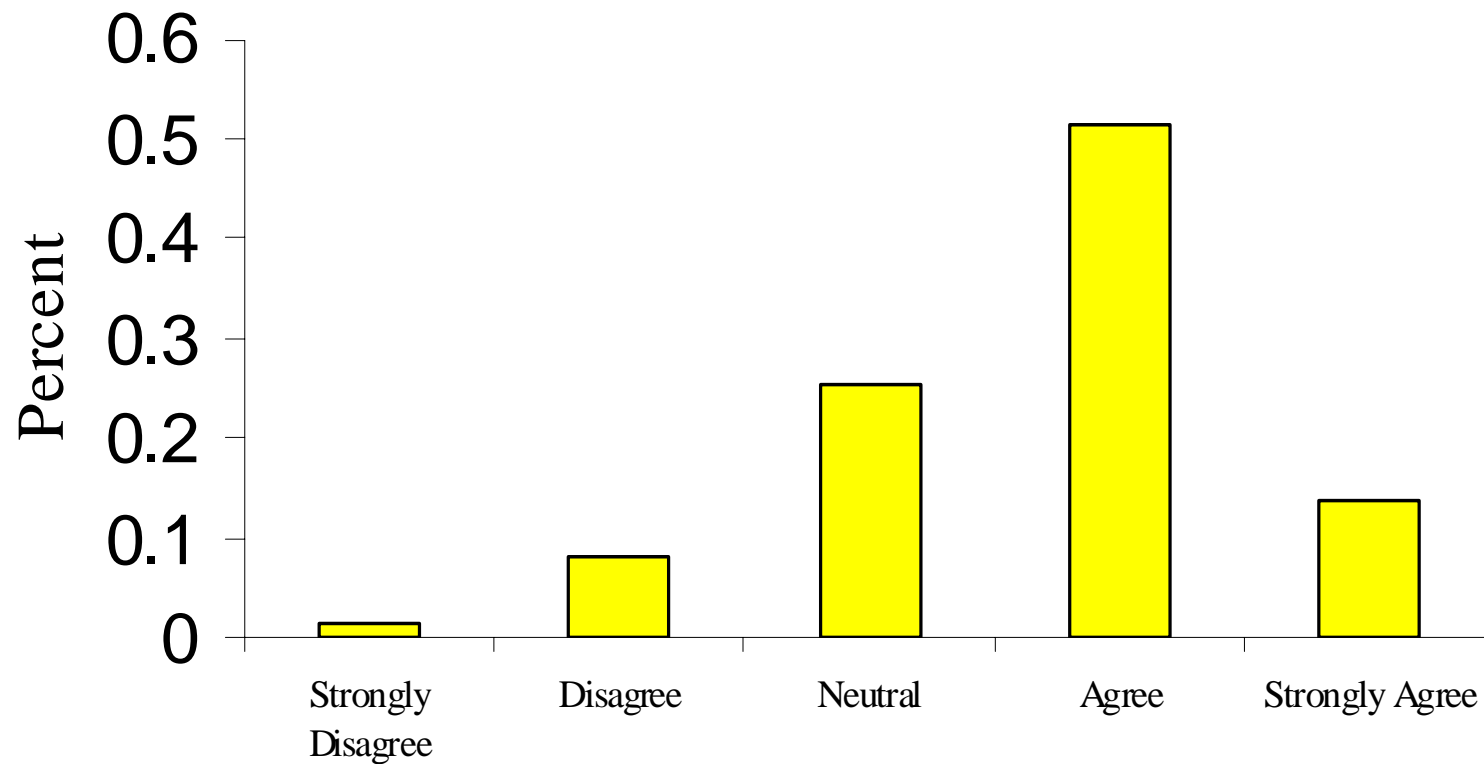
1. This course gave me insight into the process by which biological knowledge is advanced.



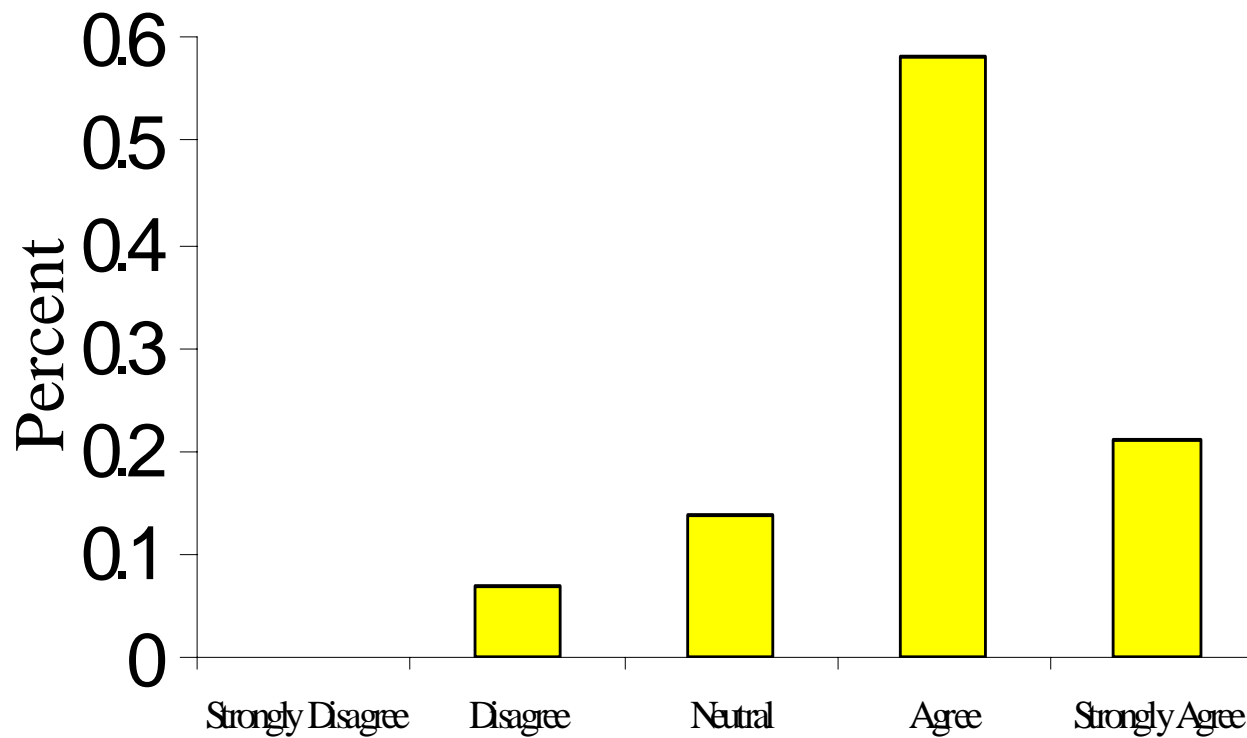
2. Because of taking this course I am more confident in my ability to learn something about a scientific topic that is new to me.



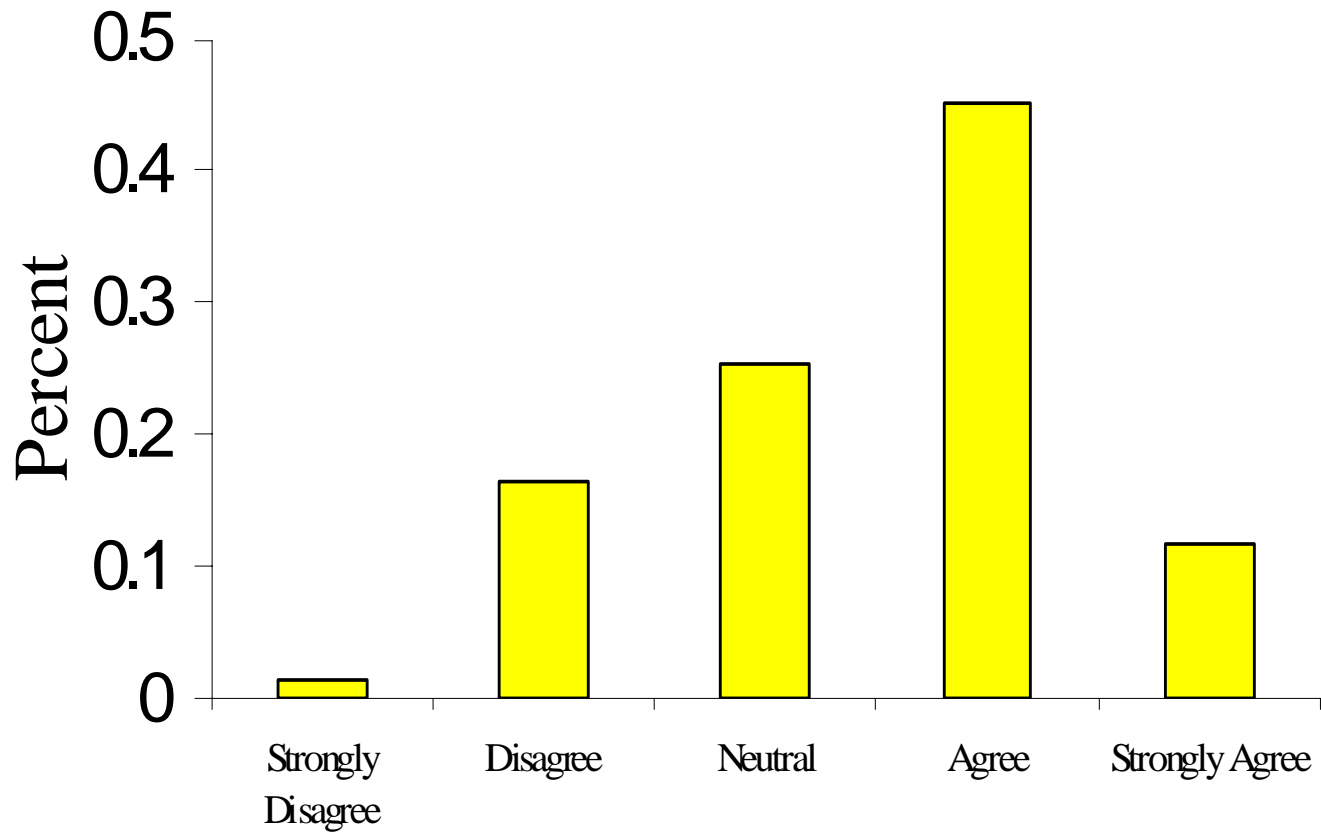
3. I have a different perspective on science than I did before taking this course.



4. Because of taking this course I am more confident in my ability to critique scientific work.



5. The work I did in this course improved my writing skills.



Summary

Most students enjoyed the process-driven style of the course and we documented substantial increases in their knowledge of factual information, experimental design, and data analysis. Students also had a better understanding of how biological knowledge is accumulated and where to look for new information.

Finally, we saw dramatic improvement in student writing and students themselves felt their writing improved significantly. We believe that the *Introduction to Biological Inquiry* course should prepare students well for mid- and upper-level courses that include a substantial research component and for independent research.



Acknowledgements

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