

The Effect of Hands-on Biotechnology Curriculum  
on High School Students' Understanding of  
Evolution and Natural Selection

“Nothing in biology makes sense, except in the  
light of evolution” (Dobzhansky 1973)

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**Abstract:** (Will be completed after research is conducted)

**Rationale:** The concept of evolution is central to the teaching of biology. The modern synthesis of evolution unites the ideas of Mendel and Darwin. All living organisms share a universal genetic code. Through the use of biotechnology it is now possible for scientists to determine exact measurements of degrees of biochemical similarities and differences among organisms and to establish evolutionary relationships among organisms (Dobzhanski 1972). Despite the overwhelming amount of scientific data, national polls show that over 45% of Americans do not accept the theory of evolution by natural selection (Quammen, 2004). Part of the misconception about evolution and natural selection may result from the fact that “in many courses of study, students’ experience with science is merely a survey of information without any meaningful exposure to the process that produced this information (Clough and Olson 2004). Even students who accept the theory of evolution may not completely understand the mechanism of natural selection. Many students have a Lamarckian view of change in populations and believe that organisms can consciously change their traits in response to the environment because they do not understand genetic variation or mechanisms of inheritance (Heim, 2002). The purpose of this study is to determine the impact of a hands-on biotechnology unit on student’s understanding of evolution and natural selection.

### **Action Research Intervention**

This research will be conducted in AP Biology class during the first semester of the 2010-2011 school year. This biotechnology unit will serve as a bridge between the genetics and evolution units. Students will have completed the two week Mission Biotech game during the genetics unit.

Objective for the biotechnology unit include:

- Students will understand that the ultimate source of genetic variation is differences in DNA sequences. Most of those genetic differences do not affect how individuals function. Some genetic variation, however, is associated with disease, and some improves the ability of the species to survive changes in the environment. Genetic variation, therefore, is the basis for evolution by natural selection.
- Students will understand that one of the benefits of understanding human genetic variation at a molecular level is its practical value for helping us understand and treat disease. The development of effective gene-based therapies is an exciting outcome of human genetic research.

The unit will revolve around 3 major experiments

Experiment 1 Detecting Mutations, Modes of Inheritance

Experiment 2 Producing a Therapy

Experiment 3 Using an Alu Insertion Polymorphism to Study Human Populations (kit from Carolina Biological Supply)

Experiment 3 will provide an introduction to human population genetics and review the concepts of genotypes and allele frequencies which will lead to a discussion of evolution. The results of this experiment will be referred back to throughout the course of the evolution unit.

**Connection to Bench to Bedside summer institute:**

During the genetics unit (prior to this biotechnology unit) students will play the Mission Biotech game developed by Dr. Troy Sadler

Students will be presented with information from the following Bench to Bedside lectures:

“Glycogen Storage Disease- Lessons From a Rare Disease” by Dr. Weinstein

“PKU” by Dr. Philip Laipis

Students will perform the following experiments using equipment from the Bench to Bedside program

Experiment 1 Detecting Mutations, Modes of Inheritance

Experiment 2 Producing a Therapy

Experiment 3 Using an Alu Insertion Polymorphism to Study Human Populations (kit from Carolina Biological Supply)

**Data collection and analysis:** Students will be given pre and post tests focusing on their knowledge of evolution and genetics. Throughout the genetics, biotechnology and evolution unit students will keep reflection journals in which they will answer questions about the unit content and personal opinion questions. Students will also be required to turn in a formal lab report on the culminating lab activity of the biotechnology unit. This lab report will demonstrate student understanding of both genetic and evolutionary concepts.

**Literature Cited:**

Clough, M., and J. Olson. "The Nature of Science: Always Part of the Science Story." *The Science Teacher* 71.9 (2004): 28-31. Print.

Dobzhansky, T. "Nothing in Biology Makes Sense Except in the Light of Evolution." *American Biology Teacher* 35.3 (1973): 125-29. Print.

"Genetic - Introduction to the Module." *Human Genetic Variation*. NIH, NHGRI, 1999. Web. 01 July 2010. <<http://science-education.nih.gov/supplements/nih1/genetic/guide/intro.htm>>.

Heim, W. G. "Natural Selection Among Playing Cards." *American Biology Teacher* 64.4 (2002): 276-78. Print.

Quammen, D. "Darwin's Big Idea." *National Geographic* 206.5 (2004): 2-35. Print.

**Budget:**

\$ 185 + shipping Carolina Biological Supply NP-21-1232 Alu DNA Extraction, Amplification, and Electrophoresis Kit with CarolinaBLU Stain and .5mL Tubes

**Permissions:** I will need to obtain permission from the headmaster and science department chair to conduct the research project. I will need to get signed permission forms from parents and students to use data generated from the project and to use student pictures.