The Genetic Engineering of Bt corn

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Subjects
Biology

Grade level
10

Duration
4 50-minute classes

Rationale (How this relates to engineering and the STEMcinnnati theme)
Various foods such as corn are genetically engineered to enhance growth and deter insects. 70% of food in grocery stores contains a genetically modified ingredient. Therefore, students are unknowingly eating these foods purchased at Cincinnati grocery stores such as Biggs and Kroger everyday. This lesson pertains to my research as I study the bacterium E. coli O157:H7. This bacterium produces a potentially lethal toxin. Various aspects of the E. coli projects in the lab involve strains of E. coli O157:H7 that I myself have genetically engineered.

Activity Summary
Students will review what they have learned about DNA and genetic engineering. After discussing how the natural pesticide was genetically engineered into the corn, students, guided by a worksheet, will go through the paper in which the initial scientist showed that the neighboring monarch was killed after eating corn pollen, after which, a social protest ensued. Students will design their own hypothetical experiment to verify or disprove this initial study. The next assignment will include filling out a worksheet individually regarding a paper that criticized the initial study. Students will subsequently participate in a debate. The debate will consist of four student groups: one will act as farmers, one as scientists (saying the monarchs will die), one as scientists (saying that the monarchs may live), and one as the protestors.
**Objectives**

*Upon completion of this lesson, students will be able to:*

1) Cite one example of a genetically modified food.
2) Explain that the corn was genetically modified in response to the corn borer’s destruction of the corn crop.
3) Look at a picture of a protest and describe that the people are dressed up as monarchs in order to prevent foods from being genetically modified.
4) Describe the initial study that addressed the effect on the monarch.
5) Design an experiment to determine the effect that the genetically modified corn pollen will have on the monarch.
6) Participate in a debate on the genetic engineering of corn.

**Standards**

**Ohio Standard: Life Sciences**

**Benchmark J:** Summarize the historical development of scientific theories and ideas, and describe emerging issues in the study of life sciences.

**Ohio Standard: Science and Technology**

**Benchmark B:** Explain that science and technology are interdependent; each drives the other

**Ohio Standard: Scientific Inquiry**

**Benchmark A:** Participate in and apply the processes of scientific investigation to create models and to design, conduct, evaluate and communicate the results of these investigations.

**Ohio Standard: Scientific Ways of Knowing**

**Benchmark A:** Explain that scientific knowledge must be based on evidence, be predictive, logical, subject to modification and limited to the natural world

**Benchmark C:** Describe the ethical practices and guidelines in which science operates

**Background knowledge**

The corn crop was being destroyed by the corn borer. Farmers were losing money. Genetic engineering was used to address the problem. A bacterial toxin gene was introduced into the corn. Thus, the corn pollen now produces a bacterial toxin that will kill the corn borer, saving the corn crop. This toxin will not kill humans. Scientists did a study to determine if the corn pollen harmed nearby non-target organisms, specifically the monarch. The monarch was caged and its only food source was the pollen. The monarch died. Animal rights activists
protested the use of corn by dressing up as monarchs at rallies. Since then, several studies all over the world have shown that when its natural environment, monarchs don't eat the pollen and are safe. Yet, it is hard to get society to believe this new data.

**Materials Required**

Worksheet, computers, published papers

Published papers: (1-2 pages each)


Websites:

US Department of Agriculture
University of Kentucky, Department of Entomology
Greenpeace
Biotech-info

**Activities**

**Day 1**

**Gaining attention:** Students will be shown a picture of a protest in which people are dressed up as monarchs, and be asked to describe what they believe is going on in the picture. Students will then be shown a picture of a cornstalk that is being eaten by the corn borer and be asked to describe what they believe is going on in the picture.

**Informing learners of the objective:** Ignoring the “catch” pictures so I can reask what the picture is after they complete the first assignment, I will share with them they are unknowingly eating genetically engineered foods, so this lesson will discuss different aspects of genetic engineering, including why, how, and if it is good or bad.

**Stimulating the recall of prerequisite learning:** I will discuss genetic engineering within the terms of their previous lab in which they genetically engineered a strain of *E. coli* resulting in an antibiotic resistant/Green Fluorescent Protein positive strain of bacteria. I will then relate this to my own
research, explaining how I have replaced the *E. coli* O157:H7 toxin gene with Green Fluorescent Protein (GFP), a protein they have already discussed in class and worked with in lab.

**Present the stimulus material:** Students will learn about why and how corn has been genetically engineered. The class will then be divided in half. One half will read the initial research paper that concluded that monarchs, who live near cornfields, die after eating the genetically engineered corn pollen. The other half will read the paper that argues that the experiments in that paper were flawed and that other experiments need to be done.

**Eliciting the desired behavior:** Using a worksheet, students will begin to evaluate the papers.

**Day 2**

**Gaining attention:** Students will discuss the papers regarding the debate over the initial experiment that tested the question "Does Bt corn pollen harm the monarch butterfly?"

**Eliciting the desired behavior:** Students who read paper 1 will pair up with students who read paper 2. Students will describe and discuss the results of the papers within their groups.

Students will then be divided up into debate groups: farmers, scientists (monarchs die), scientists (monarchs may live), and social protestors. Students will use the remainder of the class to do research in the math and science computer room for the presentations.

**Day 3**

**Eliciting the desired behavior:** Students will use the internet to gather additional information for their presentations.

**Day 4**

**Eliciting the desired behavior:** Student groups will present to the class.
Assessment of Student Learning

Students will be given a short quiz before and after the activity. Reading assignment homework will be graded for completion. Student participation in the debate will be based on the attached rubric.

Assessment of the Activity
Students will complete a survey addressing scientific interest and their own evaluation of their engagement during the activity.