High School Students Learn about GMOs Using an Inquiry-driven Case Study

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Purpose of Project

A problem-based learning activity was designed to enable high school students to think through the inquiry process for developing a Genetically Modified Organism as a solution to a food security problem.
GMO Facts in Education

• GMOs are a controversial issue prevalent in today's world.
• Much Negativity in the Media
• Because of the issues not many students learn the value (importance) to society
Case Studies
- Based on Common problems/traits plant breeders encounter
- Each Section of the Case Study was a step in developing a GMO.
- Students were able to be scientists and develop their own research plan
- Picked different genes for each Scenario
- Described the two methods used to inset a gene into a cell and students
- Described selection methods to find what cells have the gene
- Selection of Plants that Survive to maturity
- Choose plants with good qualities and can out perform the original
- Name the Line and write report

GMOs presentation
- Comparison of two different plants
- Importance of GMOs
- Current GMOs on the Market
- Conventional Plant Breeding/Why we develop GMOs
- A simplified version of how a GMO is made
- Overview of the Case Studies

3 Phases

Students conduct their inquiry study using case study booklets

Scientific Report
- Students had to report on their GMO
- State their problem and how they plan to fix it
- What gene they used and transformation method
- Explain how they selected the line they did

Student groups report to classmates
Student Scientists

• Urban location
• Chartered High School
• High school Agricultural Education Elective class
• Mixed age and gender
• 17 students in attendance
• Students in casual professional dress
  – Polo shirts and khakis
Scenario 1

The Current World Population is 7 billion and is expected to be 7.6 billion by 2020.

Goal is to develop a plant that can achieve higher yields on less amounts of land so there is enough food to feed the growing population.
Scenario 2

Raining Season is Becoming Shorter, Experts Predict Precipitation Decreases by Half in 5 Years. Goal is to develop a crop that can survive drought-like conditions and produce high yields.
A new insect has arrived from overseas and is eating away the foliage of the crops.

Goal is to develop a plant that will reduce the number of harmful insects feeding on it.
Scenario 4

Rainfall continues to increase causing many fields to become flooded. Experts predict the trend to continue in years to come.

Goal is to develop a plant that can survive in flooding conditions and produce high yields.
Outline of Steps in Case Study

• Pick a Crop to Improve
• Pick a Gene
• Choose a Transformation Method
• Evaluate the Lines
• Name your Line
• Write the Report
Candidate Genes

We provided the students a list of genes with a short description of the function.

- **Ex. Gene: Sub1A:**
- This gene is found in Rice. Controls ethylene production and gibberellic acid (plant hormones) responsiveness during submergence, economizing carbohydrate reserves and prolonging endurance. A plant expressing this gene can last up to two weeks completely submerged. (Fukao, 2011, The Plant Cell 23:412-427)
Transformation Options

- **Agrobacterium:**
  - Agrobacterium Cell
  - Agrobacterium DNA
  - Target gene

- **Gene Gun:**
  - Plant Cell
  - Plant DNA
  - Target Gene
  - Gold Particle
Selection

Agrobacterium DNA → Target gene → Bock 2001
Selection

Select for lines where the performance exceed the Wild Type

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Inquiry Approach

• Give Students a chance to go through the process themselves and be Scientists

Get students questioning WHY?
  • (How, What if)

• What are the components that make a good plant.

• Facilitate them to understand the basic steps of developing a GMO in simple terms
Inquiry Approach

Example of two soybean plants (internodes)

How are these plants different: Stems, height, is one plant better than the other, why?

Roundup-ready soybeans. Why use roundup?
Graduate Teaching Reflections

Initial Challenges
• How to take a complex process and make it simple
• How to keep the students attention and get them involved

Highlights
• Was able to include my research into the lesson
• Rewarding to see the students get involved and interested in the subject
• Was able to Collaborate with another Ph.D. Student from a different department
Teaching Observations

• Urban classrooms require
  – High activity levels of instruction
  – Multiple visual displays

• Stay on task- minimize “story telling”
  – Use white board or note space
  – Classroom teacher vital participant for behavior
Reliable Content Sites

- [http://www.nature.com/scitable/spotlight/gmos-6978241](http://www.nature.com/scitable/spotlight/gmos-6978241)
- [http://www.hudsonalpha.org/education/kits/gmod/gmos-made](http://www.hudsonalpha.org/education/kits/gmod/gmos-made)

*QUESTIONS?*
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