

Secondary Science Lesson Plan

Diane Bassett
Riverview High School

LESSON TITLE: The Grass is Always Greener on the Other Side...Or Is It?

Content Topic(s): Genetic Engineering and Biotechnology, Genetically modified crops (need for, procedures), Transgenic plants, PCR, Gel Electrophoresis

Target Grade Level(s): 11-12, International Baccalaureate (IB)

Science Subject: IB Biology 2 & 3 SL/HL (standard/high level)

Learning Styles: Linguistic, Logical-mathematical, Bodily-kinesthetic, and both Intra- and Interpersonal intelligences (based on Howard Gardner's Multiple Intelligences, 1983)

Key Question(s): Are the foods you eat genetically modified, and if so, for what purpose? How can you test foods to determine if they are GMO?

Overall Time Estimate: 5 (50-minute) class periods (at least 4 days that are consecutive in school and also requires time outside school)

Lesson Summary: This lesson is designed to open students' eyes and minds to the reality of transgenic plants used for food, as they apply previously acquired scientific techniques. Over the course of five days, a combination of methods in delivery will be employed, including a "hook", background reading/research, an investigative laboratory activity culminating in the sharing of data, discussion, analysis and inter-curricular application.

Vocabulary:

1. Allergenicity = causing an allergic sensation
2. DNA = deoxyribonucleic acid;
3. Gel electrophoresis = a laboratory technique used to separate fragments of DNA, by means of electrical currents
4. GMO = Genetically Modified Organism; an organism which has undergone artificial genetic change using the techniques of genetic engineering
5. PCR = Polymerase Chain Reaction; a laboratory technique which duplicates a very small quantity of DNA in order to have enough to analyze.
6. Pathogens = disease-causing organisms
7. Transgenic = an organism whose genes have been altered

STUDENT OBJECTIVES:

(Based on IB Diploma Assessment Statement Standards)

The student will be able to...

- 1. State that error bars are a graphical representation of the variability of data. 1.1.1
- 2. Calculate the mean and standard deviation of a set of values. 1.1.2
- 3. State that the term "standard deviation" is used to summarize the spread of values around the mean, and that 68% of the values fall within one standard deviation of the mean. 1.1.3
- 4. Explain how the standard deviation is useful for comparing the means and the spread of data between two or more samples. 1.1.4
- 5. Deduce the significance of the difference between two sets of data using calculated values for t and the appropriate tables. 1.1.5
- 6. Outline the use of polymerase chain reaction (PCR) to copy and amplify minute quantities of DNA. 4.4.1
- 7. State that in gel electrophoresis, fragments of DNA move in an electric field and are separated according to their size. 4.4.2
- 8. State two examples of the current uses of genetically modified crops. 4.4.9
- 9. Discuss the potential benefits and possible harmful effects of one example of genetic modification. 1.1.10
- 10. Research, consider, discuss and write about the economic benefits of genetic modification to biotechnology companies that perform it. Also mention the possibility that harmful changes to local

economies could result and the danger that wealth could become more concentrated in a smaller percentage of the population. Aim 8 (TOK)

- 11. Discuss how to assess whether risks are great enough to justify banning techniques, and how the scientific community can inform communities about potential risks. Aim 8 (TOK)

MATERIALS

STUDENT MATERIALS:

Per group of 4 students--in each of 4 classes, unless otherwise indicated:

- Quote on Citrus Greening¹ mounted on large paper (1 per group)
- Laboratory Activity: GMO Investigator PCR-Modified (1 copy per student)
- GMO Investigator PCR kit (1 per group)
- Transilluminator
- E-Gel power bases (1 per group)
- Digital pipettes 0-20ul and 20-200ul and box of associated tips (1 of each per group)
- Sterile distilled water (in 1.5ml microcentrifuge tube per group)
- Hot block
- 1.5ml conical tubes w/flip top (2 per group)
- Microcentrifuge tubes w/screw-top (6 per group)
- PCR strip tubes w/cap (1 per group)
- Microcentrifuge (12 slot)
- Microtube racks (1 per group)
- PCR tube racks (1 per group)
- Micropestles (2 per group)
- Timer (1 per group)
- 7 Different plant foods, such as cornmeal, corn, papaya, soybean—some organic, some not (1 type of food per group)
- Non-GMO oats

SUPPLEMENTAL MATERIALS:

- Large butcher paper (1 x 7 student groups)
- Sharpie fine point markers (1 x 7 student stations)
- Rulers
- Article: "Citrus Disease with No Cure is Ravaging Florida Groves"⁴ (1 copy per student)
- Textbook: Damon, A., McGonegal, R., Tosto, P., Ward, W. (2007) Higher Level Biology for the IB Diploma³ (student copy)

BACKGROUND INFORMATION:

Do you know that some of our most important cash crops are genetically modified (**GMO**)? Why would scientists do that? Well, there are several reasons including resistance to viruses, bacteria, and other **pathogens**, as well as increased food production; basically the loss of undesirable traits or the acquisition of more desirable traits. (Damon, A., McGonegal, R., Tosto, P., Ward, W. (2007) Higher Level Biology for the IB Diploma) Among those plants we use for food that are increasingly **transgenic** in the United States, are soybean, corn, cotton and papaya (in Hawaii).

Interestingly, you cannot tell a **transgenic** plant from that which has not been genetically modified, simply by looking at the plant. One must observe the interaction between the plant's **DNA** and a **GMO** indicator, in the laboratory. One method used to determine this, may be done by using micro-amounts of each, creating a **PCR**, then running a **gel electrophoresis**.

The United States is in the forefront on the use of **GMO**'s. The practice does have its detractors! No one knows the long-term effects of **GMO**'s. Some fear that it will increase **allergenicity**, and still others are concerned that it will put too much power in the hands of one corporation and have detrimental effects on local farmers and economies.

PROCEDURE AND DISCUSSION QUESTIONS

(This lesson follows Statistical Analysis and Scientific Measurement)

Day 1. The “Hook” and Pre-lab

1. Pass out the large butcher paper with the attached quote about Huanglongbing¹. Students in each group of 4 (pre-assigned groups) are given different colored markers with which to record their thoughts, questions, or responses to other students on the large paper. **THERE IS TO BE NO TALKING!! (2 min)**
2. Teacher walks around the room and adds written comments to some of the papers, if appropriate, but keeps time and reminds of “no talking” rule. At the end of the two minutes, teacher instructs groups rotate in a clockwise fashion, taking their markers with them, to the next group’s paper.
3. Students add their comments, answer questions, or pose new ones. Students should only rotate to three more stations—they won’t visit them all, before returning to their original station. **(1.5 min per new group station)**
4. Students use tape to hang up their group’s large butcher paper, with quote and comments around the room. Have an open discussion. *What do the students want most to know?* **(10 min)**
5. Hand out article entitled, “Citrus Disease with no Cure is Ravaging Florida Groves”⁴. Instruct students to read this article and their textbook, *Higher Biology for the IB Diploma*³, pp 101-108. These will be used as background information for their lab write-up to be completed at home for tomorrow’s lab. **(remainder of class)**

Day 2. Begin the Lab activity, *The Grass is Always Greener on the Other Side...Or Is It?*

1. Teacher passes out the laboratory activity to groups of 4 (pre-assigned). Each group is to become familiar with the lab and to continue their lab write-up to include title, objectives, hypothesis, materials, etc. **(5 min)**
2. Students should move to their lab station (pre-assigned), and perform procedures 1 and 2 up to but not including step 7. Teacher monitors and takes photos. **(remainder of period)**

Day 3. Continue the Lab activity, *The Grass is Always Greener on the Other Side...Or Is It?*

1. Students move to their group’s station and continue their lab, picking up with Procedure 2, step 7 and completing all steps through Procedure 3--Run Gel step 1. Teacher reminds students to take pictures/photos, and completes steps 2, 3 after students have left class. **(full class period)**

Day 4. Continue the Lab activity, *The Grass is Always Greener on the Other Side...Or Is It?*

1. Students return to their group and read their group’s gel electrophoresis results (teacher gives them their developed gel pack from the previous day) and record their data in a table which they must construct on their own lab write-up. Pictures/photos should be included. **(15 min)**
2. Students return to classroom seats and teacher asks for class results. *When compared to the controls, was the tested food + or – for the GMO protein?* All students should record class results on their lab write-ups by increasing the size of their table. **(15 min)**
3. Students complete the lab by applying the Statistical Analyses they learned in the previous unit, and by creating and writing their own conclusion and application, individually. **(remainder of period and homework!)**

Day 5. Lab conclusion/discussion/application.

1. Teacher randomly chooses students to explain the reasons for the steps of the lab, the results and implications. *Students should state that the DNA needed to be broken up to small bits, duplicated, before checked for the GMO protein. Those samples that tested positive contain the protein which indicates it is a GMO. Students should also mention that some foods may be genetically modified to increase productivity or to prevent disease caused by pathogens. Some students may give opinions, but should be re-directed, as that is reserved for TOK class. (15 min)*
2. Teacher collects labs and associated pictures/photographs for grading/feedback and incorporation in student portfolios.
3. Students use the remainder of the time to reflect and formulate their writing/presentations for TOK (Theory of Knowledge) class. **(remainder of period)**

ASSESSMENT SUGGESTIONS:

Objectives 1-11: After introduction to the GMO issue, students will perform, record, and use habits of mind to conduct, a laboratory activity which requires the utilization of proper scientific methodology and techniques, application of statistical analysis and critical thinking and writing regarding the global implications of the use of genetically modified foods.

RESOURCES/REFERENCES:

¹Huanglongbing (Citrus Greening), What ARS is doing. (2012) Retrieved from USDA Agricultural Research Service. <http://www.ars.usda.gov/citrusgreening/>

²GMO Investigator PCR (adapted from UF eLearning resources)

³Damon, A., McGonegal, R., Tosto, P., Ward, W. (2007) Higher Level Biology for the IB Diploma

⁴Alvarez, L. (2013). Citrus Disease With No Cure is Ravaging Florida Groves. Retrieved from [\(taken from UF eLearning resources\)](http://wt.o.nytimes.com/dcsym57yw10000s1s8g0boozt_9t1x/njs.gif?dcsuri=nojavascript&WT.js=No&WT.tv=1.0.7)