

**The Effect of Hands-On Biotechnology Activities  
and Video Games on the Attitudes, Knowledge,  
and Career Awareness of Students in a High  
School Medical Academy**

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**Abstract:** The purpose of this paper is to share the results of a study that focused on the effects of hands-on biotechnology activities and video games on the knowledge, attitudes, and career awareness of a group of medical academy students. Biotechnology careers are not commonly covered in the constructs of a medical career academy. This study will look at how biotechnology may be a viable curriculum choice for this population of students.

**Rationale:** A Medical Laboratory Assisting program is being started at Park Vista Community High School during the 2010-2011 school year. As part of my action research, I would like to see the feasibility of adding a 9 week biotechnology component to this course. In the past, a biotechnology component was not offered in any of the medical academy courses for the following three reasons: (1) resources to teach this portion of the course were not readily available; (2) teachers on staff were not adequately trained in this field; and (3) opportunities for clinical/real-world applications were not accessible. After attending the “Bench to Bedside” program this summer at University of Florida, I would like to try to incorporate a biotechnology unit into the Medical Laboratory Assisting curriculum. I feel that by attending this program that the 3 barriers that previously existed for delivering this program at my school were removed. I feel that I have obtained valuable resources for my classroom that I can use for my research and the training necessary to teach this subject. In addition, I have the opportunity to provide my students with real-world/clinical applications by providing them with hands-on labs and computer simulations on pipetting techniques, DNA extraction, Polymerase Chain Reaction (PCR), Reverse Transcription (RT) and gel electrophoresis.

It has been determined that teachers have not readily adopted curriculum related to biotechnology into their curriculum (Stotter, 2004). This was definitely the case at my high school as was mentioned above. In response to this finding, Stotter offered a two week unit on biotechnology and agriculture to two classes of high school technology education students. The students from this study demonstrated significant gains in knowledge about agriculture and biotechnology and they also showed a greater level of acceptance of genetically engineered products. In addition, the students in this study also reported that they felt that “learning about biotechnology issues is an important part of their education and that biotechnology is not covered in other classes.” I would like to determine if the same results might be true in my medical academy students.

Hands-on activities as it relates to delivering science curriculum has been widely studied in the literature. Stohr-Hunt (1996) stated that “teachers in hands-on science classrooms should be concerned with actively motivating and involving students in experiences that will in some way extend the students knowledge and understanding of the science context being studied.” Hands-on science is “any educational experience that actively involves students in manipulating objects (Haury & Rillero, 1994).

The effectiveness of various hands-on science activities has been evaluated. Stohr-Hunt (1996) determined that students that engaged in hands-on activities frequently (defined as every day or once a week) scored significantly higher on standardized achievement tests than students that did not use hands-on activities as frequently (defined as once a month, less than once a month, or never). In addition, Mueller, Knobloch, & Orvis (2009) found that a high school program that included hands-on learning (including

computer-based) had higher levels of learning and more positive views on learning about biotechnology than students that did not participate in hands-on learning.

The purpose of this study is to use the Mission Bio-Tech video game and curriculum and various hands-on biotechnology activities to measure changes in attitudes, knowledge, and level of career awareness in high school medical academy students.

**Action Research Intervention:** I plan to implement a 9 week biotechnology curriculum in two of my Medical Lab Assisting 3 classes. I will start this by introducing the concept of biotechnology by watching the movie, “Extraordinary Measures.” By watching the movie, I would like my students to see the impact that biotechnology research can have on patients. We will also discuss what “Bench to Bedside” really means. (Please see attached lesson plan on this topic) I plan to use the Mission Bio-Tech video game and curriculum to introduce biotechnology concepts and careers to my students. In addition, I will use a hands-on pipetting lab, two gel electrophoresis labs, a simplified pGlo lab, and a simulated ELISA lab to give my students a hands-on experience of real-life biotechnology techniques. I anticipate doing this research during the period of August through October 2010.

**Connections to Bench to Bedside Summer Institute:** Mission Bio-tech Video Game and Curriculum, “Extraordinary Measures” Movie, pipetting lab, gel electrophoresis techniques, pGlo lab, and simulated ELISA testing.

**Data Collection and Analysis:** I will be using Dr. Sadler’s evaluation instruments for the Mission Biotech program. In addition, I plan to use the following evaluation tools:

- journal notes of daily class activities
- skills checklist for the pipetting lab
- small student focus group sessions to discuss attitudes about biotechnology, biotechnology careers and what worked and what didn’t work with the 9 week biotechnology curriculum

**Budget:**

- 96 Well Microtiter Plates-Package of 6:-S19384 \$30.00 (Fisher Scientific)
- Transformation of E.Coli with a Plasmid Containing the Gene for the Green Fluorescent Protein (GFP) Lab-S68654: \$85.00 (Fisher Scientific)
- Microcentrifuge Tubes-Package of 500-S34890-3-\$19.50 (Fisher Scientific)
- Cube Racks-Pack of 5-732104-\$44.95 (Carolina)

Total Cost of Items: \$179.45 with the remainder of the money going to shipping and handling of the materials for a total budget of \$200.00. These items will be used for the hands-on labs that I will do with my students.

## **Literature Cited:**

- Haury, D. L. & Rillero, P. (1994). *Perspectives of hands-on science teaching*. Columbus, OH: ERIC Clearinghouse for Science, Mathematics, and Environmental Education.
- Mueller, A., Knobloch, N.A, & Orvis, K.S. (2009). The effects of an active-learning biotechnology and genomics unit on high school students' knowledge, motivation, and learning experiences. *American Association for Agricultural Education Research Proceedings*, 272-275.
- Stohr-Hunt, P. (1996) An analysis of frequency of hands-on experience and science achievement. *Journal of Research in Science Teaching*, 33(1), 101-109.
- Stotter, D.E. (2004). *Assessment of the learning and attitude modification of technology education students who complete an instructional unit on agriculture and biotechnology* (Unpublished doctoral dissertation). North Carolina State University. Raleigh, NC.

**Permissions:** Mission Biotech Permission Forms, Parent Letter to inform parents about research, Focus group permission form, Photo Release Form

## ***Biotechnology Lesson Plan***

<b>Lesson Title</b>	<b>Introduction to Biotechnology-Why is it important?</b>
<b>Grade Span</b>	<b>11-12</b>
<b>Content Emphasis (Mathematics or Science)</b>	<b>Science</b>
<b>Targeted Benchmark(s) – Florida Sunshine State Standards</b>	<p><u>SC.912.L.16.6</u>: Discuss the mechanisms for regulation of gene expression in prokaryotes and eukaryotes at transcription and translation level.</p> <p><u>SC.912.L.16.7</u>: Describe how viruses and bacteria transfer genetic material between cells and the role of this process in biotechnology.</p> <p><u>SC.912.L.16.10</u>: Evaluate the impact of biotechnology on the individual, society and the environment, including medical and ethical issues.</p>
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<b>School</b>	<b>Park Vista Community High School</b>
<b>District</b>	<b>Palm Beach</b>

### **Lesson Preparation**

**Learning goals:**

- As a result of this lesson, students will become familiar with the impact that biotechnology research has on the development of therapies and potential cures for diseases.
- As a result of this lesson, students will understand what biotechnology and genetic engineering are and be able to apply this understanding to real-world uses of this technology including discussions such as ethics, clinical trials, and regulatory body control of biotechnology research.
- As a result of this lesson, students will become familiar with career opportunities in the field of biotechnology.

**Estimated time:** This lesson will require approximately **2 1/2** 90 minute block periods or **4** 50 minute class periods to complete.

**Materials/Resources:**

“Extraordinary Measures” DVD & Student Study Guide

**Clip of Dr. Barry Byrne-chief researcher for Pompe Disease:**

<http://news.medinfo.ufl.edu/articles/top-stories/byrne-is-no-stranger-to-extraordinary-measures-when-it-comes-to-pompe-disease/>

**Movie clip of a boy who has Pompe Disease:**

<http://phoenixfox.net/index.html>

**Biotechnology Careers PowerPoint:**

[http://www.massbioed.org/downloads/pdf/preparing\\_todays\\_students.pdf](http://www.massbioed.org/downloads/pdf/preparing_todays_students.pdf)

## **Biotechnology and Genetic Engineering PowerPoint**

[microvet.arizona.edu/courses/mic205/10geneng/geneticengineering.ppt](http://microvet.arizona.edu/courses/mic205/10geneng/geneticengineering.ppt)

### **Teacher Preparation:**

- Obtain a copy of the movie “Extraordinary Measures” starring Harrison Ford and Brendan Fraser. It may be helpful to watch this movie before your students do so that you can answer questions they have while they are watching the movie.
- Print out enough copies of the “Extraordinary Measures” Study Guide for each of your students.
- Bookmark the four websites with information and PowerPoints to present to the students.

### **Lesson Procedure and Evaluation**

#### **Introduction:**

This lesson is intended to be an introduction to a unit on biotechnology in the classroom. Students will be able to witness biotechnology and genetic engineering in action through the movie “Extraordinary Measures,” which is based on a true story. Students will see the devastating effects of a genetic disease (Pompe Disease) and the process it took to develop a gene therapy for this disease. It is important for students to understand that gene therapies are not developed overnight to cure diseases, but rather they may take a long process of many years of research that is also subjected to regulatory approval by governmental agencies such as the FDA. Through the movie, students can begin to understand the important role that biotechnology research has on finding the cure for diseases. This lesson will also explore what biotechnology and genetic engineering actually are and the different ways they are currently being used. In addition, students will be exposed to different career opportunities in biotechnology

#### **Exploration:**

1. Give students a copy of the “Extraordinary Measures” Study Guide and have them answer the questions on the study guide as they are watching the movie.
2. After the movie, play the additional feature included with the “Extraordinary Measures” movie entitled “Meet John Crowley.” Students will be able to see the real people that the movie is based on. To put another real-life face to Pompe disease, consider playing the video at the bottom of the following web page about a boy named Phoenix that has Pompe Disease: (<http://phoenixfox.net/index.html>). In addition, play the movie clip from University of Florida about Dr. Byrne (<http://news.medinfo.ufl.edu/articles/top-stories/byrne-is-no-stranger-to-extraordinary-measures-when-it-comes-to-pompe-disease/>) You may

want to also read the article aloud in class about Dr. Byrne in class with your students. Explain to students that Dr. Byrne was one of the chief researchers for the gene therapy for Pompe disease.

3. Ask students to turn in their answers to the study guide. Lead a discussion of the movie using the study guide questions as a guide. Have students also ask their questions about parts of the movie that they might have.

**Application:**

The following two PowerPoint presentations will help students apply the information they learned about the development of gene therapies from the movie to what actually happens in actual research labs.

1. Use the PowerPoint entitled "Biotechnology and Recombinant DNA" to help explain to students what biotechnology and genetic engineering are and how they work. Use this presentation to demonstrate to students how the gene therapy that was developed in "Extraordinary Measures" is actually developed in "real-life."
2. Show students the PowerPoint entitled, "Preparing Students for the Biotechnology Workforce of Tomorrow" This presentation is nice to show students (especially those that were interested in the research aspect of the movie) about the many types of job that are available in the field of biotechnology.

**Assessment:**

"Extraordinary Measures" Student Study Guide-(See attached key)  
Have students write two paragraphs. The first paragraph should summarize how genetic engineering works. The second paragraph should be to write about one biotechnology job that interested them from the presentation and why.

## *Extraordinary Measures* Study Guide

Name \_\_\_\_\_

1. What unusual physical characteristics do you notice about the little girl (Meagan) and her brother (Patrick) at the beginning of the movie? List at least 3 of these characteristics.
2. What disease do these 2 children have? \_\_\_\_\_  
What is the average lifespan for a person with this disease? \_\_\_\_\_
3. What do patients with this disease suffer from? (i.e. what symptoms do they have?)  
  
Is there currently a drug to treat this disease? Yes or No
4. What happened to Meagan when she was hospitalized?
5. Where did John go after Megan had her first episode in the hospital?
6. According to Dr. Stonehill, what causes this disease? What is his theory for a cure?
7. It takes many years of research before a drug/therapy can be even sent to clinical trials. How long had Dr. Stonehill been working on his research?



8. How much are the medical costs for the Crowley's two kids per month?
  
9. What does Meagan give to Dr. Stonehill when he visits?
  
10. What does Mrs. Crowley mean by her statement, "Do we just accept our fate and do what the well meaning doctors say and wait for the worst to happen, or do we fight it?" What do you think you would do if you were in this position?
  
11. What difference did the Crowley's notice with Patrick when he was feeding the ducks? How is this related to the progression of his disease?
  
12. Why did the investors want the drug therapy in clinical trials within a year? Do you think this a reasonable time frame? Why or why not?
  
13. Explain what Dr. Stonehill meant by the following comment: "I don't care about the money, I am a scientist."
  
14. What do you think the term "orphan drug" means?
  
15. Describe your feelings after the Temple family told/shared their story about their two girls at the fundraiser event.

16. How old was Lauren when she passed away?
  
  
  
  
  
  
  
  
  
  
17. Decisions have to be made as to who can participate in clinical trials. Imagine that you had a child who could be potentially cured from a horrible disease by participating in a clinical trial. However, your child does not qualify for the clinical trial. What would you do? Explain your answer.
  
  
  
  
  
  
  
  
  
  
18. What is a sibling clinical trial?
  
  
  
  
  
  
  
  
  
  
19. Why was John Crowley's job in the biotech company a conflict of interest?
  
  
  
  
  
  
  
  
  
  
20. At the end of the movie, how did Dr. Stonehill know that the therapy worked on Meagan and Patrick?

## *Extraordinary Measures* Study Guide (Key)

Name \_\_\_\_\_

1. What unusual physical characteristics do you notice about the little girl (Meagan) and her brother (Patrick) at the beginning of the movie? List at least 3 of these characteristics.

- *Both are in a wheelchair*
- *Both are on a ventilator*
- *Both have poor head control*

2. What disease do these 2 children have? *Pompe Disease*  
What is the average lifespan for a person with this disease? *9 years*

3. What do patients with this disease suffer from? (i.e. what symptoms do they have?) *muscle deterioration in every part of the body-enlarged heart*

Is there currently a drug to treat this disease? *No*

4. What happened to Meagan when she was hospitalized?

*She went into cardiac arrest and almost died*

5. Where did John go after Megan had her first episode in the hospital?

*Nebraska*

6. According to Dr. Stonehill, what causes this disease? What is his theory for a cure?

*The enzyme glycogen builds up in the skeletal muscle and the body can't break it down. The glycogen builds up in the heart and skeletal muscle and the diaphragm fails to work properly. His theory is to make the enzyme nano-6-phosphate and get more of it into the cells so that the cells can break down the glycogen.*

7. It takes many years of research before a drug/therapy can be even sent to clinical trials. How long had Dr. Stonehill been working on his research?

*10 years*

8. How much are the medical costs for the Crowley's two kids per month?

*\$40,000*

9. What does Meagan give to Dr. Stonehill when he visits?

*An orange goldfish*

10. What does Mrs. Crowley mean by her statement, "Do we just accept our fate and do what the well meaning doctors say and wait for the worst to happen, or do we fight it?" What do you think you would do if you were in this position?

*Answers will vary*

11. What difference did the Crowley's notice with Patrick when he was feeding the ducks? How is this related to the progression of his disease?

*He couldn't throw bread to the ducks; this shows that his disease is progressing*

12. Why did the investors want the drug therapy in clinical trials within a year? Do you think this a reasonable time frame? Why or why not?

*They wanted the drug therapy in clinical trials within a year because the sooner they could test it, the sooner it could potentially go to market and they could make an investment. Answers will vary for the second question.*

13. Explain what Dr. Stonehill meant by the following comment: "I don't care about the money, I am a scientist."  
*He doesn't care about the money...he is more interested in seeing his research succeed.*
14. What do you think the term "orphan drug" means?  
*An orphan drug is a drug used to treat a disease of low incidence.*
15. Describe your feelings after the Temple family told/shared their story about their two girls at the fundraiser event.  
*Answers will vary.*
16. How old was Lauren when she passed away?  
*9 years old*
17. Decisions have to be made as to who can participate in clinical trials. Imagine that you had a child who could be potentially cured from a horrible disease by participating in a clinical trial. However, your child does not qualify for the clinical trial. What would you do? Explain your answer.  
*Answers will vary*
18. What is a sibling clinical trial?  
*Siblings with the same genetic disease participate in a clinical trial together*
19. Why was John Crowley's job in the biotech company a conflict of interest?  
*He was working for the company that was developing a drug to treat a disease that his children had. If they were chosen for a clinical trial, it would be considered a conflict of interest or favoritism.*
20. At the end of the movie, how did Dr. Stonehill know that the therapy worked on Meagan and Patrick?  
*They were laughing because they were on a sugar high. The glycogen could break down to sugar in their cells.*

