A Simulated Investigative Approach to Teaching Biotechnology in the Classroom:

***Breaking News*- Outbreak at the CDC under Investigation**

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Abstract

The purpose of this guided three day *Unit* is to introduce students within Biology courses to the structure and function of DNA, the impact of biotechnology on individuals, society, environment, medical and ethical implications that impact the law and politics. It also serves the purpose of exposing students to the impact on public health by pathogens, and how they can be utilized as a method of bioterrorism, all the while teaching them about pathogen prevention, detection, and possible treatments.

Keywords: *biotechnology, denature, pathogen, virus, bacteria, epidemic, pandemic, gel electrophoresis, dot blot, S.T.E.M. career*

Rational Background

The State of Florida has implemented an accountability assessment for all Biology Teachers in the State. The students in any Biology course regardless of level will be tested with the Biology End-of-Course (EOC) Assessment at the end of the year. The strands for the Biology EOC are dictated by the state, and where distributed in the item specifications booklet given to teachers through their schools and through the Florida Department of Education.

All science teachers need to teach the universal qualities of the genetic code across all organisms, they need to inform students of the many applications of biotechnology and its effects at the individual, social, medical, and ethical level. The teachers also need to ensure to emphasize how pathogens are spread, how they can be detected and possibly treated. The author of this curricular *Unit* aimed to create an interactive Project-Based Learning (PBL) experience that allows students to fully immerse in the material and become thoroughly engaged.

Description of Teaching Unit

In this activity students will be placed in an in-class simulated internship at the CDC internal investigative unit, which is currently undergoing an internal death investigation to determine the cause of death, the implications across the CDC, if any cover-up is being attempted, and to determine if any pathogen has been spread. They will be asked to extract fruit DNA as practice in their internship, then to assist in the actual investigation by utilizing the "Outbreak DNA Lab Kit" provided by UF, and then further determining the gram-positive bacterial pathogen (anthrax) strain that the victim spread by determining the antibody positive colleagues of the victim through a simulated "ELISA Lab". The last part of this *Unit* is for the intern to take a S.T.E.M. Career Placement Questionnaire.

Outcome Expectations

"**SC.912.L.16.9-** Explain how and why the genetic code is universal and is common to almost all organisms." (Florida Department of Education, 2011, p.67)

- Be able to discuss the structure and function of DNA

"**SC.912.L.16.10-** Evaluate the impact of biotechnology on the individual, society and the environment, including medical and ethical issues." (Florida Department of Education, 2011, p.69)

Students will be able to meet the following objectives:

- Be able to describe the impacts of biotechnology on an individual, and/or social institution
- Be able to describe the ethical and medical implications of utilizing biotechnology to solve problems (i.e. crimes)
- Be able to describe the possible impacts to the environment at the social, political, and personal level

"**SC.912.L.14.6-** Explain the significance of genetic factors, environmental factors, and pathogenic agents to health from the perspectives of both individual and public health." (Florida Department of Education, 2011, p.54)

"**HE.912.C.1.8.-** Analyze strategies for prevention, detection, and treatment of communicable and chronic diseases." (Florida Department of Education, 2011, p.54)

- Be able to describe how pathogens can affect the environment, individuals, and public health

- Be able to describe preventive methods, detection methods, and the common possible treatments of a pathogen, or if it is untreatable

Extensions & Cross-Curricular Applications

The beauty of this *Unit* is that students not only will be given vital experiences across the biotechnology field, but they will also be exposed to the possibility of future careers in the Science Technology Engineering & Mathematical (S.T.E.M.) careers, through an author-created S.T.E.M. Career Guided Questionnaire.

Procedures

Before the onset of this *Unit:* Reading of "The Demon in the Freezer" by Richard Preston has been completed. Students have read the book during Silent Sustained Reading (SSR) everyday in class for at least 10 minutes.

****Classroom sessions are 100 minutes in length****

Day 1-

Data Collection Techniques and Assessments

- Pre-Quiz on Anthrax and Biotechnology (10 minutes)
- Strawberry & Banana DNA Extraction Lab and Lab Report (50 minutes)

UF Equipment Lockers Utilized

- Pipetting Designer Plates Kit Equipment Locker (40 minutes)

Day 2-

- Advanced Gel Electrophoresis Equipment Locker: Outbreak Lab Kit (50 minutes)

ICORE HHMI Summer Institute Workshop UF Connections

- ELISA Technique Simulation (50 minutes)

Day 3-

Other Techniques and Assessments

- Post-Quiz on Anthrax and Biotechnology (10 minutes)
- S.T.E.M. Careers Questionnaire Research & Portfolio finishing (90 minutes)

Discussion

Normally when teaching biotechnology applications right after DNA replication and gene expression has been taught we begin the section with a Strawberry DNA Extraction Lab and then we follow-up with a Biotechnology Research Project. Through

various years of utilizing that method, it has become obvious to me that the best way to get students to comprehend biotechnology is for them to apply it.

For the sake of this Action Proposal the conventional Strawberry DNA Extraction Lab will be modified to include Banana DNA extraction as well. The main reason behind this inclusion is to demonstrate to the students that other organisms including plants all have the basic components of the genetic code. Many students that have been taught by the author of this Action Proposal before have done the Strawberry DNA Extraction Lab, and then correlated DNA being found in DNA but not other fruits, and vegetables let alone other organisms. The purpose is to demonstrate to them that anything that is considered a living organism contains DNA, and fruits are no exception. So by having multiple fruits to extract DNA from, the message will come across more clearly. The Outbreak Lab Kit provided by UF will be modified to befit a hand-out written by the author of this Action Proposal emphasizing an Outbreak at the CDC of the Anthrax bacterial pathogen. A portfolio consisting of four handouts will be given to the students with the expectation of being turned in at the conclusion of the three class days: the DNA Strawberry & Banana Extraction Lab Worksheet, the Outbreak at the CDC Worksheet, the ELISA Lab Worksheet, and the S.T.E.M. Career Questionnaire. Apart from the portfolio, a pre-quiz and post-quiz will be given as a means of measuring learning gains through the content. Furthermore, the book by Richard Preston "The Demon in the Freezer" will be read from the beginning of the year until the initiation of this particular *Unit*, so that the end assessment of the *Unit* can contain elements of the book. However, there is a possible extension of the *Unit* that may occur if timing is done appropriately. The extension would be my classes would Skype with another teacher's classes in Jacksonville, FL as a means of simulating a real-life Bioterrorism attack and how the CDC responds. The reasoning behind Skype being utilized is to integrate technology in the classroom, by exposing students to a real-life social network communication tool that can be used by Professionals across different careers. Skype can be used to simulate a teleconference between CDC scientists at the Fort Lauderdale institution, and CDC scientists at the Jacksonville office. The goal is for them to interact with other individuals other than themselves, and we would simulate the spread of the bacterial pathogen from one CDC office to the other CDC office. This would allow the students to get a better

appreciation of how bacterial pathogens can spread as epidemics and eventually migrate to pandemics. It also allows them to see the importance of prevention, detection, and treatment of bacterial pathogens in a Bioterrorism attack, by seeing how the CDC in Jacksonville (the other student class), and the CDC in Fort Lauderdale can collaborate to find a treatment for the contamination.

References

Florida Department of Education, "Florida EOC Assessments: Biology 1 End-of-Course Assessment Test Item Specifications" Paper presented at Biology Department Meeting at West Broward High School Davie, FL, August 24-31, 2011. (p.1-115)

Budget Justifications – *(Total Number of Biology Sections: 3 Classes of approximately 25)*

- The Demon in the Freezer by Richard Preston
    - 5.19 each x 25 = $129.75 estimated cost for a class set
- Strawberries & Bananas = estimated cost of $10.00
- Ethyl Alcohol = estimated cost of $3.00
- Led Blacklight = estimated cost of $20.00
- e-gel = estimated cost $92.00
- DNA for e-gel = estimated cost $200 (Site Link, Item #211204)

Total estimated cost: $454.75

All extra costs will be sought from either personal, or SAC committee funds. UF has provided 18 e-gels, and DNA needs to be bought independently for the labs.

Attachment 1

DNA Strawberry & Banana Extraction Lab Student Worksheet

Premise: You are an intern at the Center for Disease Control (CDC) at the Fort Lauderdale Office, your director (Dr. Azua) wants you to become acquainted with the process of DNA extraction. She assigns you the task of isolating DNA from two types of fruit. She then wants you to explain to her the reasons why the extraction is capable of happening through a Lab Report. Take good notes, your career at the CDC is riding on it! Later on you will determine what position you might wish to fill in the CDC under the S.T.E.M. Careers Questionnaire.

Background Research: Define the following words utilizing the Frayer Method on separate index cards (Front of Card, just contains word)

biotechnology, denature, pathogen, virus, bacteria, epidemic, pandemic, gel electrophoresis, dot blot, S.T.E.M. career

Frayer Method Example Back of Card:

Word Meaning: BIOLOGY- The study of Life	Word Sentence: When I went to college I became a ***Biology*** major because I was fascinated by how things in life worked.
Non-example of Meaning: DEATH	Visual Example: Living Frogs 

Materials:

Freezer Bag, Clear Colored Shampoo, pipette, salt, kitchen filter or filter paper, funnel, test tube, 20 mL extraction buffer (shampoo/water/salt), ethyl alcohol at least 70% (COLD)

Procedures:

1. Get two ziplock freezer bags, label one “strawberry supernatant”, and label the other “banana supernatant”.
2. Place strawberry into the bag labeled for it, and make sure you have removed the green leaves. Place the banana into the bag labeled for it, and make sure you have removed the banana’s covering.
3. You will now add 20mL of buffer, and mash GENTLY once you have closed the ziplock bags. Ensure to mash until you see all the buffer and fruit look like a soupy mixture (takes about a 1 to 2 minutes)
4. Take the test tube and insert the funnel, now go to the teacher, and they will pour your mixture through a kitchen filter into the funnel into your test tube.
5. Add 5 to 10 mL of ethanol to your test tube (depends on size of test tube and sample of your fruit mixture). Allow it to sit for 3 minutes, you will begin to see a white DNA precipitate at the top of your solution.

I.Observations:_____

_____

_____

II. Problem: Is it a possibility to extract DNA from any kind of fruit?

III. Hypothesis: If _____ then _____.

IV. Results (**Raw Data**): Create a T-Chart describing what you observe in the banana DNA tube, and in the strawberry DNA tube.

Banana DNA Tube	Strawberry DNA Tube

V. Analysis:

- Which of the following chemical properties of DNA did you utilize to isolate DNA? Hydrophobic, hydrophilic, hydrogen bonds, and covalent bonds

- Describe why DNA is soluble in water but not in ethanol, and how does that affect this particular extraction._____

  _____

  _____

- In order to study genes in humans scientists extract DNA from tissues in the body, would the method of DNA extraction be the same in human tissue, why or why not? If yes, how would it be slightly different?_____

  _____

  _____

VI. Conclusion:

_____

_____

Attachment 2

******This lab is a SIMULATION, no real pathogens are utilized******

Outbreak at the CDC Student Worksheet

Breaking News- *Azua, J.,* Fort Lauderdale, FL (Broward Health Department)

A death in Lab 55, BSL 4 Level Lab was discovered early this Monday morning. The CDC was evacuated, and the floor cleared. Only two others have come into direct contact with the Lab 55, and are currently quarantined at the Memorial Hospital. The symptoms presented by the victim where flu-like symptoms: nausea, vomiting, abdominal pain, and irregular heartbeat. The individual fainted shortly after arriving at work, but after being examined by the CDC Physician he declined treatment and said he was just having some indigestion due to an overnight binge drinking session. However, shortly after he returned to his Lab 55, two of his co-workers found him dead on the floor in his Lab 55. The autopsy sighted a myocardial infarction as cause of death, however the Director of the CDC strongly believes that the true cause of death is exposure to anthrax that can cause all such symptoms. The Director is extremely concerned because both co-workers that discovered the body ran into the hallway and lobby area coming into contact with a total of 13 other individuals as seen in the Security Camera Recordings. He assigns you to investigate the bacterial strain affecting the victim, and to determine if the total 16 individuals (including Patient 2= victim) where infected with *Bacillus anthracis 1 (BA1)* or if he was infected with *Cutaneous bacillus anthracis 2 (CBA2).*

You have two steps you must take, the first lab you will be performing is to determine which of the strains of Anthrax the individual victim was infected with, and the second lab you will perform is to determine through ELISA which other individuals were actually infected if any of them were infected at all.

OUTBREAK at the CDC

Objective: To be able to detect the type of bacterial strain that is affecting the victim that passed away at the CDC Lab 55. The bacterial strain is presumed to be an airborne

pathogen, the individual had been working on mutating a form of anthrax *CBA2*, it is suspected that something went wrong with the victims HAZMAT equipment, and he was exposed to the anthrax version he was mutating. He presents all the symptoms of anthrax in the autopsy. We are going to sample his blood DNA to determine if the anthrax version he died from is the anthrax version he was mutating in the lab.

Background Info:

Your team is going to be utilizing restriction digestion and gel electrophoresis to examine the bacterial DNA of Anthrax. You have added enzymes to determine which Anthrax bacterial DNA you have present on the victim, which is the one that would have been spread across the other individuals. The enzymes will be cutting DNA at specific locations of the genetic sequence and will create an electrophoresis bacterial fingerprint unique to that strain. The two possible strains are: *Bacillus anthracis 1 (BA1)* or the *Cutaneous bacillus anthracis 2 (CBA2*).

Observations:

1. List key elements of the 'Breaking News' that might be of use to you in the actual analysis you will be creating in the lab._____

_____

_____

_____

Hypothesis:_____

_____

Materials:

- 1 E-gel for three groups *(Class Size = 25, so 6 groups of 4 students and one of 5 students which equals the use of 2 E-gels per class)*
- 4 pipettes
- Water centrifuge tube

- Victim centrifuge tube
- *BA1* centrifuge tube
- *CBA2* centrifuge tube

Procedures:

1. Plug in PowerBase into an electrical outlet in front of the class.
2. Remove the gel from the package.
3. Gently place the gel from the right side into the PowerBase, then snap it in on the left side. Now you may remove the comb. A steady red light will illuminate if the gel cassette is correctly inserted into the PowerBase.
4. DNA is negative so it will be moving from the cathode (-) side to the anode (+) side, and separating the fragments by molecular weight, and size. Draw a diagram below of the gel electrophoresis, label the cathode and anode regions.

5. Load samples as follows in the following wells:

Well #	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
What to add to the well	10µl water + 8 µl Victim DNA	10µl water + 8 µl *BA1*	10µl water + 8 µl *CBA2*	20µl water	10µl water + 8 µl Victim DNA	10µl water + 8 µl *BA1*	10µl water + 8 µl *CBA2*	20µl water	10µl water + 8 µl Victim DNA	10µl water + 8 µl *BA1*	10µl water + 8 µl *CBA2*	20µl water

Group 1

Add 10µl sterile distilled H_2O to wells 1-3

Add 8 µl of victim DNA into well 1

Add 8 µl of *BA1* into well 2

Add 8 µl *CBA2* into well 3

Group 2

Add 10µl sterile distilled H_2O to wells 5-7

Add 8 µl of victim DNA into well 5

Add 8 µl of *BA1* into well 6

Add 8 µl *CBA2* into well 7

Group 3

Add 10µl sterile distilled H_2O to wells 9-11

Add 8 µl of victim DNA into well 9

Add 8 µl of *BA1* into well 10

Add 8 µl *CBA2* into well 11

Add 20 µl of water to well 4, 8, and 11

6. Run gel, press and release the 30 minute button on the E-Gel PowerBase to begin the actual electrophoresis process. At the end of the run , the current will automatically shut off and the power base will display a flashing red light an beep rapidly. Press either button to stop the beeping.

7. View the gel on the transillumators.

Data Recorded (Raw Data): Draw out your Gel Electrophoresis Results below

Results:_____

_____

_____

Towards which pole of the gel (cathode or anode) does the DNA migrate with the electric current running through it?_____

Why do the DNA molecules move towards that pole?_____

What significance does the size of the DNA fragments have with the way they separate in the agarose gel?

_____

_____

Discussion & Error Analysis:

_____

_____

_____

_____

_____

_____

_____

Conclusion:_____

_____

_____

_____

What anthrax type did the victim die of?_____

Attachment 3

******This lab is a SIMULATION, no real pathogens are utilized******

ELISA Lab Student Worksheet

Objective: You and your colleagues will be comparing the victim's blood to the other 15 individuals that were exposed to the anthrax type the victim was diagnosed as having. Your team of 25 lab technicians decided to split into groups of 4 and one group of 5. You will have a total of 6 groups in the lab, and you will be performing an ELISA Lab Test.

Background Info:

What is an ELISA Lab Test?

ELISA (Enzyme-linked immunoabsorbant assay) is utilized to detect antibodies, peptides, proteins, and hormones present in a serum. So if I have a serum of each patients' blood I can essentially detect any antibodies they may have created in their body to fight off a bacterial or viral infection.

In the following Chart, fill in the diagram with the appropriate information given by the Director of the CDC (Teacher):

Antigens on a Blood Cell	Antibodies in Blood

Is the antigen found in the outside of a membrane or in the extracellular fluid? _____

Is the antibody found in the outside of a membrane or in the extracellular fluid?_____

Which of the following attacks a pathogen? (Antigen or Antibody)

Observations:

1. List key elements of the 'Breaking News' that might be of use to you in the actual analysis you will be creating in the lab._____

_____

_____

_____

Hypothesis:_____

_____

Materials:

Groups will contain the following-

- 1 yellow tube (Patient # ____)
- 1 yellow tube (Patient # ____)
- 1 violet tube (+ control)
- 1 blue tube (- control)
- 1 green tube (Purified Antigen)
- 1 orange tube (Secondary Antibody)
- 1 brown tube (Enzyme Substrate)
- Use ONLY A Row of the Microplate
- 6 pipettes
- Stack of Paper Towels

Procedures:

1. Use a fresh pipette tip to transfer 50 µl of the purified antigen into wells 1-12 of the microplate Row A.
2. Wait 5 minutes for the purified anthrax antigen to adhere to the surface of the bottom of the well.
3. Wash:
    a. Tip the microplate strip upside down onto the paper towels and the strip a few times upside down (not in the same place) until it is free of liquid.
    b. Discard the paper towel
    c. Use another pipette to fill each well (1-12) with wash buffer, taking care not to spill over into neighboring wells. Note: You can use the same pipette for ALL wells.
    d. Tip the microplate upside down onto the paper towels and tap like before.
    e. Discard the paper towel.
4. Use a fresh pipette to transfer 50 µl of the postive control into wells 1-3
5. Then repeat Step 3 (Wash all over again)
6. Use a fresh pipette to transfer 50 µl of the negative control into wells 4-6
7. Then repeat Step 3 (Wash all over again)
8. Use a fresh pipette to transfer 50 µl of the Patient # ____ into wells 7-8
9. Then repeat Step 3 (Wash all over again)

10. Use a fresh pipette to transfer 50 µl of the Patient # ____ into wells 9-12
11. Then repeat Step 3 (Wash all over again)
12. Use a fresh pipette to transfer 50 µl of the secondary antibody into ALL 12 wells of the microplate
13. Wait for five minutes to allow antibodies to bind to the target samples.
14. Repeat Step 3 (Twice)
15. Use a fresh pipette to transfer 50 µl of the Enzyme Substrate into all 12 wells of the microplate.
16. Wait five minutes. Once the timer rings come to the Director (Dr. Azua) and have her examine the wells with you using a Black Led Light. You will determine which patients have been contaminated with anthrax and which have not been contaminated.

Data Recorded (Raw Data):

Results:_____

_____

_____

_____

Which individuals were infected with Anthrax?

_____

_____

_____

Are there any treatments they can acquire for anthrax, or is it lethal?

_____

_____

_____

Discussion & Error Analysis:

_____

_____

_____

_____

_____

Conclusion:_____

_____

_____

CDC Outbreak Report to Supervisor:

It seems that the victim was infected with anthrax type _____, which was passed on to the following individual patient numbers _____. However, it is apparent that the first victim was infected due to sabotage in his HAZMAT BSL 4 equipment, as a means of infecting him with the actual bacterial pathogen. By infecting the victim one of his co-workers was better able to test the reliability of a vaccine developed by them. The co-worker that sabotaged the victim's equipment was Patient 3, and the victim was Patient 2. Patient 3 displays antibodies for the pathogen, however is unaffected to the pathogen due to prior vaccination to the disease. Now Patient 3 faces a life-sentence in Federal prison because he committed an act of bioterrorism as a means of demonstrating the effectiveness of his vaccine. When he admitted to the crime during an interrogation he stated that his next course of action would have been to release the pathogen airborne to the entire CDC, and other CDC members from the Jacksonville community actually were part of the patient groups tested that came across both gentlemen that had seen the victim die. Those individuals had gone to the Jacksonville, FL office without being aware of having been contaminated, and had to be recalled back as a means of testing them. The outbreak in the Jacksonville, FL office can thereby be linked to the crime and bioterrorism attack

committed here at the Fort Lauderdale, FL CDC office (Extension of the Broward County Health Department)

Attachment 4

Pre-Quiz & Post-Quiz

1. Which of the following was the leader at the USAMARID in "The Demon in the Freezer"?

    a. Vladimir Pasechnik

    b. Peter Jahrling

    c. Dr. Renolds

2. Name the career Peter Jahrling has in "The Demon in the Freezer"_____

3. List the most likely method of spreading smallpox in a bioterrorist attack:

    a. Airborne

    b. Water Contamination

    c. Person-to-Person

4. The following pathogens qualify as bacteria:

    a. Cholera, Smallpox, Ebola

    b. Smallpox, MRSA, Dengue

    c. Anthrax, Cholera, MRSA

5. These two locations in the world stored Smallpox without the United States Government's knowledge:

    a. Iceland & England

b. Iraq & Korea

c. Pakistan & Bangladesh

d. United States & Japan

6. H1N1 was called the swine flu, because it came from the following organisms:

    a. Pigs

    b. Dogs

    c. Horses

    d. Cows

7. Bioterrorism is defined as the following:

    a. To initiate an act of harm upon a nation using biological components that are nearly undetectable

    b. To initiate an act of harm upon a nation utilizing agricultural pathogens

    c. To initiate an act of harm upon a nation and/or organizational body that utilizes components of chemicals, biological, and agricultural modifiable pathogens (bacteria/viruses) that can easily spread

    d. All of the above

8. The latin name for Anthrax is:

    a. *Bacillus anthracis*

    b. *Cutaneous Bacillus anthracis*

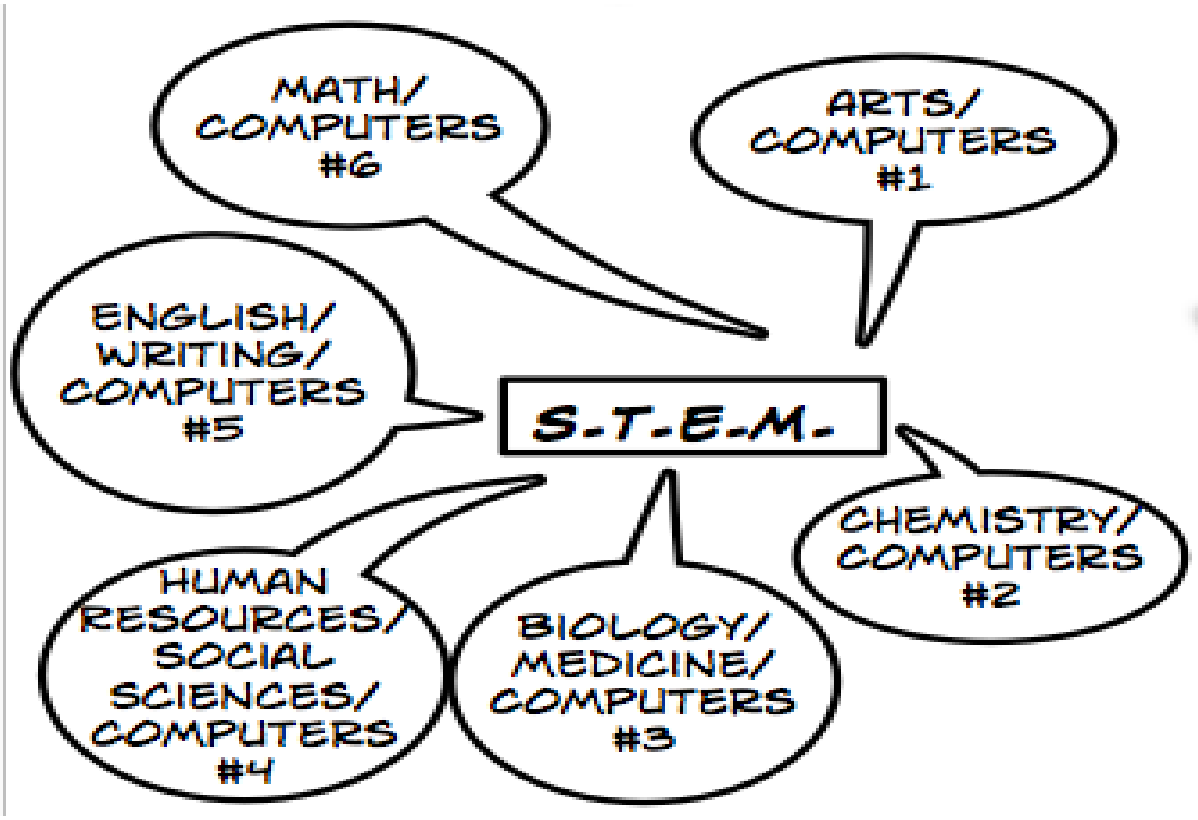
    c. *Airborne anthracis*

    d. *Anthracis bacillus*

Attachment 5

S.T.E.M. Career Questionnaire for Career Placement

Step 1- Use the Concept Map to isolate the top three interests you possess, highlight those three interests. Refer to the number, go to Step 2 and find the number that correlates to that interest.



Step 2- Use the interest box and highlight the skills/interests you like the most and refer to the number that correlates to the group you highlighted in Step 1. After you have highlighted your tops skills/interests in this chart, look at the chart in Step 3 using the three box numbers you highlighted the most in Step 2.

# 1 Drawing Graphics Animation Web Design Television Acting Drama Movie Making/Production Graphic Design Interpersonal	#2 Biology Technology Pharmaceutical Drug Creation Forensics (CSI, NCIS, etc.) Chemistry Protein Sequencing Molecular Biology Graphing / Data Interpersonal/Intrapersonal
#3 Medicine Bacteria Viruses Anatomy Protein Sequencing Molecular Biology Graphing/Data Technology Nursing Arithmetic Intrapersonal/Interpersonal	#4 Teaching Counseling History Law Politics Social Work Psychology Graphing/Data Helping others Interpersonal
#5 Writing Poems Fiction Non-Fiction Reading Journalism Interpersonal	#6 Arithmetic Algebra/Geometry Trigonometry/Calculus Physics Statistics Graphing / Data Intrapersonal/Interpersonal

Step 3- Refer to the box with the number you got from the prior page, now answer the questions of the ones in that box. Highlight the three careers from this page that you like the most based on the questions you have answered. After you have chosen these three careers go to Step 4.

<table>
<tr>
<td># 1
Possible Careers
A) Do you like to draw nature, or scientific things?
Science Illustrator
Scientific Graphic Animator

B) Like to graph on a map, or geography layouts?
Geomatics

C) Like to take pictures of nature?
Science/Nature Photographer</td>
<td>#2
Possible Careers

A) Like to work with pharmaceuticals/dispense them?
Chemist
Pharmacist
B) Like to create, or modify existing chemical components to a medical drug?
Drug Chemist
Drug Toxicology
Drug Sequencing
Chemical Engineer
C) Like to understand how chemicals work in the body?
Neurochemist
Biochemist</td>
</tr>
<tr>
<td>#3
Possible Careers
A) Do you want to work in a laboratory?
B) Do you want to work at a University doing Research and Development?
C) Do you want to work at a hospital with patients, or at a clinic with patients?
D) Do you want to work for a company in Research and Development?
E) Do you want to work with bacteria/viruses?
F) Do you want to work with infections, etc.?
All the careers below have two or more aspects of above:
Anatomist
Pathology
Bacteriology
Virology
DNA/Serology</td>
<td>#4
Possible Careers
A) Do you like to teach, or instruct others?
Teacher
College Professor
B) Do you like to counsel or help others better themselves?
Counselor
Psychologist
Social Worker</td>
</tr>
</table>

Cellular & Molecular Biology Proteomics Neurology Entemology (Insects) Lab Technician Histologists Biotechnologists Biomedical Engineers Doctors (M.D., D.M.D., D.V.M., etc.) Nurses Physician Assistants Paramedics LPN, RN, MSN Biotechnology Engineer Anesthesiology Assistants	
#5 Possible Careers A) Do you like to write about science? Science Journal Writer B) Do you like to raise and earn money for science? Grant Writer C) Do you like to write facts about science? Textbook Writer	#6 Possible Careers A) Like to work with your hands and build things? Mechanical Engineer B) Like to work to decipher problems on the computer through math and technology? Bioinformatics Forensic Technologists Biophysics Physics Neurophysics Kinesiology/Physiology Engineering Software Development

Step 4- Fill in the following information for the following three careers of which you chose from the above list of options in Step 3. Use the attached rubric for this research assignment, remember your Portfolio is an overall Lab & Research grade.

Number of School Years-
Highest Degree Needed-
Median Salary-
Locations with MOST employment in this profession-
Average Vocational, College, and/or University Price for this Degree-

Outline of how S.T.E.M. Career Placement Questionnaire Step 4 is to be completed:

1. Use the following websites to research the information required in Step 4:

http://whatcanidowiththismajor.com/major/

http://www.hccfl.edu/ssem/career-center/web-resources.aspx

Layout of Career Information Chart

Career Name	Number of School Years	Highest Degree	Median Salary	Locations	Average Price for this Degree

LESSON PLAN- DAY 1

LESSON TITLE : CDC Internship Before the Outbreak

Content Topic(s):DNA Extraction & Biotechnology Introduction

Target Grade Level(s): (9-12th graders)

Specific Subject: Biology Honors & Biology Regular Courses

OBJECTIVES

"**SC.912.L.16.9-** Explain how and why the genetic code is universal and is common to almost all organisms." (Florida Department of Education, 2011, p.67)

- Be able to discuss the structure and function of DNA

"**SC.912.L.16.10-** Evaluate the impact of biotechnology on the individual, society and the environment, including medical and ethical issues." (Florida Department of Education, 2011, p.69)

Students will be able to meet the following objectives:

- Be able to describe the impacts of biotechnology on an individual, and/or social institution
- Be able to describe the ethical and medical implications of utilizing biotechnology to solve problems (i.e. crimes)
- Be able to describe the possible impacts to the environment at the social, political, and personal level

MATERIALS

Teaching Materials

Class Set (27) of Attachment 1 – DNA Strawberry & Banana Extraction Lab Worksheet

Class Set (27) of Attachment 4- Pre-Quiz for Anthrax & Biotechnology

Student Materials

Materials for Strawberry & Banana DNA Extraction Lab:
Freezer Bag, Clear Colored Shampoo, pipette, salt, kitchen filter or filter paper, funnel, test tube, 20 mL extraction buffer (shampoo/water/salt), ethyl alcohol at least 70% (COLD). *Students will be in groups of 3, for a total of 9 groups.*

Day 1 Procedures:

When students walk in distribute Class Set of Attachment 4 (the quiz). You will give the students 10 minutes to answer the pre-quiz questions on a separate sheet of paper. They will keep their pre-quiz to look over as the 3-day lesson occurs. Before students get to this Day 1 Lesson, they have been taught the structure of DNA and its function through notes the class before. They have also been taught the basics of Biotechnology and have done a vocabulary homework assignment before the classroom began.

After the Pre-Quiz tell students to clear their desks and that you will be explaining the Class Set Attachment 1 Procedures. After you have discussed the procedures you will ask students to get into groups of 3 and go to the stations already pre-set around the classroom, then they will perform the experiment with the Procedures below, as the teacher you will be filtrating their supernatant into the test tube in the front of the room, once each group has been completed they are to finish writing down their lab report information in their Portfolio.

Procedures for Strawberry & Banana DNA Extraction Lab for Students (50 minutes):
1. Get two ziplock freezer bags, label one "strawberry supernatant", and label the other "banana supernatant". (approximately 5 minutes)
2. Place strawberry into the bag labeled for it, and make sure you have removed the green leaves. Place the banana into the bag labeled for it, and make sure you have removed the banana's covering. (approximately 2 minutes)
3. You will now add 20mL of buffer, and mash GENTLY once you have closed the ziplock bags. Ensure to mash until you see all the buffer and fruit look like a soupy mixture (takes about a 3 minutes)
4. Take the test tube and insert the funnel, now go to the teacher, and they will pour your mixture through a kitchen filter into the funnel into your test tube. (takes about 10 minutes)
5. Add 5 to 10 mL of ethanol to your test tube (depends on size of test tube and sample of your fruit mixture). Allow it to sit for 3 minutes, you will begin to see a white DNA precipitate at the top of your solution.

(Then the rest of the 27 minutes can be used to fill in the answers on Attachment 1, that has been distributed to the students)

After the 1st lab has been completed, you will send the students to Pipetting Lab Stations, for them to practice their Pipetting Lab Techniques. This particular Lesson Plan is already provided by UF, and is called 'Pipetting by Design Lesson Plan'. It is not attached to this ARP because it is already provided by UF. However, if a substitute were to be doing these activities they would be provided the attachment separately. The Pipetting by Design Lesson Plan takes approximately 50 minutes, and the lab stations are pre-set by the Teacher the class before.

ASSESSMENT

Pre-quiz for Anthrax & Biotechnology (Attachment 4)

Portfolio documentation of Strawberry & Banana DNA Extraction Lab (Attachment 1)

RESOURCES/REFERENCES

UF E-Learning ICORE Resource Documents:

-Pipetting by Design Lesson Plan provided by Drew Joseph on the E-Learning site

- Florida Department of Education, "Florida EOC Assessments: Biology 1 End-of-Course Assessment Test Item Specifications" Paper presented at Biology Department Meeting at West Broward High School Davie, FL, August 24-31, 2011. (p.1-115)

LESSON PLAN- DAY 2

LESSON TITLE : CDC Internship During & After the Outbreak

Content Topic(s): Gel Electrophoresis, Biotechnology Techniques, ELISA Method

Target Grade Level(s): (9-12th graders)

Specific Subject: Biology Honors & Biology Regular Courses

OBJECTIVES

"**SC.912.L.16.9-** Explain how and why the genetic code is universal and is common to almost all organisms." (Florida Department of Education, 2011, p.67)

- Be able to discuss the structure and function of DNA

"**SC.912.L.16.10-** Evaluate the impact of biotechnology on the individual, society and the environment, including medical and ethical issues." (Florida Department of Education, 2011, p.69)

Students will be able to meet the following objectives:

- Be able to describe the impacts of biotechnology on an individual, and/or social institution
- Be able to describe the ethical and medical implications of utilizing biotechnology to solve problems (i.e. crimes)
- Be able to describe the possible impacts to the environment at the social, political, and personal level

"**SC.912.L.14.6-** Explain the significance of genetic factors, environmental factors, and pathogenic agents to health from the perspectives of both individual and public health." (Florida Department of Education, 2011, p.54)
"**HE.912.C.1.8.-** Analyze strategies for prevention, detection, and treatment of communicable and chronic diseases." (Florida Department of Education, 2011, p.54)

- Be able to describe how pathogens can affect the environment, individuals, and public health
- Be able to describe preventive methods, detection methods, and the common possible treatments of a pathogen, or if it is untreatable

MATERIALS

Teaching Materials

Class Set (27) of Attachment 2- Outbreak at the CDC Student Worksheet

Class Set (27) of Attachment 3- ELISA Lab Worksheet

Teacher Instructions for Attachment 2

Notes on Scenario:

- BSL 4 Level Lab requires HAZMAT suite (military suite) for nuclear, chemical, or biological investigation
- Respirator with filtered air, self-contained breathing apparatus, and they utilize chemicals to cleanup such as: bleach, ethyl oxide, chlorine dioxide, hydrogen peroxide, methyl bromide, and paraformaldehyde (Dr. Chauncey's UF Presentation, 2012)
- In Lab 55, the scientist was working with a strain of anthrax (*CBA2)* he had mutated along with the normal strain (*BA1)*
- It is suspected that the individual was infected with *CBA2*, however we need to determine that with a gel electrophoresis test that will determine which of the following anthrax types the patient was exposed to.
- So we use restriction enzymes to break apart the DNA sequence in the bacteria and the human DNA, and then compare them to the blood of your patient through a gel electrophoresis
- The DNA will travel from the cathode (the negative top side of the gel) to the positive end of the gel (anode). The DNA moves towards the positive end because DNA is negative.
- Gel electrophoresis of DNA separates the DNA by charge, and size of nucleotides

Set-up for Lab:

-There should be 7 stations, of 4 to a group and one group of 5

- The seven stations should be equipped with 1 water centrifuge tube, victim centrifuge tube, *BA1* centrifuge tube, *CBA2* centrifuge tube, and 4 pipettes.

- Each student has a task, one is the writer, the other is the one responsible for the two anthrax tubes, another student is responsible for the water and victim tubes. The fourth student is responsible for cleaning the set-up once complete.

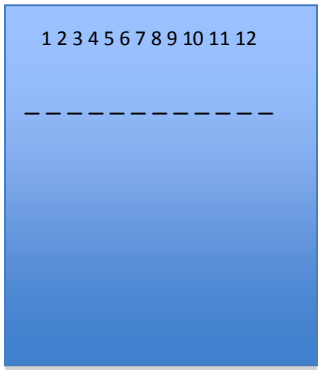
Procedures:

8. Plug in PowerBase into an electrical outlet in front of the class.

9. Remove the gel from the package.

10. Gently place the gel from the right side into the PowerBase, then snap it in on the left side. Now you may remove the comb. A steady red light will illuminate if the gel cassette is correctly inserted into the PowerBase.

11. DNA is negative so it will be moving from the cathode (-) side to the anode (+) side, and separating the fragments by molecular weight, and size. Draw a diagram below of the gel electrophoresis, label the cathode and anode regions



Well #	1	2	3	4	5	6	7	8	9	10	11	12

What to add to the well	10µl water + 8 µl Victim DNA	10µl water + 8 µl *BA1*	10µl water + 8 µl *CBA2*	20µl water	10µl water + 8 µl Victim DNA	10µl water + 8 µl *BA1*	10µl water + 8 µl *CBA2*	20µl water	10µl water + 8 µl Victim DNA	10µl water + 8 µl *BA1*	10µl water + 8 µl *CBA2*	20µl water

12. Load samples as follows in the following wells:

***** 3 groups to one E-gel*****

Group 1

Add 10µl sterile distilled H_2O to wells 1-3

Add 8 µl of victim DNA into well 1

Add 8 µl of *BA1* into well 2

Add 8 µl *CBA2* into well 3

Group 2

Add 10µl sterile distilled H_2O to wells 5-7

Add 8 µl of victim DNA into well 5

Add 8 µl of *BA1* into well 6

Add 8 µl *CBA2* into well 7

Group 3

Add 10µl sterile distilled H_2O to wells 9-11

Add 8 µl of victim DNA into well 9

Add 8 µl of *BA1* into well 10

Add 8 µl *CBA2* into well 11

Add 20 µl of water to well 4, 8, and 11

13. Run gel, press and release the 30 minute button on the E-Gel PowerBase to begin the actual electrophoresis process. At the end of the run , the current will automatically shut off and the power base will display a flashing red light an beep rapidly. Press either button to stop the beeping.

14. View the gel on the transillumators.

Then the students will report their results in their Lab Reports.

Student Materials

Materials Day 2 Procedures for Outbreak at the CDC (9 Stations are set-up)

- 1 E-gel for three groups *(Class Size = 27, so 9 groups of 3 students which equals the use of 3 E-gels per class)*
- 4 pipettes
- Water centrifuge tube
- Victim centrifuge tube
- *BA1* centrifuge tube
- *CBA2* centrifuge tube

Day 2 Procedures for Outbreak at the CDC Lab *(Approximately 50 minutes)*

1. Plug in PowerBase into an electrical outlet in front of the class. (3 minutes)
2. Remove the gel from the package. (1 minute)
3. Gently place the gel from the right side into the PowerBase, then snap it in on the left side. Now you may remove the comb. A steady red light will illuminate if the gel cassette is correctly inserted into the PowerBase. (1 minute)
4. DNA is negative so it will be moving from the cathode (-) side to the anode (+) side, and separating the fragments by molecular weight, and size. Draw a diagram below of the gel electrophoresis, label the cathode and anode regions.
5.
6. Load samples as follows in the following wells: (5 minutes)

Group 1
Add 10µl sterile distilled H_2O to wells 1-3

Well #	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
What to add to the well	10µl water + 8 µl Victim DNA	10µl water + 8 µl *BA1*	10µl water + 8 µl *CBA2*	20µl water	10µl water + 8 µl Victim DNA	10µl water + 8 µl *BA1*	10µl water + 8 µl *CBA2*	20µl water	10µl water + 8 µl Victim DNA	10µl water + 8 µl *BA1*	10µl water + 8 µl *CBA2*	20µl water

Add 8 µl of victim DNA into well 1
Add 8 µl of *BA1* into well 2
Add 8 µl *CBA2* into well 3

Group 2

Add 10µl sterile distilled H_2O to wells 5-7
Add 8 µl of victim DNA into well 5
Add 8 µl of *BA1* into well 6
Add 8 µl *CBA2* into well 7

Group 3

Add 10µl sterile distilled H_2O to wells 9-11

Add 8 µl of victim DNA into well 9
Add 8 µl of *BA1* into well 10
Add 8 µl *CBA2* into well 11

Add 20 µl of water to well 4, 8, and 11

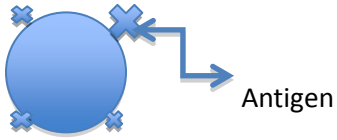
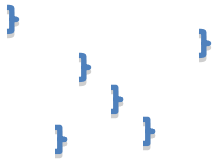
7. Run gel, press and release the 30 minute button on the E-Gel PowerBase to begin the actual electrophoresis process. At the end of the run , the current will automatically shut off and the power base will display a flashing red light an beep rapidly. Press either button to stop the beeping.

8. View the gel on the transillumators.

Assessment for Outbreak at the CDC Lab
-Attachment 2 Class Set is documented in the student's Portfolio

Day 2 Materials for ELISA Lab *(Approximately 50 minutes)*
Day 2 Teacher Instructions for ELISA Lab

- ELISA test's are used to identify patient antibodies, peptide, protein, or hormone presents. In this case, we are trying to identify the antibodies present in the individual and match them to the bacterial strain that contains that sequence.

Antigens on a Blood Cell	Antibodies in Blood
	

- Antigen's are found on the exterior of the cell, they serve like door locks, the bacteria, or other cells that come into contact with your cell need the right key in order to go through the door (cell membrane).
- Antibodies are floating around the blood serum ready to come into contact with the bacteria or foreign agent that contains that door lock, and it will serve as a key to destroy the foreign agent by either causing it to explode, or calling a phagocyte to eat it up.

Materials:

Groups will contain the following- (Each group will hold the following, there will be a total of

- 1 yellow tube (Patient # ____)
- 1 yellow tube (Patient # ____)
- 1 violet tube (+ control)
- 1 blue tube (- control)
- 1 green tube (Purified Antigen)

- 1 orange tube (Secondary Antibody)
- 1 brown tube (Enzyme Substrate)
- Use ONLY A Row of the Microplate
- 6 pipettes
- Stack of Paper Towels

The whole lab is really a simulation, so you have to set it up properly. There are a total of eight microplates. The eight microplates have different results. This is the results your students will yield:

Microplate	**1st Sample Patient**	**2nd Sample Patient (either they are + or – for anthrax)**
1	**1 (-)**	**2 (+ = victim)**
2	**3 (+)**	**4 (-)**
3	**5 (+)**	**6 (+)**
4	**7(-)**	**8 (+)**
5	**9(+)**	**10(+)**
6	**11 (-)**	**12 (+)**
7	**13 (-)**	**14 (+)**
8	**15 (+)**	**16 (-)**

The microplates were colored with invisible ink in the well corresponding to these patients, when the students perform the final test the results should yield as above. All materials utilized are actually water with coloring.

Procedures:

17. Use a fresh pipette tip to transfer 50 µl of the purified antigen into wells 1-12 of the microplate Row A.
18. Wait 5 minutes for the purified anthrax antigen to adhere to the surface of the bottom of the well.
19. Wash:
    a. Tip the microplate strip upside down onto the paper towels and the strip a few times upside down (not in the same place) until it is free of liquid.
    b. Discard the paper towel

c. Use another pipette to fill each well (1-12) with wash buffer, taking care not to spill over into neighboring wells. Note: You can use the same pipette for ALL wells.

d. Tip the microplate upside down onto the paper towels and tap like before.

e. Discard the paper towel.

20. Use a fresh pipette to transfer 50 µl of the postive control into wells 1-3
21. Then repeat Step 3 (Wash all over again)
22. Use a fresh pipette to transfer 50 µl of the negative control into wells 4-6
23. Then repeat Step 3 (Wash all over again)
24. Use a fresh pipette to transfer 50 µl of the Patient # ____ into wells 7-8
25. Then repeat Step 3 (Wash all over again)
26. Use a fresh pipette to transfer 50 µl of the Patient # ____ into wells 9-12
27. Then repeat Step 3 (Wash all over again)
28. Use a fresh pipette to transfer 50 µl of the secondary antibody into ALL 12 wells of the microplate
29. Wait for five minutes to allow antibodies to bind to the target samples.
30. Repeat Step 3 (Twice)
31. Use a fresh pipette to transfer 50 µl of the Enzyme Substrate into all 12 wells of the microplate.
32. Wait five minutes. Once the timer rings come to the Director (Dr. Azua) and have her examine the wells with you using a Black Led Light. You will determine which patients have been contaminated with anthrax and which have not been contaminated.

Day 2 Procedures for ELISA Student Lab Procedures:

1. Use a fresh pipette tip to transfer 50 µl of the purified antigen into wells 1-12 of the microplate Row A.
2. Wait 5 minutes for the purified anthrax antigen to adhere to the surface of the bottom of the well.
3. Wash:

    a. Tip the microplate strip upside down onto the paper towels and the strip a few times upside down (not in the same place) until it is free of liquid.

    b. Discard the paper towel

    c. Use another pipette to fill each well (1-12) with wash buffer, taking care not to spill over into neighboring wells. Note: You can use the same pipette for ALL wells.

d. Tip the microplate upside down onto the paper towels and tap like before.

e. Discard the paper towel.

4. Use a fresh pipette to transfer 50 µl of the postive control into wells 1-3
5. Then repeat Step 3 (Wash all over again)
6. Use a fresh pipette to transfer 50 µl of the negative control into wells 4-6
7. Then repeat Step 3 (Wash all over again)
8. Use a fresh pipette to transfer 50 µl of the Patient # ____ into wells 7-8
9. Then repeat Step 3 (Wash all over again)
10. Use a fresh pipette to transfer 50 µl of the Patient # ____ into wells 9-12
11. Then repeat Step 3 (Wash all over again)
12. Use a fresh pipette to transfer 50 µl of the secondary antibody into ALL 12 wells of the microplate
13. Wait for five minutes to allow antibodies to bind to the target samples.
14. Repeat Step 3 (Twice)
15. Use a fresh pipette to transfer 50 µl of the Enzyme Substrate into all 12 wells of the microplate.
16. Wait five minutes. Once the timer rings come to the Director (Dr. Azua) and have her examine the wells with you using a Black Led Light. You will determine which patients have been contaminated with anthrax and which have not been contaminated.

Assessment for ELISA Lab
- Attachment 3 Class Set is documented in the student's Portfolio

RESOURCES/REFERENCES

UF E-Learning ICORE Resource Documents:

-Outbreak Worksheet provided by Drew Joseph on the E-Learning site (used as reference)

-ELISA Worksheet provided by Drew Joseph on the E-Learning site (used as reference)

- Florida Department of Education, "Florida EOC Assessments: Biology 1 End-of-Course Assessment Test Item Specifications" Paper presented at Biology Department Meeting at West Broward High School Davie, FL, August 24-31, 2011. (p.1-115)

LESSON PLAN- DAY 3

LESSON TITLE : S.T.E.M. Career Questionnaire Placement

Content Topic(s): Biotechnology Careers, S.T.E.M. Careers

Target Grade Level(s): (9-12th graders)

Specific Subject: Biology Honors & Biology Regular Courses

OBJECTIVES

"**SC.912.L.16.10**- Evaluate the impact of biotechnology on the individual, society and the environment, including medical and ethical issues." (Florida Department of Education, 2011, p.69)

Students will be able to meet the following objectives:

- Be able to describe the impacts of biotechnology on an individual, and/or social institution
- Be able to describe the ethical and medical implications of utilizing biotechnology to solve problems (i.e. crimes)
- Be able to describe the possible impacts to the environment at the social, political, and personal level

"**SC.912.L.14.6-** Explain the significance of genetic factors, environmental factors, and pathogenic agents to health from the perspectives of both individual and public health." (Florida Department of Education, 2011, p.54)
"**HE.912.C.1.8.-** Analyze strategies for prevention, detection, and treatment of communicable and chronic diseases." (Florida Department of Education, 2011, p.54)

- Be able to describe how pathogens can affect the environment, individuals, and public health
- Be able to describe preventive methods, detection methods, and the common possible treatments of a pathogen, or if it is untreatable

MATERIALS

Teaching Materials

Class Set (27) of Attachment 4- Post-Quiz on Anthrax & Biotechnology

Class Set (27) of Attachment 5- S.T.E.M. Career Questionnaire

Skype on the Internet

Student Materials

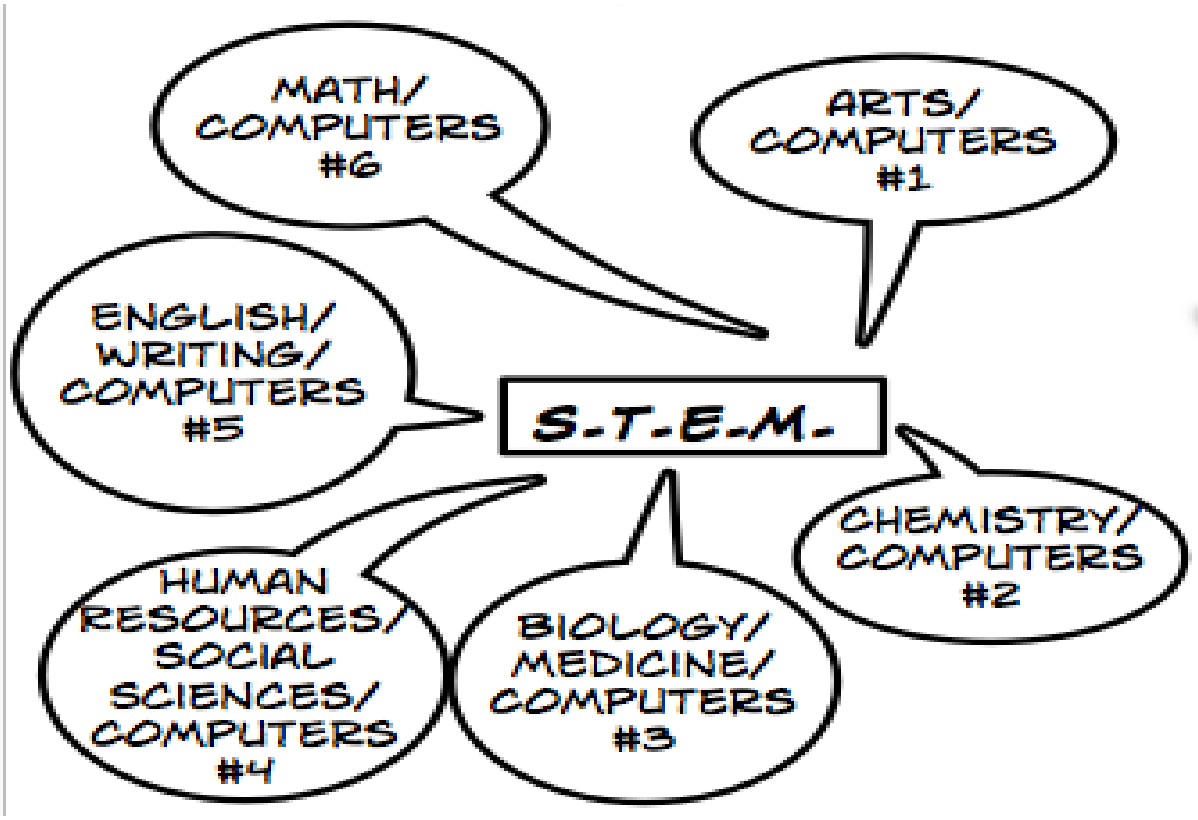
Distribute the Attachment 4, have the students take the test for ten minutes and collect the test.

Then have students work on Attachment 5 for 70 minutes of class time, and for the last 20 minutes of class time you will Skype with the Jacksonville teacher and her classroom. You will discuss how your lab's went with her students, have a student summarize what anthrax the patients were infected with, and then have the Jacksonville students discuss what happened in their CDC simulation. Discuss why and how the infection could have spread that far, and how bioterrorism affects the governmental offices, and jeopardizes the populations.

Assessment

S.T.E.M. Career Questionnaire for Career Placement

Step 1- Use the Concept Map to isolate the top three interests you possess, highlight those three interests. Refer to the number, go to Step 2 and find the number that correlates to that interest.



Step 2- Use the interest box and highlight the skills/interests you like the most and refer to the number that correlates to the group you highlighted in Step 1. After you have highlighted your tops skills/interests in this chart, look at the chart in Step 3 using the three box numbers you highlighted the most in Step 2.

# 1 Drawing Graphics Animation Web Design Television Acting Drama Movie Making/Production Graphic Design Interpersonal	#2 Biology Technology Pharmaceutical Drug Creation Forensics (CSI, NCIS, etc.) Chemistry Protein Sequencing Molecular Biology Graphing / Data Interpersonal/Intrapersonal
#3 Medicine Bacteria Viruses Anatomy Protein Sequencing Molecular Biology Graphing/Data Technology Nursing Arithmetic Intrapersonal/Interpersonal	#4 Teaching Counseling History Law Politics Social Work Psychology Graphing/Data Helping others Interpersonal
#5 Writing Poems Fiction Non-Fiction Reading Journalism	#6 Arithmetic Algebra/Geometry Trigonometry/Calculus Physics Statistics Graphing / Data

Interpersonal	Intrapersonal/Interpersonal

Step 3- Refer to the box with the number you got from the prior page, now answer the questions of the ones in that box. Highlight the three careers from this page that you like the most based on the questions you have answered. After you have chosen these three careers go to Step 4.

# 1 Possible Careers A) Do you like to draw nature, or scientific things? Science Illustrator Scientific Graphic Animator B) Like to graph on a map, or geography layouts? Geomatics C) Like to take pictures of nature? Science/Nature Photographer	#2 Possible Careers D) Like to work with pharmaceuticals/dispense them? Chemist Pharmacist E) Like to create, or modify existing chemical components to a medical drug? Drug Chemist Drug Toxicology Drug Sequencing Chemical Engineer F) Like to understand how chemicals work in the body? Neurochemist Biochemist
#3 Possible Careers G) Do you want to work in a laboratory? H) Do you want to work at a University doing Research and Development? I) Do you want to work at a hospital with patients, or at a clinic with patients? J) Do you want to work for a company in Research and Development? K) Do you want to work with bacteria/viruses? L) Do you want to work with infections, etc.? All the careers below have two or more aspects of above: Anatomist Pathology Bacteriology Virology DNA/Serology Cellular & Molecular Biology Proteomics Neurology Entemology (Insects) Lab Technician Histologists Biotechnologists Biomedical Engineers Doctors (M.D., D.M.D., D.V.M., etc.) Nurses Physician Assistants Paramedics LPN, RN, MSN Biotechnology Engineer Anesthesiology Assistants	#4 Possible Careers C) Do you like to teach, or instruct others? Teacher College Professor D) Do you like to counsel or help others better themselves? Counselor Psychologist Social Worker
#5 Possible Careers D) Do you like to write about science? Science Journal Writer E) Do you like to raise and earn money for science? Grant Writer	#6 Possible Careers C) Like to work with your hands and build things? Mechanical Engineer D) Like to work to decipher problems on the computer through math and technology? Bioinformatics

F) Do you like to write facts about science? Textbook Writer	Forensic Technologists Biophysics Physics Neurophysics Kinesiology/Physiology Engineering Software Development

Step 4- Fill in the following information for the following three careers of which you chose from the above list of options in Step 3. Use the attached rubric for this research assignment, remember your Portfolio is an overall Lab & Research grade.

Number of School Years-
Highest Degree Needed-
Median Salary-
Locations with MOST employment in this profession-
Average Vocational, College, and/or University Price for this Degree-

Outline of how S.T.E.M. Career Placement Questionnaire Step 4 is to be completed:

1. Use the following websites to research the information required in Step 4:

http://whatcanidowiththismajor.com/major/

Layout of Career Information Chart

Career Name	Number of School Years	Highest Degree	Median Salary	Locations	Average Price for this Degree

RESOURCES/REFERENCES

Florida Department of Education, "Florida EOC Assessments: Biology 1 End-of-Course Assessment Test Item Specifications" Paper presented at Biology Department Meeting at West Broward High School Davie, FL, August 24-31, 2011. (p.1-115)

Online Resources:

http://whatcanidowiththismajor.com/major/

http://www.hccfl.edu/ssem/career-center/web-resources.aspx