Bio-Tech Brigade: Attack on Shiga Toxin-producing E. Coli (STEC)

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Abstract:
Annually food-borne pathogens cause an estimated 76 million illnesses, 325,000 hospitalizations, and 5,000 deaths in the United States. In the last three years, multiple reports of Escherichia Coli outbreaks surfaced within the food industry including Fresh Spinach (2006); Taco Bell (2007); Ground Beef Patties (2008) and now Nestle Tollhouse Cookies in June, 2009. Students are aware of these occurrences but still need to understand that there are many strains of *Escherichia coli*. Most are benign, but some, like O157:H7, are pathogenic and can cause severe illness and death. Students will perform activities including sensitivity of harvested E. Coli, viewing E. Coli under microscope, extracting non-pathogenic DNA, simulated restriction enzyme digest and gel electrophoresis. The trends in the outbreak pattern will also be covered. Students will understand the global impact of this emerging pathogen and devise ways to combat its recurrence through school and community outreach under the theme of *STOP STEC!*

Mission Statement:
This comprehensive module will provide students, teachers and the community with foundational knowledge of the basic structure and mechanism of the Escherichia Coli bacteria including identifying its common sources, mode of transmission, symptoms and complication, treatment, and prevention. Students will perform basic biotechnology techniques to identify presence of bacteria in common food substances, restaurant locations or water source by harvesting cultures. Students will complete simulated ELISA testing, DNA Extraction from non-pathogenic E. Coli bacteria, simulate isolation of genetic material using restriction enzyme digest and perform gel electrophoresis lab. As culminating activities students will deploy the *STOP STEC!* awareness campaign to educate school and local community and field visit to a local biotechnology laboratory / industry working with the bacteria. Students will not only be exposed to different facets of biotechnology as it relates to an emerging pathogen but also become better informed citizens.

Description of teaching unit or module(s)
Prerequisite: *Students must possess Basic DNA and RNA knowledge including structure and replication. Students must have completed chapter 12 in Prentice Hall Biology or chapter 9 in Holt Biology unit*. The focus will be on Standard 16 – Heredity and Reproduction and Standard 14 – Organization and Development of Living Organisms from the Florida Sunshine State Standards. Each of the four units will be centered on a progressive case study of an E.Coli outbreak in the local community. The mission of the students in the class is to form a Bio-Tech Brigade. Class will be divided into 5 battalions with each responsible for identification, tracking, scientific investigation, and communication on the E. Coli bacterial outbreak. Headed by the Lieutenant Colonel (teacher) the battalions are:

- **I**ntelligence officers
- **C**ommunications officers
- **O**perations officers
- **R**esearch officers
- **E**pidemiology officers

Within each module, the case study / mission target will include lecture/background information, video segments, hands on activity and class discussion.

Module I: Bacteria Structure Overview
- Case Study
- Lecture: Good vs. Bad Bacteria
- GenBank Web-Quest

Module II: Non-Pathogenic E. Coli vs. Shiga toxin producing E.Coli (STEC)
- Case Study
- Microscopy

Module III: Experimental Data Collection
- Case Study
- ELISA
- Testing Specificity of Antibody
- DNA Extraction of E. Coli Bacteria
- Restriction Enzyme Digest & Gel Electrophoresis

Module IV: *STOP STEC!* Awareness Campaign
- Case Study
- CDC/FDA E- cards to family, friends, teachers and administrators
- SPHS-TV Commercial, Public Service Announcements, Video Sharing through VoiceThread.com and Print Media from CDC and FDA

After completing all five modules, students will be able to:
- Identify structural components and mechanism of bacteria
- Compare and contrast between non-pathogenic E. Coli and pathogenic E. Coli
- Demonstrate competency in basic biotechnology techniques such as ELISA, DNA Extraction, restriction enzyme digestion and gel electrophoresis.
- Identify historical significance of E.Coli and trends of outbreaks in the last 3 years
- Demonstrate knowledge of current research on E. Coli
- Deploy *The STOP STEC* outreach campaign to educate school and community on prevention.

Expertise of PI:
- Bachelors of Science and Masters of Arts Degrees
- Science educator for approximately 8+ years covering Biology, Anatomy and Physiology, Earth/Space Science, and Integrated Science. Certified in Biology 6-12, ESOL endorsement, Earth Science & FELE pending.
- Former adjunct instructor at local private university for Medical Terminology, Medical Office Procedures
- Held positions of Science Department Chair, Science Fair Coordinator, Club Sponsor and School Advisory Chairperson. Currently the Science Instructional Coach.
- Conducted 1 year of community outreach and education for disadvantaged HIV victims
- Completed Professional Development Training in the following areas: CRISS, McRel, DETA I, Blackboard Learning System, Biotechnology.
- Curriculum Development: Landmine Awareness Integrated Curriculum (2009), Mini Frog Dissection Lab Guidelines (2009)
- 2009 Summer HHMI ICORE Biotechnology Participant

Literature Cited

Centers for DIsease and Prevention. (2009). Retrieved June 24, 2009, from National Centers for Zoonotic, Vector-Borne and Enteric Diseases: http://www.cdc.gov/ncved/dfbmd/disease_listing/stec_gi.html

Centers for Disease Control and Prevention. (n.d.). Retrieved 06 24, 2009, from CDC Health-e-cards: http://www2a.cdc.gov/eCards/browse.asp?act=brs&chkcategory=Environmental&submit1=GO

Emerging Pathogens Institute. (2009). Retrieved June 23, 2009, from http://www.epi.ufl.edu

Food and Drug Administration. (2009, 05 27). Retrieved June 25, 2009, from Information for Student and Teachers: HYPERLINK "http://www.fda.gov/Food/ResourcesForYou/StudentsTeachers/default.htm" http://www.fda.gov/Food/ResourcesForYou/StudentsTeachers/default.htm

Geach, C. (n.d.). *Access Excellence - Activties Exchange.* Retrieved June 24, 2009, from DNA Extraction from Bacteria: http://www.accessexcellence.org/AE/ATG/data/released/0337-CharlesGeach/index.php

(2006). Testing the Specificity of Antibodies. In J. a. Levine, *Biology* (p. 541). Chicago: Pearson / Prentice Hall.

Virtual Laboratory. (2006, March). Retrieved June 25, 2009, from Bacteria as a Model System: http://virtuallaboratory.net/Biofundamentals/labs/EColi%20introduced/Coli.html

Budget & Budget Justification:

All supplies and equipment listed below are essential components to successfully implement this proposal.

Item	**Amount**	**Cost**
ECA Check Easygel (26001)- E. coli, coliform and Aeromonas growth medium - 10 tests per set **}**	3 sets	$22.30/set = $66.90
United Bioinformatica EZNA Bacterial DNA Isolation Kit	(50 prep. @ $2.14 ea.)	$107
Bio-Rad Analysis of Lambda Pre-Cut DNA	32 Students	$108.75
Flinn Scientific Non-pathogenic bacterial culture	1 culture tube	$8.25
Carolina - ELISA Simulation Kit	32 students	$92
Flinn Scientific Escherichia Coli slide	3 slides	$3.95 = $11.85

Additional support has been provided through the use of the ICORE Biotechnology equipment locker, a $200 dollar grant to assist with implementation and the on-site research expertise of Dr. Erin Kelso.

Theme: Emerging Pathogens
Lesson Title: Bio-Tech Brigade: *Attack on **S**higa **T**oxin-producing **E**. **C**oli* (STEC)
Grade Span: 9-12
Content Emphasis: Biology, Health, Integrated Science, Biotechnology
Targeted benchmarks: SC.F1.4.5, SC.F.1.4.7, SC.F.2.4.2, SC.G.1.4.1, SC.H.1.4.1, SC.H.3.4.2
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Learning Goals
Students will be able to:

1. Identify the different types of bacteria
2. Conduct and complete basic biotechnology protocols including gel electrophoresis, microscopy
3. Execute a community/school awareness campaign on E. Coli

4. Identify structural components and mechanism of bacteria
5. Compare and contrast between non-pathogenic E. Coli and pathogenic E. Coli
6. Demonstrate competency in basic biotechnology techniques such as ELISA, DNA Extraction, restriction enzyme digestion and gel electrophoresis.
7. Identify historical significance of E.Coli and trends of outbreaks in the last 3 years
8. Demonstrate knowledge of current research on E. Coli
9. Deploy *The STOP STEC* outreach campaign to educate school and community on prevention.

Estimated Time:

A series of modules I – IV over a span of 10 days for traditional classes (50 min.) or 5 days for block schedule.

Materials/Resources:

Laboratory Equipment

LCD Projector
Internet access

Centers for DIsease and Prevention. (2009). Retrieved June 24, 2009, from National Centers for Zoonotic, Vector-Borne and Enteric Diseases: http://www.cdc.gov/ncved/dfbmd/disease_listing/stec_gi.html
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Food and Drug Administration. (2009, 05 27). Retrieved June 25, 2009, from Information for Student and Teachers: HYPERLINK "http://www.fda.gov/Food/ResourcesForYou/StudentsTeachers/default.htm" http://www.fda.gov/Food/ResourcesForYou/StudentsTeachers/default.htm
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Virtual Laboratory. (2006, March). Retrieved June 25, 2009, from Bacteria as a Model System: http://virtuallaboratory.net/Biofundamentals/labs/EColi%20introduced/Coli.htm

Teacher Preparation:
Review background knowledge on types of bacteria especially E. Coli. Teacher must prepare handouts for each module. Pre-lab will precede all lab activities. Students will first engage in a basic skill acquisition lab to sharpen technique. All labs require set up a day in advance.

Introduction:
This comprehensive module will provide students, teachers and the community with foundational knowledge of the basic structure and mechanism of the Escherichia Coli bacteria including identifying its common sources, mode of transmission, symptoms and complication, treatment, and prevention. Students will gather historical data on E. Coli outbreaks worldwide, in United States and in the State of Florida to determine patterns and possibly make predictions. Students will research causative agent for the 10 most recent E. Coli. in the United States.

Exploration:
All labs will be inquiry based and in the form of a case study. Students will research history and study trends in E. Coli outbreaks. Students will determine mode of and audience for awareness campaign.

Application:
Students will apply proper food handling and preparation techniques to reduce occurrence. Students will be able to access valid primary sources of information. Students will educate community on the impact and eradication of E. Coli bacteria.

Assessment:
Students will be evaluated using the following tools:
1. Lab Reports and Data Collection
2. Formal Assessments
3. Panel Discussion
4. Awareness Campaign: flyers, brochures, speeches, commercials, etc.

Teacher Self Evaluation:
To be determined as lesson is executed.