Biology

Hazard Mitigation: Bioterrorism

Viruses and Bacteria

http://www.state.nj.us/humanservices/dmhs/disaster/
http://slph.ncpublichealth.com/ bioterrorism/default.asp

Grade Level  9-12

Lesson # 1 of 4

Lesson Dependency none

Time Required 4 class periods at 50 minutes per class

Summary

- The student will investigate infectious diseases and the molecules that transmit them through a study in the use of biological agents as weapons, bioterrorism. The class will investigate several potential biological agents and simulate the spread of disease through a laboratory investigation and an online investigation. At the end of the unit the students will simulate a bioterrorist attack and use a model to simulate the spread of the biological agent and its impact on the community.

Engineering Connection

- Students will act as civil engineers by modeling the spread of a biological agent through the use of CalRoads model software. The students will try different scenarios to see how the community is affected given changes in variables within the model.

Engineering Category: Environmental Engineering
Keywords

- Bioterrorism
- Biological agents
- Air dispersion modeling

Educational Standards

- Science: 112.43
  - (c) Knowledge and skills.
    - (2) Scientific processes. The student uses scientific methods during field and laboratory investigations. The student is expected to:
      - (A) plan and implement investigative procedures including asking questions, formulating testable hypotheses, and selecting equipment and technology;
      - (B) collect data and make measurements with precision;
      - (C) organize, analyze, evaluate, make inferences, and predict trends from data; and
      - (D) communicate valid conclusions.
    - (3) Scientific processes. The student uses critical thinking and scientific problem solving to make informed decisions. The student is expected to:
      - (A) analyze, review, and critique scientific explanations, including hypotheses and theories, as to their strengths and weaknesses using scientific evidence and information;
      - (B) evaluate promotional claims that relate to biological issues such as product labeling and advertisements;
      - (C) evaluate the impact of research on scientific thought, society, and the environment;
      - (D) describe the connection between biology and future careers;
      - (E) evaluate models according to their adequacy in representing biological objects or events;
    - (4) Science concepts. The student knows that cells are the basic structures of all living things and have specialized parts that perform specific functions, and that viruses are different from cells and have different properties and functions. The student is expected to:
• (C) compare the structures and functions of viruses to cells and describe the role of viruses in causing diseases and conditions such as acquired immune deficiency syndrome, common colds, smallpox, influenza, and warts; and
• (D) identify and describe the role of bacteria in maintaining health such as in digestion and in causing diseases such as in streptococcus infections and diphtheria.

Math: N/A

Pre-Requisite Knowledge
• Structure of Virus
• Structure of Bacteria
• Spread of disease

Learning Objectives
After this lesson, students should be able to:
• Describe different infectious diseases and discuss the various ways that an infectious disease attacks the human body and impacts the body’s immune system.
• Create a model to show how an act of bioterrorism can affect individuals and the entire community.

Introduction / Motivation
• Bioterrorism: then and now
• Why use a biological weapon?
• What agents are used or could be used?
• How do they infect the body?
• Who could be affected?

Lesson Background & Concepts for Teachers

CAL Roads View Traffic Air Dispersion Modeling Software
The CalRoads software includes the CALINE model that was developed in California and is used to detect emissions from cars. The data can be used to determine the amount of
pollution emitted by cars on a given roadway. The model takes into account the type of pollutant, the rate of emission, the speed of the car, the weather and details about the roadway including whether or not the road is at grade (level with the ground), above grade (a bridge), or below grade (underground or in a valley). This model reflects the emissions from the car as the car is moving.

In this lesson, the model has been used to predict the effects of an airborne release of a biological agent on a given stretch of roadway from a moving vehicle. The model was not made for the purpose of modeling the release of a biological agent and so some assumptions and calculations must be made in order to adapt the model to the scenario. The model requires you to choose a type of pollutant (NO\textsubscript{x}, CO, PM (particulate matter)), one of which lends itself more closely to a bacterial spore, the particulate matter. In working with the Civil Engineering Department of the University of Texas at Arlington, I asked if this choice would cause the model to accurately predict the effects of a release of a biological agent and it was confirmed that choosing particulate matter would in fact present an accurate picture of the effects of a release of an airborne biological agent. To accurately input the emission rate or release rate of the toxin, choose a total amount of the agent to release and then divide the release mass by the release time all divided by the velocity of the vehicle. This will give a release rate of grams per mile which you can then input into the model. The street being modeled is chosen and a link is made that traces the street (Figure 2).

![Figure 1](image1.png) ![Figure 2](image2.png)

When the model is complete, there will be several different colors of contours covering the base map picture of the street being modeled (Figures 3 & 4). The colored contours represent varying levels of toxicity in the air and conclusions can be drawn from studying these contours. We chose to assume that anthrax spores were released into the air and we found that a lethal dose of spores was equal to .8 micrograms per cubic meter. When viewing the contours, each value is represented by a color change. If the area in red represents a plot of space where the concentration of the spores in the air exceeds the lethal dose then it is understood that people within that area would be killed by inhaling the spores. Tables and graphs can be made to gather the information and organize the data from the model.
Vocabulary / Definitions

<table>
<thead>
<tr>
<th>Word</th>
<th>Definition</th>
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<tbody>
<tr>
<td>Virus</td>
<td>Infectious agent that only replicates itself within the cells of living organisms</td>
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<tr>
<td>Bacteria</td>
<td>Single celled organism whose nucleus and organelles are not bound by a membrane</td>
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<tr>
<td>Bioterrorism</td>
<td>Terrorism by intentional release of biological agents</td>
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<tr>
<td>Infectious disease</td>
<td>Clinically evident disease resulting from the presence of pathogenic agents</td>
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<tr>
<td>Immune System</td>
<td>Collection of biological processes within an organism that protects against disease by identifying and killing pathogens.</td>
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Associated Activities

- Disease Spread Hands-on Lab
- Disease Spread Gizmo
- Research and present a report on a biological agent
- Model a scenario of bioterrorism

Lesson Closure

This might be a good time to reflect on the ethical component in discussing bioterrorism and how this model can be used to help predict and prepare for a terrorist attack rather than used to plan a terrorist attack. Students could be asked to write a response or have class discussion.
Assessment

- Quiz: Critical thinking questions about disease spread
- Test Grade: Presentation on report of biological agent

Lesson Extension Activities

- Ethics
- Preparedness and Response

Additional Multimedia Support

http://people.uwec.edu/piercech/Bio/Presentation.ppt

http://roundtable.healthsafe.uab.edu/pages/resources/bioterrorism.ppt

References

http://www.bioone.org/doi/full/10.1662/0002-7685%282003%29065%5B0013%3AITAOBI%5D2.0.CO%3B2

http://www.sciencecases.org/bioterrorism/bioterrorism_notes.asp


Owner

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