

Title: Oil Eating Bacteria and Our Immune Response

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Abstract

The recent BP oil spill will set the stage for evidence of environmental disruption. The subsequent occurrence of *Vibrio* species in Gulf waters will serve as possible “Emerging Pathogens” that students will investigate. Students will explore the various modes of *Vibrio* transmission. Students can learn about foreign antigens and the resulting immune responses they illicit as these microbes enter our bodies. Students will participate in hands-on laboratory investigations as they solve the puzzle of possible *Vibrio* infection. Students will be able to examine treatment modalities and discuss how they aid our immune systems. Infection prevention will become relevant and students will gain a deeper understanding and appreciation for how our environment and personal health are interrelated. The important roles of the Center for Disease Control and World Health Organization will become apparent.

Rationale

For billions of years, humans have had a close connection with microbes. In this symbiotic relationship, microbes can be beneficial or harmful to us as we become their host. Many times, bacteria can suppress or illicit our bodies’ defenses. Our immune system then becomes a most important factor in our survival to pathogen exposures. High school students have a difficult time comprehending these specific and non-specific responses. They can accept the idea that bacteria can become our enemy, but have trouble understanding our bodies’ response to infection. Likewise, they do not understand methodologies for diagnostic testing and vaccination success. Most do not understand the cause of antibiotic-resistant bacterial strains and do not connect ecosystem disturbances with possible threats to our health.

This action plan will stimulate students’ interest in the “inner workings” of their body’s immune system and lead to understandings in how scientists use biotechnology for diagnosis, bacteria identification, and treatment. Hands-on labs will engage students and provide practice for current scientific testing. They will be able to evaluate how environment and personal health are interrelated and discuss its impact. Students will be able to carry this information forward as they become adults.

Description of Teaching Unit

Module 1

Students will be introduced to three types of *Vibrios* that can be found in our water environment and how each may affect human health. Previous bacterial knowledge from biology will be reviewed, followed by an explanation of pathogens becoming foreign antigens to humans. Students will look at and discuss recent *Vibrio* findings in the Gulf of Mexico after the recent BP oil spill. Students will

observe bacterial plates of *Vibrio* colonies and also their typical microscopic morphology. Modes of transmission will be discussed and health ramifications of subsequent infections. Typical signs and symptoms of disease will be discussed. The immune response brought on by *Vibrio* pathogens will be taught including leukocyte proliferation and antibody production by lymphocytes.

Module 2

Micropipetting will be introduced and proper lab technique explained. Students will practice proper pipetting techniques as they follow a set of instructions using pipettes and colored water samples.

Module 3

Students will be given simulated patient stool samples, water samples, and a written scenario. They will perform Rapid-Test dipstick tests on each sample and interpret results. ELISA methodology will be discussed briefly as students begin their laboratory investigation, including the role of enzymes and significance of a color change. The roles of positive and negative controls will be stressed. Students will perform a simulated ELISA antibody test on unknown patient samples which will include “what did we just do” questions interspersed. They will accurately record all results and interpret them.

Module 4

Students will research recommended treatments for patients with *Vibrio* infections and comment on how these aid our body’s immune response. They will look to see if vaccinations are available and if any drug resistant *Vibrio* strains have been identified. They will list prevention and protection procedures. Final class discussions will include laboratory data with interpretations and comments on how environmental disruptions might affect our health.

Student Assessments

Following directions and proper testing techniques will be included in assessments. At the end of this unit, students will be given a patient case study with diagnostic testing results. Students will complete a document where they will explain possible reasons for any signs and symptoms exhibited by this patient. They will interpret testing results and make recommendations for treatment including their rationale. They will suggest possible modes of transmission and ways to prevent future infections.

Equipment needed

Pipetting stations from ICORE equipment lockers

ELISA simulation kits from Dr. Lawrence/CPET

Teacher supplied colony and microscopic *Vibrio* pictures, Rapid-test dipsticks, simulated water and patient samples, lab sheets, and access to student computers.

ICORE elements included

Emerging Pathogen notebook

What You Need to Know About Infectious Disease book

Medical Mystery of Epidemic Proportions worksheet and testing

ELISA simulation kits

Literature cited

Medical Mystery of Epidemic Proportions (cholera activities)
Molecular Biology of Cholera, presentation by Dr. Judy Johnson
Vibrio in Oysters, presentation by Dr. Anita Wright
Aquatic Pathobiology, presentation by Dr. Andrew Kane

Budget Justification

Fixed Volume Mini-Pipet (20ul) X 3	\$34.00 each	sub total:	102.00
Fixed Volume Mini-Pipet (100ul) X 3	34.00 each		102.00
Micropipette tips, non-sterile, 1-200ul	rack/\$23.00		<u>23.00</u>
		Total:	\$227.00

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Subject: Anatomy and Physiology Honors (junior and seniors)

Time estimate: 4 days to complete lesson with day 5 for assessment (50 minute class time)

Student Learning Objectives with Standards:

Objectives: The student will be able to...

- 1) Identify foreign antigen exposure and subsequent humoral antibody formation (active immunity) by analyzing data
- 2) Discuss the importance of positive and negative controls in gathering accurate data during laboratory testing.
- 3) Explain the role of enzymes in biochemical reactions as seen in the ELISA assay
- 4) Identify ways to prevent bacterial infections
- 5) Evaluate the impact of biotechnology concerning a medical issue

Standards:

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| SC.912.L.14. | Explain the basic functions of the human immune system, including specific and nonspecific immune response, vaccines, and antibiotics |
| HE.912.C.1.3 | Evaluate how environment and personal health are interrelated |
| SC.912.L.14 | Identify ways to prevent infection from bacteria and viruses |
| SC.912.L.14.6 | Explain the significance of environmental factors and pathogenic agents to health from the perspectives of both individual and public health |
| SC.912.L.16.10 | Evaluate the impact of biotechnology on the individual, society and the environment |

Materials:

Essential:

1 map of Gulf of Mexico oil spill indicating the range of polluted waters
Pictures of Vibrio colonies on blood agar plates and their typical microscopic morphology
Fixed Volume Mini-pipettes (20 ul and 100ul) X 3 each (student groups will share)
Micropipette tips, non-sterile 1-200ul
Micropipette stations (plates) x 10
ELISA simulation kits x 8 per class x 3 classes
Rapid-test dipsticks x 8 per class x 3 classes
Simulated water and patient samples

Supplemental:

Access to student computers

Procedure and Discussion Questions:

(Day 1 will include 1-6 = one class period or approx. 50 minutes)

1. The lesson will start with a picture of the Gulf oil spill on a US map indicating the range of the spill in the Gulf of Mexico. Discuss prior knowledge of spill with students – how long did the spill last, how many gallons dumped into the Gulf, what are some clean-up measures that students observed on our beaches

2. Brief lecture of oil eating bacteria and introduce three types of Vibrio bacteria and what diseases they commonly cause. Students will observe pictures of Vibrio colonies on agar plates and also microscopic pictures of the bacterium. Discuss previous knowledge of bacterial shapes learned in biology and compare to pictures.
3. Brief lecture explaining the modes of transmission for the three types of Vibrio to include typical signs and symptoms of disease.
4. Brief lecture explaining how these pathogens become foreign antigens to humans and how the body's leukocytes will mount an immune response, proliferate, and produce specific antibodies against them. Ask students to name other foreign invaders that illicit an immune response (cold virus, transplanted organs, HIV). Remind students about leukocytosis previously learned in the blood chapter.
5. Brief lecture on antibody production by lymphocytes using picture visuals of antibody attaching to pathogen to eliminate these bacteria from the body.
6. Students will answer questions on their lab sheets to reinforce above concepts.

(Day 2 will include 7-10 = one class period or approx 50 minutes)

7. Micro-pipetting will be introduced by demonstration and proper lab technique will be explained and stressed.
8. Students will practice proper pipetting techniques using colored water samples and micropipettes and micro-plates as they follow a set of instructions. Students will be in groups of 3 per station and take turns practicing pipetting into the wells properly.
9. Discuss things that could go wrong and influence results such as cross contamination between wells and not pipetting the correct amount of fluid into each well.
10. Students will clean lab stations and wells, discard tips, and return equipment

(Day 3 will include 11 –13 = one class period or approx 50 minutes)

11. Brief lecture introducing ELISA methodology to include the role of enzymes and the significance of a color change.
12. Students will be given simulated patient stool samples, water samples, and a written scenario about their specific patient. After a brief discussion on dipstick procedure, students will perform Rapid-test dipstick tests on their patient sample and the water sample and interpret results as positive for Vibrio infection or negative and record on lab sheet.
13. Students will perform a simulated ELISA antibody test on their patient sample which will include “what did we just do” questions interspersed in their lab directions to review what is happening between the antibody from the patient if present and the bacterial antigen. They will accurately record all results on their lab sheet and interpret them.

(Day 4 will include 14-17 and will be in the computer lab for 50 minutes)

14. Students will research recommended treatments for patients with Vibrio infections and comment in their lab report, how these aid our body's immune response.
15. Students will research to see if vaccinations are available and if any drug resistant Vibrio strains have been identified and comment in their lab report.
16. They will list prevention and protection procedures to avoid bacterial infection.
17. They will comment in their lab reports how environmental disruptions may affect our health.

Assessment: Case study interpretation (on day 5)

For objective 1 – students will be given a patient case study with diagnostic dipstick and ELISA testing results which they will interpret.

For objective 2 – students will be asked to comment on how their interpretation would change if the positive and negative controls were not correct.

For objective 3 – students will discuss the role of enzymes in the ELISA assay.

For objective 4 – students will recommend a treatment plan for their case study patient and suggest a possible transmission mode and future prevention strategies for their patient.

For objective 5 – students will provide a brief summary explaining the impact biotechnology can have on providing quick and reliable diagnostic answers for physicians and their patients.

Resources/references:

Emerging Pathogen notebook

What You Need to Know About Infectious Disease book

Medical Mystery of Epidemic Proportions worksheet and testing

Molecular Biology of Cholera, presentation by Dr. Judy Johnson

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