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Plastic as a Habitat for Bacteria and Human Pathogens. Subjects: Life Science / Biology Grades: 6-8

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PLASTIC AS A HABITAT FOR BACTERIA AND HUMAN PATHOGENS

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Grade Level
Middle School

Subject area
Biology or Environmental Science

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Title: Plastic pollution as a habitat for bacteria and human pathogens

Focus: Human activity can directly affect the environment and the organisms living there.

Grade Level: I believe my research would best fit 7th grade Life Science students.

Virginia Science Standards addressed: The relevant SOLs are as follows: LS.1, LS.6, LS.8, and LS.11

LS.1 – The student will demonstrate an understanding of scientific reasoning, logic, and the nature of science by planning and conducting investigations in which: a.) Data are organized into tables showing repeated trials and means; e.) Sources of experimental error are identified; h.) Data are organized, communicated through graphical representation, interpreted, and used to make predictions; i.) Patterns are identified in data and are interpreted and evaluated.

LS.6 – The student will investigate and understand that organisms within an ecosystem are dependent on one another and on nonliving components of the environment (biofilms on substrate; other organisms consuming these plastics)

LS.8 – The student will investigate and understand interactions among populations in a biological community (niches – plastic serves as a habitat).

LS.11 – The student will investigate and understand the relationships between ecosystem dynamics and human activity (environmental issues – plastic pollution).

Learning Objectives:

A.) Students will examine plastic pollution as a novel habitat for bacteria in the environment.

B.) Students will demonstrate an understanding of scientific reasoning and be able to analyze and interpret data.

C.) Students will calculate averages and create graphs to visualize their data.

D.) Students will examine how human activity can have an impact on the environment.

Length of Time Required for lesson: One class period

Key Words:

Plastic pollution - https://en.wikipedia.org/wiki/Plastic_pollution

Microplastics - https://en.wikipedia.org/wiki/Microplastics

Plastic types - https://www.qualitylogoproducts.com/lib/different-types-of-plastic.htm

Biofilm - https://en.wikipedia.org/wiki/Biofilm

Bacteria - https://en.wikipedia.org/wiki/Bacteria

Colonies (Microbial colonies) - https://en.wikipedia.org/wiki/Colony_(biology)

Colony forming units (CFUs) - https://en.wikipedia.org/wiki/Colony-forming_unit

Pathogens - https://en.wikipedia.org/wiki/Pathogen

Pathogenic - causing or capable of causing disease

Vibrio species (*V. parahaemolyticus,* and *V. vulnificus. V. cholerae*) - https://en.wikipedia.org/wiki/Vibrio

CHROMagar Vibrio - http://www.chromagar.com/food-water-chromagar-vibrio-focus-on-vibrio-species-23.html#.V4ArCVeSGIl

Background:

In less than a century, plastic has gone from invention to ubiquity primarily due to its lightweight and durable nature. These desirable qualities in a commercial material, however, also make its disposal quite challenging. Plastic disposal has become a cause for concern as knowledge of plastic pollution in the marine environment has increased exponentially in the past few decades. Only more recently has marine plastic been examined as a habitat for aquatic microbial communities. Since plastics degrade very slowly, they remain in the environment on much longer timescales than most natural substrates. This long lasting substrate can provide a habitat for the colonization and possible spreading of microbial communities, including bacteria that are human pathogens.

We set up two experiments on a local dock in the Lafayette River to examine *Vibrio* spp. colonization over time. We hung different plastic types from a floating dock and sampled the biofilms on each over time. We looked at days 1, 2, 4, 8, and 16. Biofilms were scraped off a section of the plastics (2cm by 1cm = $2cm^2$) and then filtered onto CHROMagar, a selective growth medium for *Vibrio* bacteria. Colonies were counted after ~24 hours. Colonies counted can be recorded as CFU or colony forming units. CFUs are then normalized to the size of the area scraped ($2cm^2$). Water samples were taken in tandem to compare with plastic colonization over time.

Student Handouts: Handouts will include data sheets to record counts and discussion questions for the final assessment.

Materials and Supplies: I will provide laminated pictures of CHROMagar plates for colony counts.

Classroom Set up: This will be a classroom set-up. Students will be grouped together into six groups (3-4 students/group). Each group will count six – seven plates. Set up for equal work distribution (later days have many more colonies) - Group 1: Polypropylene (three plates from days 2 and 16). Group 2: Polypropylene (three plates from days 4 and 8). Group 3: Low-density polyethylene (three plates from days 2 and 16). Group 4: Low-density polyethylene (three plates from days 4 and 8). Group 5: H2O (three plates from days 1 and 2 and one plate from day 4). Group 6: H2O (three plates from days 8 and 16 and two from day 4).

Procedure: Students will count colonies on CHROMagar plates for 2 substrates plus water in replicates (3) and over time (Days 1, 2, 4, 8, & 16). They will do this for one experiment totaling to 39 plates counted (day 1 are all zeros). Numbers will be recorded and then graphed. Students should calculate CFU/ml for water by taking the average of the three replicate water plates for each day and then dividing by the amount of water filtered – in this case 2ml. Students should also calculate CFU/cm^2 for plastic substrates by dividing by the size of the scraped plastic pieces – in this case 2 cm by 1 cm ($2cm^2$). Each group will graph water temperature over time to have an opportunity to practice graphing. The entire class will then combine CFU data and graph together. After graphing, they can spend some time looking at differences among plastics and water over time.

Assessment: I think a good assessment for this lesson will be for students to combine data and graph as a group. They can then examine the graph and answer discussion questions. Discussion questions should be reviewed before moving on to the craft activity (if there's time).