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Sari Solution

Discovering Methods to Prevent Cholera Epidemics

Inquiry Challenge How can the bacteria that cause cholera (*Vibrio cholerae*) be removed from river water without the use of chemicals or expensive equipment?

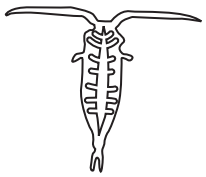
Lab Overview In this inquiry investigation, you will learn how *Vibrio cholerae* can live in and on the bodies of copepods, tiny animals that live in fresh and salt water. Using simulated river water, you will develop an inexpensive filtering method to remove copepods.

Introduction To start your investigation, you will read about how *Vibrio cholerae* causes disease and the relationship between the bacteria and copepods. Then, you will decide which abundant and cheap materials can be used to make a practical tool to filter the copepods.

Background *Vibrio cholerae* is a rod-shaped, motile bacterium with one flagellum. When consumed by humans, *Vibrio cholerae* attaches to the small intestine. The bacteria then produce a toxin that causes the small intestine to secrete massive amounts of water and salts. Without proper medical care, more than 50 percent of those with severe cholera infections die from dehydration and loss of salts.

The most common source of cholera infection is drinking water containing *Vibrio cholerae*. In the United States and other developed nations, water is filtered and treated to remove and kill microorganisms. While filtration and chlorination have decreased cholera in developed nations, people in many developing nations continue to suffer from cholera. For example, in developing nations such as Bangladesh, many people live in poverty in crowded areas without water treatment facilities.

If a person consumes about 1,000,000 *Vibrio cholerae* bacteria, the person will most likely develop cholera. Almost all the *Vibrio cholerae* bacteria are associated with tiny crustaceans called copepods. Up to 10,000 *Vibrio cholerae* bacteria can attach themselves to and inside one copepod, which is about the size of an uncooked grain of rice. If the copepods are removed from water before the water is consumed, then the *Vibrio cholerae* will also be removed.



Copepod

Vibrio cholerae

Prelab Activity Scientist Dr. Rita Colwell and her colleagues looked for a simple method to remove *Vibrio cholerae* from drinking water using household materials. Suppose you are one of the researchers working with Dr. Colwell. You have collected 1 L river water containing copepods. Your task is to determine the best method of filtering the water to reduce the occurrence of cholera. Study the list below of household items commonly found in Bangladeshi homes. Think about how these items might be used to filter the copepods, and thus *Vibrio cholerae*, from the water. When you are finished, answer the Prelab Questions.

Common Household Items

- clay jar or pot
- bangle bracelets
- spices
- cloth for saris (garments)
- bamboo matting

Prelab Questions

1. Discuss the relationship between copepods and cholera.

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2. Which common household items from the list above do you think would work best for filtering out the copepods? Explain your reasoning.

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3. Devise a method for using these materials to filter the water.

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Materials

- simulated Bangladeshi water (copepod culture)
- plastic droppers
- well slides
- microscope
- transparent metric ruler
- new sari cloth (or other cotton cloth)
- worn sari cloth (or other cotton cloth)
- graduated cylinder
- clear plastic cups

Procedure

Part A: Observing and Measuring Copepods

1. Place a drop of copepod culture on a well slide. View the slide through the microscope using low power and focus on the copepods. (**NOTE:** *The copepods in the culture* do not *carry* Vibrio cholerae.)
2. Determine the approximate size of a copepod by estimating how much of the field of view it takes up under low power. (You can measure the diameter of the field of view under low power by placing a transparent metric ruler across the stage.)

Part B: Designing and Carrying Out Your Experiment

1. Before designing your filtration technique, follow the steps below to determine the size of the holes in the weaves of the new and worn cloth.
   a. Place the transparent metric ruler on the microscope stage. Under low power, measure the diameter of the field of view in millimeters. Calculate the field of view of the medium- and high-power objectives using these formulas:

   $$\frac{(\text{diameter of low-power field of view}) \times (\text{power of low-power objective})}{(\text{power of medium-power objective})}$$

   = diameter of medium-power field of view

   Diameter of medium-power field of view = _____

   $$\frac{(\text{diameter of medium-power field of view}) \times (\text{power of medium-power objective})}{(\text{power of high-power objective})}$$

   = diameter of high-power field of view

   Diameter of high-power field of view = _____

   b. Examine the cloth through the microscope. Estimate the size of one hole in the weaves of the new and old cloth based on how much of the diameter of the field of view one hole takes up.

2. Predict whether new or old cloth will be more effective at filtering out copepods. Explain your prediction.

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3. Design an experiment to answer the following questions.

a. Is new cloth or old cloth the most effective filter?

b. Once you have decided whether new or old cloth is more effective, how many layers of cloth are necessary to completely filter out the copepods?

Write the experimental procedure you plan to use below.

4. Have your teacher review your procedure, then revise it as necessary based on your teacher's suggestions.

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5. Carry out your experiment. Record your data in the space below.

Analysis and Conclusions

1. What problems did you face when you performed your experiments? If you performed the experiments again, explain what you would do differently.

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2. Which type of cloth, new or old, did you find was the most effective? Explain.

3. How does the size of a copepod compare to the size of the holes in the cloth?

4. Suppose a science writer visits your class while you are doing this lab and is writing a feature article about your work. The writer challenges the notion that sari cloth can be an effective filter for bacteria and tells you that cholera bacteria are far too small to be filtered with cloth. Write an explanation that supports the effectiveness of sari filters.

Extension

You have observed how sari cloth can be used to remove copepods from a water supply. Design an experiment that would enable scientists to determine if the amount of *Vibrio cholerae* bacteria in a contaminated water sample would change after filtering with this method. Recall that in the lab you only modeled the system for bacteria removal. The copepods did not carry *Vibrio cholerae*.