Performance-Based Assessment

Cholera in Haiti

Managing a Crisis

Obtaining, Evaluating, and Communicating Information

The country of Haiti has suffered many problems over the years, but cholera had not been one of them. Then, in 2010, a strong earthquake struck the island. Rescue workers arrived to help victims recover. Unfortunately, the workers likely brought with them the bacteria that cause cholera. Haiti soon was suffering its first cholera epidemic—and others would follow. By 2016, cholera had killed about 10,000 Haitians. Whole communities were wiped out.

The cholera bacterium, *Vibrio cholerae*, causes illness by producing a protein known as cholera toxin. This protein causes chloride channels to open in the membranes of cells lining the intestine. As chloride ions flow out of the cells, osmosis causes water to follow, producing massive diarrhea. In what way does the production of this protein benefit the bacterium, and why might evolutionary natural selection have favored it?

Cholera is a bacterial infection of the digestive tract. Without treatment, victims can die quickly from dehydration. The bacteria spreads through contaminated drinking water. For this reason, cholera outbreaks can be common in places, such as Haiti, where sanitation is poor and people live close together. How should cholera be managed in Haiti today? Public health officials are struggling to find the best combination of strategies. Some possible strategies include vaccination, education, and improved sanitation.

Vaccination In 2016, health officials in Haiti launched a campaign to administer the vaccine against cholera in high-risk areas. Their goal was to vaccinate 800,000 people, which is about 8 percent of the population.

Education Haitians are learning how to prevent cholera by treating drinking water with chlorine and washing their hands before they eat.

Improved Sanitation Installing and maintaining modern sewage systems is perhaps the most effective way to prevent cholera and similar diseases. However, these systems are expensive.

1) SEP Define the Problem Why does cholera remain a problem in Haiti?

2) Conduct Research Find out how public health officials are preventing and treating cholera in Haiti today. Work in a small group to research the variety of strategies used in Haiti, including vaccination programs, quarantines to contain cholera outbreaks, treatment methods for cholera victims, and efforts to provide clean drinking water and improved sanitation throughout the country. Record your findings. Be sure to evaluate your sources for accuracy.

3) SEP Connect to Society A cholera epidemic ravaged the city of London in 1854. The epidemic was ended by the work of a physician named Dr. John Snow. Consult historical resources to learn how Dr. Snow discovered the source of the epidemic and also how he helped public health authorities to end it. Does the history of the London epidemic suggest any lessons for the best way to combat cholera in Haiti?

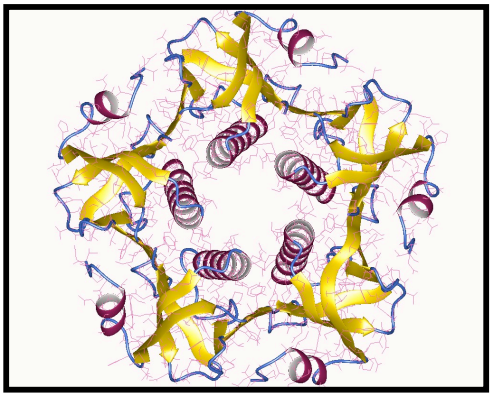
4) Evaluate Review the results of your research. Evaluate the different strategies and methods for fighting cholera in Haiti. In your evaluation, consider the importance of containing a cholera epidemic if it occurs, as well as preventing future epidemics.

5) Construct an Argument Based on your research, what actions or policies for fighting cholera would you recommend to the government, public health officials, and people of Haiti? Describe both the costs and benefits of your recommendations, as well as the potential consequences if no new actions were taken. Try to include scientific evidence, logical reasoning, and an economic analysis to support your argument.

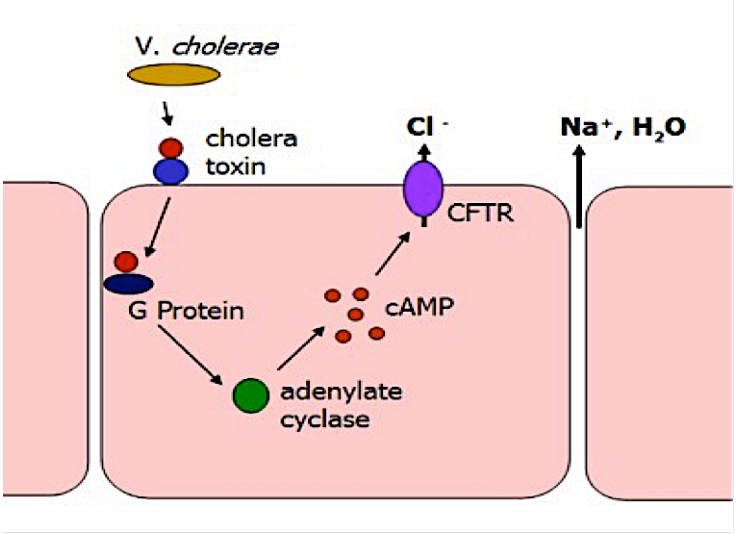
6) SEP Communicate Information Organize your research findings and your argument for a solution in an essay or computer presentation. Share your report with classmates.

Investigating Cholera

Vibrio cholera, the cholera bacterium, lives in the intestine and produces a protein (shown at right) known as cholera toxin.



The toxin binds to a protein on the surfaces of intestinal cells, and activates a series of biochemical changes (shown below) which increase the permeability of a membrane protein known as CFTR to chloride ions (Cl-).



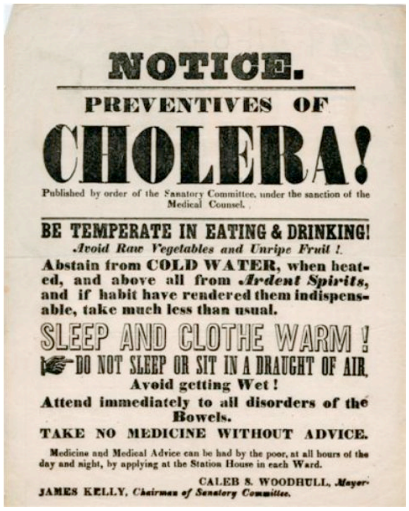
Research Questions

The flow of both chloride and sodium ions into the intestine has an important consequence as a result of osmosis. What is it?

The production of cholera toxin does not directly help or harm the *Vibrio* bacteria actually growing within the digestive system. Nonetheless, the effectiveness of the toxin clearly represents an evolutionary advantage for the bacterium. Explain.

As noted in this diagram, the mode of action of cholera toxin involves a critical membrane protein known as CFTR. What is CFTR, and what genetic disorder, unrelated to cholera, is associated with it?

The London Cholera Epidemic



NOTICE.

PREVENTIVES OF

CHOLERA!

Published by order of the Sanatory Committee, under the sanction of the Medical Counsel.

BE TEMPERATE IN EATING & DRINKING!

Avoid Raw Vegetables and Unripe Fruit !.

Abstain from COLD WATER, when heated, and above all from *Ardent Spirits*, and if habit have rendered them indispensable, take much less than usual.

SLEEP AND CLOTHE WARM !

DO NOT SLEEP OR SIT IN A DRAUGHT OF AIR.

Avoid getting Wet !

Attend immediately to all disorders of the Bowels.

TAKE NO MEDICINE WITHOUT ADVICE.

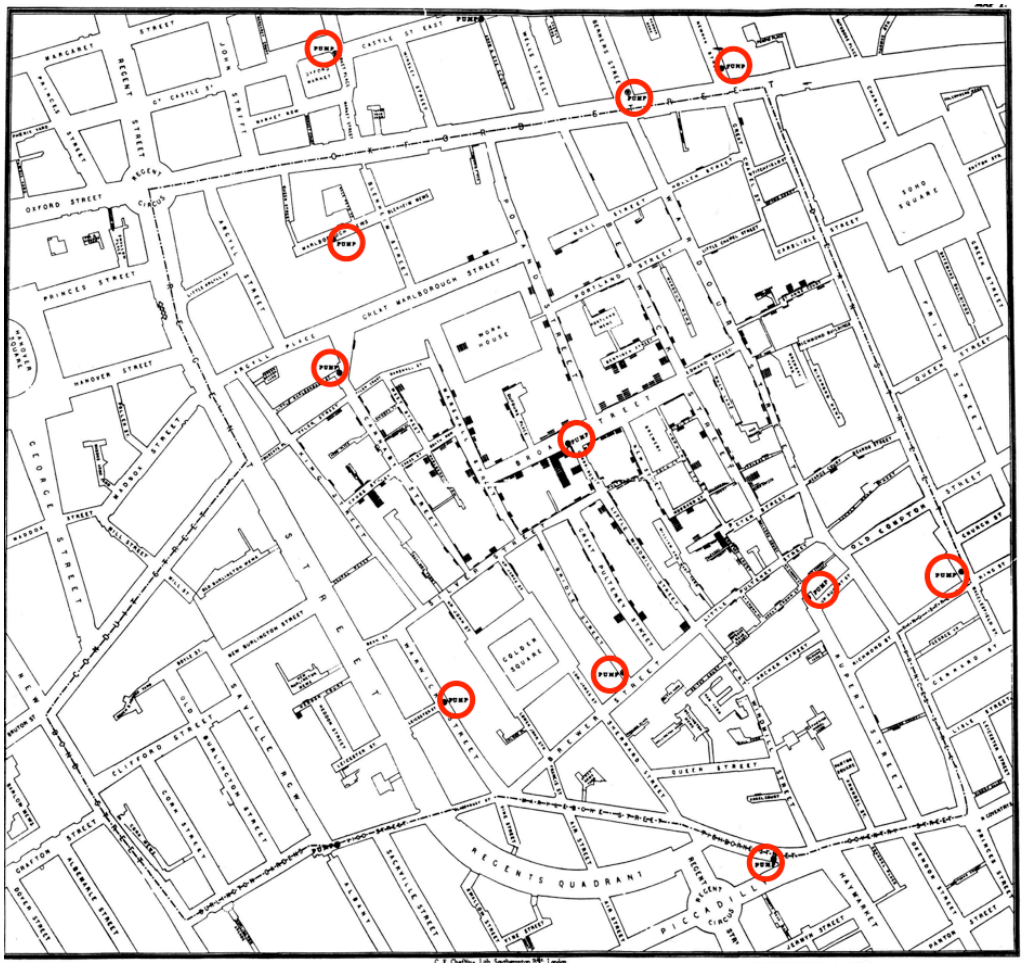
Medicine and Medical Advice can be had by the poor, at all hours of the day and night, by applying at the Station House in each Ward.

CALEB S. WOODHULL, *Mayor.*

JAMES KELLY, *Chairman of Sanatory Committee.*

In the 18th and 19th centuries, London suffered periodic epidemics of cholera. One of the most severe broke out in 1854 in central London. Medical opinion at the time suggested that cholera was an airborne disease, and people were advised to avoid contact with cholera sufferers. It was also believed that cholera could be caused by the chilly night air.

While the city suffered and people died, one physician, Dr. John Snow, thought to make a map of the affected region of the city to see if it provided any clues as to the source of the disease.



Dr. Snow's map showed the home of each victim as a black square. Note how they were concentrated in the center of the map. He also noted the location of public taps which were used for drinking water (London had no central water supply at the time). The pump locations are marked with red circles.

Research Questions

What conclusions would you draw from Dr. Snow's map of the epidemic?

After you've drawn your own conclusions, research out what Dr. Snow concluded from his map, and what actions he took to end the epidemic.

What effects did his actions and their results have on the prevailing ideas about the causes of cholera?

Are Snow's findings applicable to the situation in Haiti today? What do they suggest about the continuing problem of cholera in that country?

Several oral vaccines for cholera have recently been developed (brand names include: Vaxchora, Dukoral, and ShanChol). Pick one of these to search for information about its effectiveness, and evaluate it with respect to how it might be used in Haiti.