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Potential Effects of Nano silver on a Bacteria Population

Curriculum Alignment to Standards

NGSS:

HS-LS2-6 Evaluate the claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem.

HS-LS4-7 Create or revise a simulation to test a solution to mitigate adverse impacts of human activity on biodiversity.

Science TEKS:

8.11(B) *Investigate how organisms and populations in an ecosystem depend on and may compete for biotic and abiotic factors such as quantity of light, water, range of temperatures, or soil composition*

ELPS:

c.3(D) *Speak using grade-level content area vocabulary in context to internalize new English words and build academic language proficiency*

c.3(E) *Share information in cooperative learning interactions*

c.5(B) *Write using newly acquired basic vocabulary and content-based grade-level vocabulary*

c.4(K) *Demonstrate English comprehension and expand reading skills by employing analytical skills*

CCRS:

VI.C(2) *Recognize variations in population sizes, including extinction, and describe mechanisms and conditions that produce these variations*

Essential Questions

- Are bacteria bad or good for the environment?
- How do bacteria influence the environment?
- What is Nanotechnology?

Essential Understandings

- Nanotechnology is currently being used in multiple applications across the sciences, but as these technologies improve so much of life processes, the technologies may also be disrupting some of nature's balances.
- Bacteria are both harmful and essential organisms that help provide balance to an ecosystem.

Vocabulary

- ***Bacteria:*** prokaryotic unicellular microorganisms which lack a nucleus and membrane bound organelles.
- ***Colloidal:*** a solution that has particles ranging between 1 and 1000 nanometers in diameter, yet are still able to remain evenly distributed throughout the solution.

Teacher Notes

- ***Concentration:*** a measure of the amount of dissolved substance contained per unit of volume in a solution.
- ***Nano:*** a unit prefix meaning one billionth. A nanometer is one billion times smaller than a meter.
- ***Zone of Inhibition:*** the area around an antibiotic disc that contains no bacterial growth.

Materials

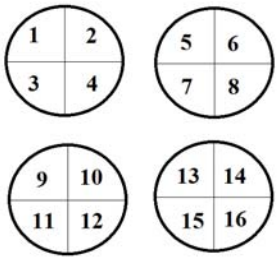
- 16 sterile paper disks
- *E. coli* HB 101 K-12 or Spoiled Milk
- 4 Petri dishes
- Distilled water
- 8 oz 500 PPM colloidal silver
- Sterile disposable pipettes
- Sharpie
- Sterile inoculating loop
- Nutrient agar powder
- Incubator at 37°C or foam ice chest
- Nutrient broth
- Silver coated sock. Soaked in water for 48 hours.

Safety Notices

- No recombinant strains of bacteria will be used during this lab exercise.
- Colloidal silver is known to have antibacterial effects against Escherichia coli (E. coli) and Methicillin resistant Staphylococcus aureus. (Gardner, 2009)
- Colloidal Silver has been found to be nontoxic to humans when expose to the particles less than twice a week for a period of 1 month. (Fung, 1996)
- To protect against excess exposure to the colloidal silver, proper lab attire should be worn throughout the entire lab including: gloves, safety goggles, and a lab coat.

Teacher Preperation

To prepare for the discussion on the effects of nano silver on bacterial populations, complete the setup of the bacterial plates with various concentrations of colloidal silver. Alternatively, this activity may be setup by the students.



Day 1:

1. Prepare the nutrient agar per package instructions.
2. Label the bottom of the four petri dishes as shown to the right.
3. Pour the agar into 4 sterile petri dishes.
4. Place the dishes back into their sleeve and refrigerate for 24 hours.
5. Add 250 µl of the nutrient broth to the *E. coli* HB 101 K-12 with a sterile pipette and incubate for 24 hrs. Alternatively, spoiled milk may be used as a bacteria source.
6. Place a nano silver infused article of clothing, for example a sock, in distilled water for at least 24 hours.

Teacher Notes

Day 2:

1. Create the following dilutions using distilled water and 500 PPM colloidal silver.

Final Silver Concentration	Amount of 500 PPM Stock (ml)	Amount of Distilled Water (ml)	Number on Petri Dish
500 PPM	10	0	2
400 PPM	8	2	3
300 PPM	6	4	4
200 PPM	4	6	6
100 PPM	2	8	7
50 PPM	1	9	8
25 PPM	5	95	10
10 PPM	2	98	11
5 PPM	1	99	12

2. Place 1 sterile paper disk in each of the created solutions for at least 5 minutes.
3. Place 4 sterile paper disks in distilled water for at least 5 minutes.
4. Add 3 sterile paper disks to the water from the soaked silver infused sock for at least 5 minutes.
5. Use a sterile inoculating loop; streak all four petri dishes with the *E. coli* HB 101 K-12 bacteria, or spoiled milk.
6. Place the paper disks on their appropriate Petri dish quadrant. See table above. Numbers 1, 5, 9, and 13 will be the controls; while 14-16 will be the water sample from the soaked silver coated soak.
7. Place petri dishes upside down in the incubator and set to 37°C. If an incubator is not available, a foam ice chest may be used to grow the bacteria. Check growth after 2 to 3 days.

Control Treatment:

Distilled water will be used as a control measure.

Disposal:

At the conclusion of the lab activity, all materials will be autoclaved for 15-20 minutes; while lab tables and benches will be wiped clean with a 10% bleach solution. If an autoclave oven is not available, soak the Petri dishes in a 10% bleach solution for at least 30 minutes then dispose the petri dishes in the trash.

Nano Silver on Clothing

Begin by discussing with students the concept of nano-silver infused socks or clothing by posing the following question: “If you were able to wear clothing that prevented you from smelling bad by killing bacteria, would you wear it?”

Instruct students to first think quietly to themselves for 1-2 minutes. Next, with their group, discuss their

answer and reasoning.

Each group will then prepare a white board or chart paper that explains the group's decision. Each group may choose to present their answer as a paragraph or drawing with events.

Bacteria: Good or Bad?

Discuss with students or show a quick video explaining the role of bacteria in the environment or why they are important to the ecosystem. For example the 2 minute video "What is Bacteria?" can be found on YouTube at https://www.youtube.com/watch?v=pcXdfofLoj0.

By the end of the discussion, students should be able to answer the following questions:

1. What are bacteria also called? *Prokaryotes*
2. What are the major parts of a most bacteria? *Cell wall, cell membrane, and DNA*
3. How do bacteria reproduce? *Binary fission*
4. What are the two domains of bacteria? *Archaebacteria and Eubacteria*
5. What are some important functions of bacteria? *Bacteria in the gut help digest food, cyanobacteria make oxygen through photosynthesis, bacteria fix nitrogen molecules use that they may be used by plants, bacteria is used in the production of food for example yogurt and cheese, and bacteria are used in medicine.*
6. How much of your body is bacteria? *90% of the cells on your body are bacteria*

Nano Silver on Clothing

Restate the initial question: "If you were able to wear clothing that prevented you from smelling bad by killing bacteria, would you wear it?" Allow the class to answer aloud and discuss freely. Students' answers may be mixed.

Now pose a new question to students: "Does the use of nano silver infused clothing pose a threat to the role of bacteria in an ecosystem?"
Most students do not really understand what nanotechnology is or how research is currently being used. Use pictures and videos to explain to students how nanotechnology researcher has assisted in everyday life.

Discuss with student where the water goes that we use to wash our clothes. In Houston the most of the sewage water is run to Lake Houston. Visit your city government page to determine where the water goes in your area.

Effect of Nano Silver on the Bacteria within Lake Houston

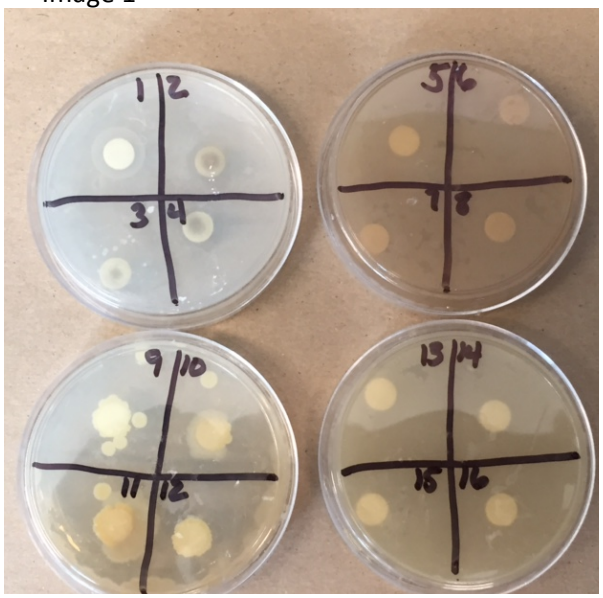
Have students determine at which concentration the nano silver runoff might be dangerous to Lake Houston or your local water supply area. Lake Houston holds a volume of 2×10^{14} ml of water.

Teacher Notes

Show students the petri dishes prepare before class and explain the concentration of silver that was added to each paper dish in each quadrant.

Students will draw what each Petri dish looks like and record the nano silver concentration of each quadrant in the table provided.

Image 1



Quadrant	*Nano Silver Concentration*	*Quadrant*	*Nano Silver Concentration*
1	*0 ppm*	9	*0 ppm*
2	*500 ppm*	10	*25 ppm*
3	*400 ppm*	11	*10 ppm*
4	*300 ppm*	12	*5 ppm*
5	*0 ppm*	13	*0 ppm*
6	*200 ppm*	14	*
7	*100 ppm*	15	*
8	*50 ppm*	16	*

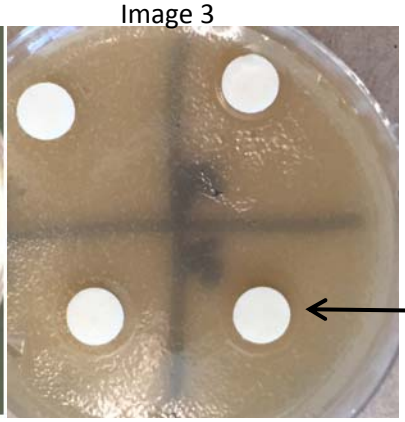
* Concentration on quadrants 14-16 are determined based on the size of the zone of inhibition which is compared to quadrants 1-12. Students may determine that quadrants 14-16 may contain the same concentration of silver as quadrants 2, 3, or 4. These are all expectable answers, depending on the source of bacteria.

Ask students to determine which concentration of nano silver produces the least amount of bacetia growth. Explain to students that the areas around the paper disks without bacteia growth may be different sizes depening on the agent that is preventing growth of the bacteria and is called the Zone of Inhibition. In the image 2 below, both disks labeled A and C have no effect on the bacteria's growth while disk E has the greatest effect on bacteria growth. This may be measused quanatatively be have students measure the diameter of the ring of no growth around each disk. The nano silver's effect is not as potent as antibiotics so the ring of inibition is less noticable.

Image 2

Zone of Inhibition in antibiotic example

Image 3



Zone of Inhibition using silver quadrant 3

Teacher Notes

Once students understand what is happening to the plates, have them compare quadrents 13-16 to quadrants 1-12.

Explain that the paper disks on quadrents 13-16 have been soaked with runoff water from an article of clothing infused with nano silver. Based on the comparison, that may be qualative or quanative, have students determine the probable nano silver concentrations for quadrants 13-16.

Finally, have students relate the nano silver concetrations for quadrants 13-16 to an actual concentration of bacteria in Lake Houston.

From the experimental petri dishes, it can be determined that the silver concentration dangerous to bacterial is 500 ppm. 1 ppm is the same as saying that $\frac{1g\ of\ Silver}{1\ X10^6\ mL\ of\ Water}$.

Using the concentration determined as dangerous, find how many grams of silver is harmful to the bacteria population of Lake Houston, which has a volume of 2 X 10^{14} ml of water?

$$\frac{500\ g\ of\ Silver}{1\ X10^6\ mL\ of\ Water} = \frac{X\ g\ of\ Silver\ in\ Lake\ Houston}{2\ X\ 10^{14}\ mL\ of\ water\ in\ Lake\ Houston}$$

$$(2\ X\ 10^{14}\ mL\ of\ water\ in\ Lake\ Houston) \times (500\ g\ of\ Silver) = (1\ X10^6\ mL\ of\ Water)\ \times (X\ g\ of\ Silver\ in\ Lake\ Houston)$$

$$\frac{(2\ X\ 10^{14}\ mL\ of\ water\ in\ Lake\ Houston)\times(500\ g\ of\ Silver)}{(1\ X10^6\ mL\ of\ Water)} = X\ g\ of\ Silver\ in\ Lake\ Houston$$

$$1\ X\ 10^{11} = X\ g\ of\ Silver\ in\ Lake\ Houston$$

1 X 10^{11} grams (100 billion grams) of nano silver most be present in Lake Houston for the nano silver to have a negative effect on the bacteria population present.

Nano Silver on Clothing

Revisit the initial question. As an assessment, students will write a paragraph explaining their position on the use of nano silver clothing and its potential effect on the environment. Is the threat realistic?

Once all students have written their paragraph, have the students view the animation "Nanosolution to the Water Problem" created by Wisc-Online at https://www.wisc-online.com/learn/career-clusters/info-tech/nan305/nanosolutions-to-the-water-problem. This animation depicts to students the use of nanotechnology to treat contaminates in water supplies.

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Soltanloo, Hassan, Mohammad Alimohammadi, S. Sanaz Ramezanpour, Mohammad Bagher, and Bagherieh Najar. "Nanosilver Colloid a Novel Antimicrobial Candidate Applicable in Plant Tissue Culture Medium." *Australian Journal of Basic and Applied Sciences,* 4.10 (2010): 5338-345. *INSInet Publication*. Web

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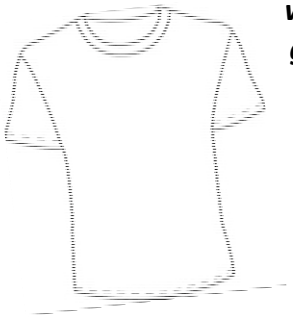
Nano Silver on Clothing

If you were able to wear clothing that prevented you from smelling bad by killing bacteria, would you wear it? Discuss with your group why you would or would not wear the clothing. As a group, create a paragraph or a drawing that will explain your decision to the class.



Bacteria: Good or Bad?

Are bacteria good or bad? Make a prediction _____

Watch the YouTube video "What is Bacteria?" https://www.youtube.com/watch?v=pcXdfofLoj0 ***As the video plays, answer the questions below:***

1. What are bacteria also called?

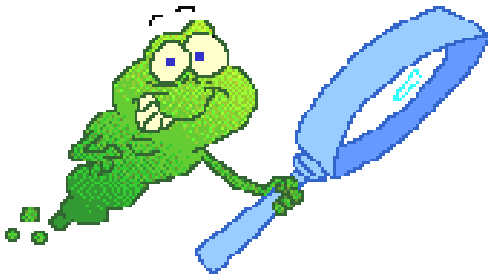
2. What are the major parts of a most bacteria?

3. How do bacteria reproduce?

4. What are the two domains of bacteria?

5. What are some important functions of bacteria?

6. How much of your body is bacteria?



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Nano Silver on Clothing and Bacteria

Discuss with your group the following questions:

1. If you were able to wear clothing that prevented you from smelling bad by killing bacteria, would you wear it?

2. Does the use of nano silver infused clothing pose a threat to the role of bacteria in an ecosystem?

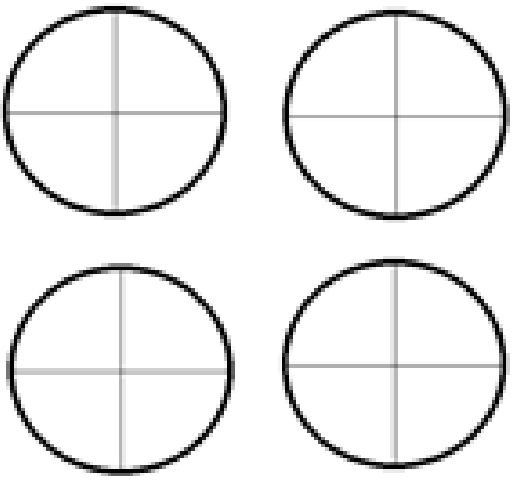
3. Where does the water go when you wash your clothes?

Effect of Nano Silver on the Bacteria in Lake Houston

Most of Houston's sewage runoff goes into Lake Houston. Lake Houston has a volume of 2 X 10^{14} mL of water.

If Nano silver happens to pollute the waters of Lake Houston, how many grams of nano silver will provide a dangerous environment for the necessary bacteria that live in Lake Houston?

1. Observe and draw each petri dish presented by the instructor. What is the concentration of nanosilver used on each quadrent of the petri dishes?



Quadrant	*Concentration*	*Quadrant*	*Concentration*
1		9	
2		10	
3		11	
4		12	
5		13	
6		14	
7		15	
8		16	

2. Which concentration of nano silver produced the least amount of bacteria growth? How do you know?

3. Quadrants 13-16 use nano silver that has been collected from the nano silver infused article of clothing that has been soaked in distilled water. Compare quadrants 13-16 to quadrants 1-12. Based on the comparison, what are the probable nano silver concentrations of quadrants 13-16?

4. From the experimental petri dishes, it can be determined that the silver concentration most dangerous to bacterial is _____ ppm. 1 ppm is the same as saying that $\frac{1g\ of\ Silver}{1\ X10^6\ mL\ of\ Water}$.

   Using the concentration determined as most dangerous, find how many grams of silver is harmful to the bacteria population of Lake Houston, which has a volume of 2 X 10^{14} ml of water?

NanoSilver on Clothing

If you were able to wear clothing that prevented you from smelling bad by killing bacteria, would you wear it?

Write a paragraph explaining your position on the use of nano silver clothing and its potential effect on the environment. Correlate you answer to a food web, the carbon cycle, or the nitrogen cycle.