

Student Worksheet **Answer Key**

- What is nanotechnology?
- What classifies something as a silver nanoparticle?
- How can silver nanoparticles be used to clean water?

Individual Research Notes:

Student answers will vary. Students should write that nanotechnology is the branch of technology that deals with dimensions and tolerances of less than 100 nanometers, especially the manipulation of individual atoms and molecules. Students will identify that a silver nanoparticle is a particles of silver of between 1 nm and 100 nm in size. Silver nanoparticles can be produced by reducing the silver found in silver nitrate to its colloidal form. They may note that nanoparticle come in different shapes as well. Students should understand that silver nanoparticles are being used in water filters to mill bacterial because of its antimicrobial properties. Students may note that there is current research being done to use silver nanoparticles in water filtration columns to remove disinfection byproducts that occur after chlorination of water.

Making Silver Nanoparticles with Plant Extract

Materials:

- 400 ml beaker with 200 ml of distilled water
- plant sample of your choice
- empty 400 mL beaker
- razor blade
- mortar and pestle
- hot plate
- funnel and 2 coffee filters
- 15 ml conical tube
- 10 ml of 0.1 M AgNO_3 (silver nitrate) from teacher when ready to use
- gloves
- goggles
- scale

To make plant extract:

1. Clean your plant leaves with distilled water to remove dirt and debris.
2. Mash leaves with the mortar and pestle or cut up your plant into small pieces. Your goal is to have about 10 grams of plant material. Place your plant on the scale to determine the mass of our plant material after it has been cut up. Mass of your plant: _____ g (The mass may vary between students. Encourage them to get close to 10 grams if they can.)
3. Bring your beaker of 200 ml of distilled water to a boil and add your plant material. Boil for 10 minutes or until the color of the water changes.
4. Place your funnel in an empty 400 ml beaker and put the filter paper inside the funnel.

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5. Wait for your beaker with the plant material to cool. Once cool, pour the contents into your funnel with the filter. Be careful to not puncture the filter.

To make silver nanoparticles:

1. Obtain 10ml of silver nitrate and add it to your 15 ml conical tube.
2. Add your plant extract, 1 ml at a time, to the silver nitrate until you reach a total volume of 5 ml of plant extract.
3. Incubate the silver nanoparticles overnight.

Observations:

Students will see a wide range of color differences based on the size of the silver nanoparticles produced. The less of the color change means a smaller nanoparticle. These solutions will have more of a yellowish tint. The more brown the solution, the larger the nanoparticles that were produced. If there is no color change at all, then the plant did not reduce the silver nitrate into silver nanoparticles. If any solid precipitates are found, the plant may not have been cleaned very well and interacted with something in or on the plant to make chunks of silver instead of silver nanoparticles

Student reflection:

1. Why do you think the solution changed color when the silver nitrate was added?

Students may put that the color changed because the silver nanoparticles were produced. The color change was actually due to the excitation of surface vibrations with the silver nanoparticles

2. How did your silver nanoparticles compare to others?

Student answers will vary. Their silver nanoparticles may have been larger smaller, or in more concentration than their classmates.

3. Would you recommend using your plant for creating silver nanoparticles to be added to the water filters or water columns in a water treatment plant? Why or why not?

The smaller the nanoparticle, the better it is to use in a water filter because you can add more of them. If there nanoparticles are large, they may suggest not using them because you would have less in the filter and it would not work as well.

4. Is there anything you would change about this procedure or any errors you might have made?

Student answers will vary. Students may decide to boil the plant for long, using a different method of cutting up the plant, or a mixture of plants.

Retest:

Now that you have had time to analyze your plant's ability to produce silver nanoparticles and have listened to other's results, it is time to retest! You may use your same plant and change part of the procedure (i.e. how much plant is used, how it is cut up, change the part of the plant, amount of time to boil), you may pick a different plant, or you may use a combination of plants. Develop a plan with your group and write it down below.

Name: _____ Date: _____ Class: _____

Retest Design:

Students state any changes they have made to their original procedure.

Observations:

Students should note the color of their solution.

Reflection:

How did the results of your retest differ from your original test?

Students explain any differences they saw in the color of their solution or amount of silver nanoparticles.

Did your retest improve the ability to make silver nanoparticles? (Was there less color change?)

Students explain how amount of color change relates to the size of the nanoparticle. They will state whether they were able to create smaller nanoparticles or not. Students may talk about the concentration of their nanoparticles.

Write a letter to the foreman of your local water plant.

Explain to the foreman why silver nanoparticles should be used on the water filters and columns. Describe the problem with the current method with making silver nanoparticles and why doing it the green way with plants is better. Describe the process of how to get silver nanoparticles from plants. Include your suggestion for what plant should be used and justify your recommendation using data.

Criteria for Success:

1. Students describe how silver nanoparticles can be used to clean water by removing bacteria and/or harmful disinfection byproducts
2. Students compare the current method of making silver nanoparticle to using plants to make the silver nanoparticles. Students should state how the current method uses a lot of energy and is toxic whereas using plants reduces the amount of energy needed and does not leave behind toxic chemicals because it is a natural process.
3. Students explain their procedure for making their silver nanoparticle in their own words.
4. Students recommend a type of plant (or plants) to use to make the silver nanoparticles and justify their claim using evidence from their lab.