Student Worksheet

Now You See it, Once it's Filtered, Hope you Don't

Safety
Use the bacteria solution with care, wash your hands before leaving the classroom.
All waste need to be discarded in the containers marked "Bacteria Waste" or Solution.
Make sure all glassware is very clean before beginning the activity.

Introduction: Imagine hiking in the backwoods of big, beautiful Wyoming. At your midday break, you are thirsty for a cool drink of water or even a swim in the nearby lake. The water looks inviting and sparkles in the hot afternoon sun. However, unbeknownst to you, a diseased elk carcass lies submerged in the water just up shore from your position. Water quality, especially untreated water, should never be taken for granted. How is water filtration related to nanotechnology? Some systems use nanoscopic pores such as those found in zeolite and activated carbon. These nanotechnologies are being used to filter sediments, bacteria, pathogens, charged particles, and chemical effluents (such as agricultural runoff). Nanofilters have advantages over conventional or micro-filters for several reasons: they have large surface areas (surface area to volume increases with reduced size); they are more efficient, are small in volume, and are easily cleaned.

Water is a valuable resource with only 2.5 percent of earth's water available for human consumption. This includes agricultural, industrial, electrical production and household usage. Water quality is often jeopardized by various contaminants. Water quality can be improved by removing contaminants from the water whether they are macro (dirt and debris,) micro (bacteria) or nano (metallic ions and small organic molecules.) in scope. Water filtration is one way to purify drinking water. Your challenge is to investigate the filtration capabilities of two common filters: *Activated Carbon and Zeolite*. To understand the functionality of these materials as well as the common contaminants associated with fresh or well water you will conduct a pre-lab investigation to better formulate a predication of which filter is superior.

Day 1: Pre-Lab Jigsaw:
Your group will be divided into four categories. Your teacher will explain how to perform a Jigsaw activity. Each member of your group will perform Internet research on one of four assigned topics. At the end of the activity, your group will present your research results and compare and contrast them with other class groups.

Groups:

1. **The biology group** is responsible for finding specific information on pathogenic waterborne microorganisms.
2. **The chemistry group** is responsible for presenting the chemistry of water including identifying the elemental constituents of ground water, their periodic table position, and size of each elemental constituent.
3. **The geology group** is responsible finding specific geologic information on each filtration material and presenting SEM images of filtration materials to the class while explaining the filtration characteristics of each image.
4. **The technical group** is responsible for constructing the filtration apparatus reading and understanding the lab procedure, collecting and labeling all materials, and calibrating the Vernier spectrometer to prepare it for data collection.
5. **All groups:** find and save Scanning Electron Microscope (SEM) images of zeolite and activated carbon.

Day 2 Walter Filtration Testing:

Question: Based on the Day 1 research and the SEM images of Activated Carbon and Zeolite, which filter material do you think will capture the most bacteria, pesticide, iron, or copper?

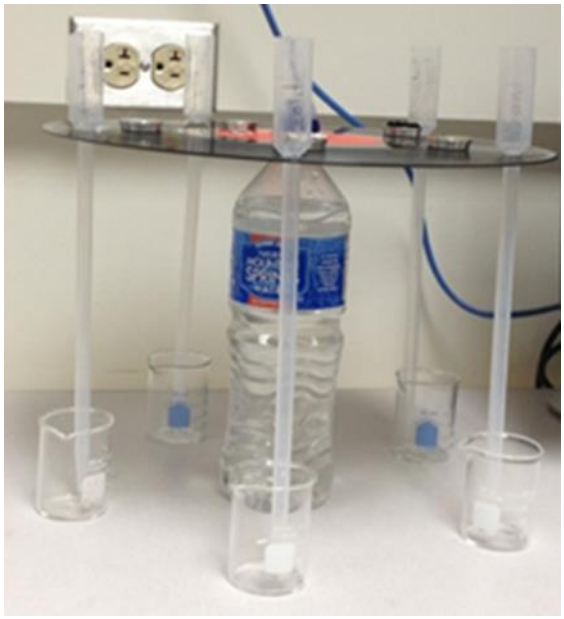
Make a Prediction:

Materials:

- distilled water (DI)
- rinse bottle with DI
- filtration apparatus
    - Ring Stand
    - 2 stabilizer washers
    - 2 LP records (or sturdy round material cut into disk) with 7 - ¼" holes drilled at equal intervals
- Beakers :
- (2) 100 ml beakers to carry solid materials back to their lab station
    - solid materials:
        - 60 ml Zeolite (10 ml required per filtration)
        - 60 ml Activated Carbon (10 ml required per filtration)
- (9) - 50 ml beakers for solutions. 1 to collect each solution from the shared materials bench to be rinsed and reused, and the other beakers to capture the filtrate.
    - 2 sets of the Prepared Solutions for each of the filter materials test:
        - 1. Activated carbon
        - 2. Zeolite
    - contaminant solutions:
        - 10 ml of Distilled Water for the Control
        - 10 ml of 0.5 M Copper Sulfate used to get rid of algae $CuSO_4$

- 10 ml of 0.5 M Iron Oxide (Fe_2O_3)
- 10 ml of 0.5 M Calcium Nitrate $Ca(NO3)_2$
- 10 ml of 0.5 Magnesium Nitrite $Mg(NO2)_2$
- 10 ml dilute Pesticide Solution .5 ml per L
- 10 ml prepared *Lactobacillus acidophilus* solution

- 14 large volume pipettes
- 1 pair of scissors
- 1 permanent marker for labeling
- Label tape
- Petri dish with nutrient agar
- Cotton swabs or similar to transfer bacteria to petri dish



Completed filtration apparatus

Procedure:

1. Collect all materials and inspect them for cleanliness, wash if necessary.
2. Using scissors, cut off the top nob portions of 14 large pipettes and discard the cut portion.
3. Construct the filtration apparatus as pictured above.
4. Label and fill 7 pipette columns with rinsed activated carbon. Set in apparatus each of the 7 filter material and solution type:
    - 10 ml of Distilled Water for the Control
    - 10 ml of 0.5 $CuSO_4$
    - 10 ml of 0.5 M Fe_2O_3
    - 10 ml of 0.5 M $Ca(NO3)_2$
    - 10 ml of 0.5 $Mg(NO2)_2$
    - 10 ml dilute Pesticide Solution .5 ml per L
    - 10mL prepared *Lactobacillus acidophilus* solution
5. Label and fill 7 pipette columns with rinsed zeolite. Set in apparatus each of the 7 filter material and solution type:

- 10 ml of Distilled Water for the Control
- 10 ml of 0.5 $CuSO_4$
- 10 ml of 0.5 M Fe_2O_3
- 10 ml of 0.5 M $Ca(NO3)_2$
- 10 ml of 0.5 $Mg(NO2)_2$
- 10 ml dilute Pesticide Solution .5 ml per L
- 10mL prepared *Lactobacillus acidophilus* solution

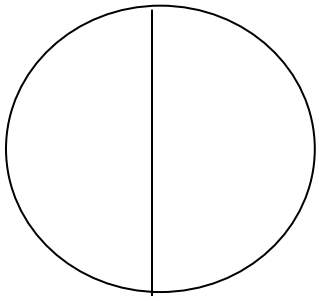
6. Use the filtrate from the bacterial solution to inoculate your petri dish. Place in incubation oven set at 37° and leave overnight. Incubate 12 to 36 hours.
7. Review the data table to organize your thoughts and expectations and to determine your data collection and analysis. You have available the Vernier LabQuest Spectro Vis and Conductivity Probe. How will you use these to collect data? Think back to the Jigsaw activity to help guide your data collection. Record the data in the table below.

Record Your Observations:

48 Hour Bacteria Inspection

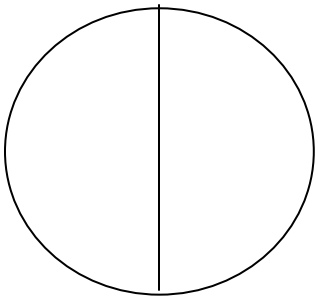
Activated Carbon

Unfiltered Filtered



Zeolite

Unfiltered Filtered



Absorption Spectra	Control No Action Required	Activated Carbon	Zeolite
Control			
Fe			
Cu			
Pesticide			
Nitrate			
Nitrite			
Hardness			

Analyze the Results:

You will write a final lab report incorporating your results. Examine your data in the table above and determine which of the two materials worked best to remove the contaminants. Did one work better with certain pollutants? You should relate these results to particle size of the pollutant. Connect the results to what you learned in the Jigsaw activity. Include in your analysis answers to the following:

1. What is the compelling evidence that either filter will or will not filter bacteria from the water.

2. Why are the controls so important?

3. What factors affect the filtration success of the two materials, activated carbon and zeolite ?

4. Would you expect nanoparticles of zeolite and activated carbon to be more or less efficient? Explain your answer.

5. What other pollutants would you want to include in the testing and why?