
Nanofiltration

Water

- Which one would YOU drink?
  - *Answer on your worksheet

Isn’t all drinking water clean?

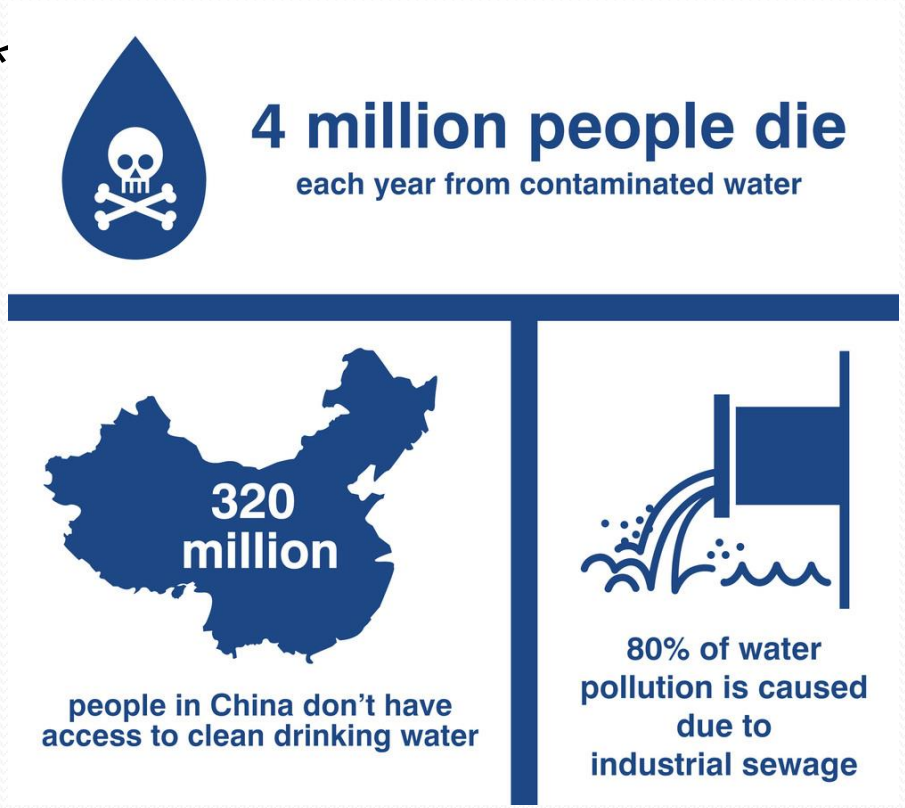
- Do you think tap water goes through a filtration process?*
- What would happen if water wasn’t filtered?*
- Are there places in the world where drinking water is not filtered?*

Tap Water in the U.S.

- Drinking water in the United States is among the safest in the world!
- Our water goes through a very specific filtration process
  - Things are even added to make the water taste better!

Meanwhile in China

- In China 60% of their water is undrinkable.
- Even their tap water is undrinkable!
- Why is the water so dirty?*
  - Pollution



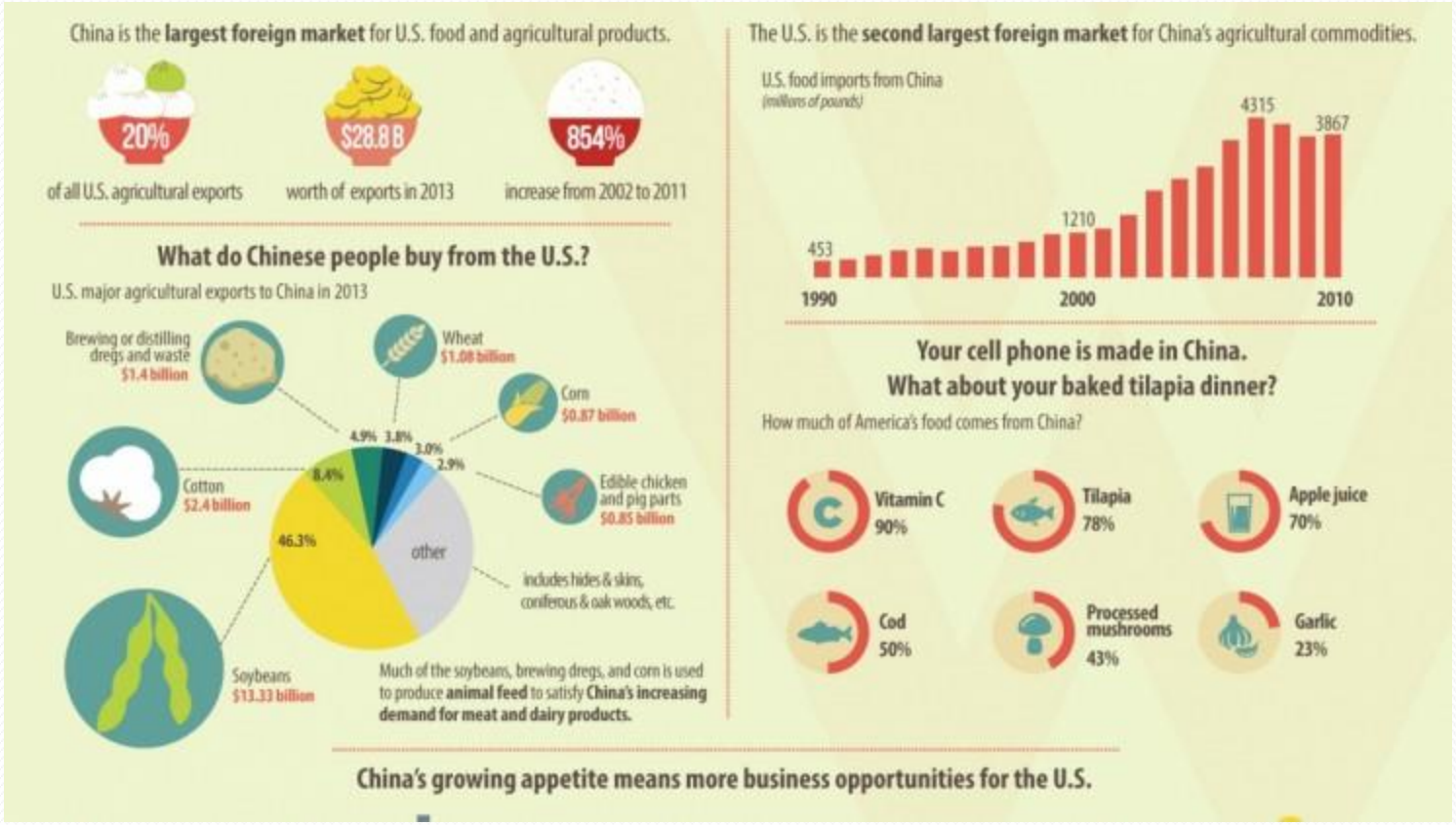
Meanwhile in China…

- Due to high levels of urban development, the air in China is highly polluted.

  - So, when it rains the rain is impure and goes into the ground
- Agriculture is important to their country, but what do plants need to grow?*
  - Clean water
  - If the water is polluted, do you think the plants are okay to eat?*
- Why is this a problem? And can it affect you?

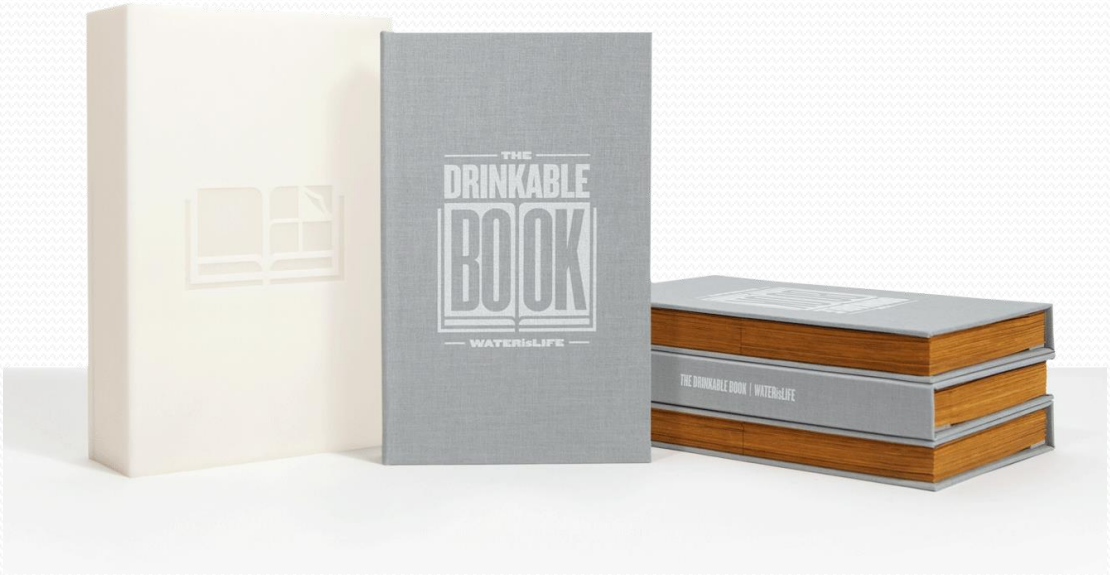
America and China

- United States imported roughly 3.9 billion pounds of agricultural products from China in 2010
  - How does that affect you?*



Is anything being done?

- http://waterislife.com/
- https://drinkablebook.tilt.com/the-drinkable-book
- What do you think about the drinkable book?*



Problem solving!

- Now it's your turn! Get in groups of 4 and…
  - Come up with a scenario where suddenly America's water became polluted.
  - The president comes to YOU and says "Help! All of our water is polluted. We need your help to get it clean again because people are getting sick. What should I do?"
    - What do you tell him to do?*
  - Have fun with it!

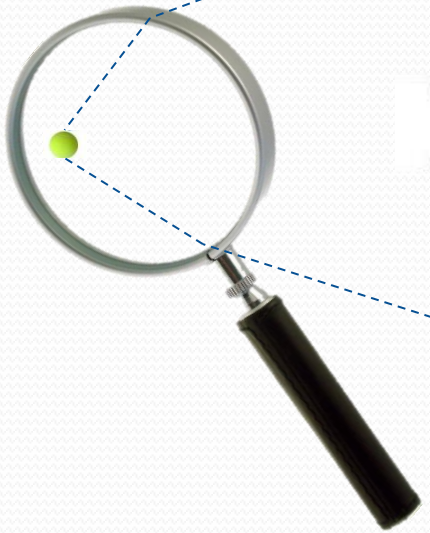
Did you know?

- Did you know that we can use **REALLY** small things called nano-particles to help us clean water?
- WHAT IS NANO?

First, what is nano?

- Nano is a size, and it's really small! It comes from the Greek word meaning "dwarf" and means one-billionth (1/1,000,000,000)
- A nanometer is one-billionth of a meter
- Your fingernail grows 1 nm per second

What is nano?



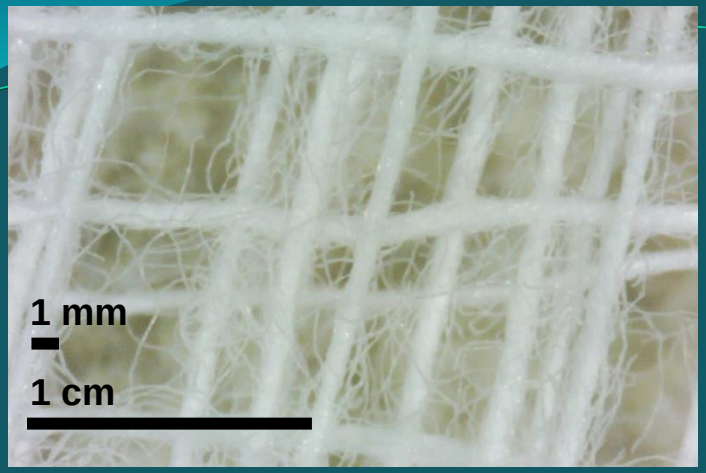
One nanometer is to a tennis ball
what a tennis ball is to the Earth

But really, how small is nano?

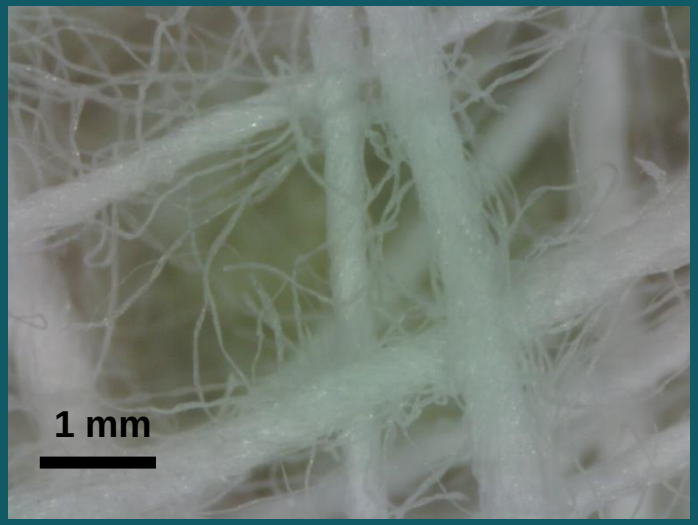
- Nanoscale refers to measurements between 1 and 100 nanometers.
- http://learn.genetics.utah.edu/content/cells/scale/

Engage Questions

- How many of you have a water filter at home?
- Do any of your parents drink coffee?
- Have you ever seen what is left in a coffee filter after it is brewed?

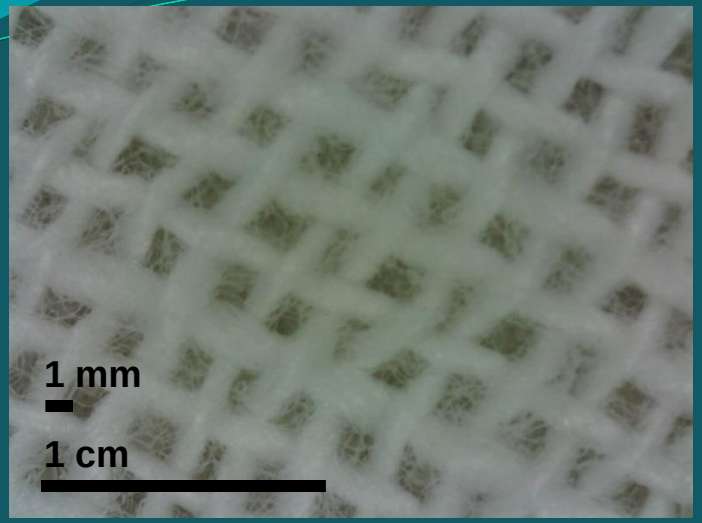


← 100X image of a cheesecloth

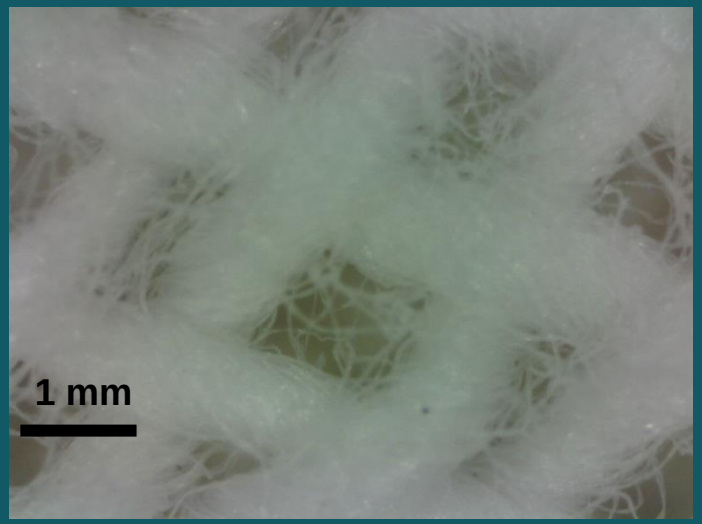


← 200X image of a cheesecloth

Cheesecloth →



← 100X image of flour sack towel



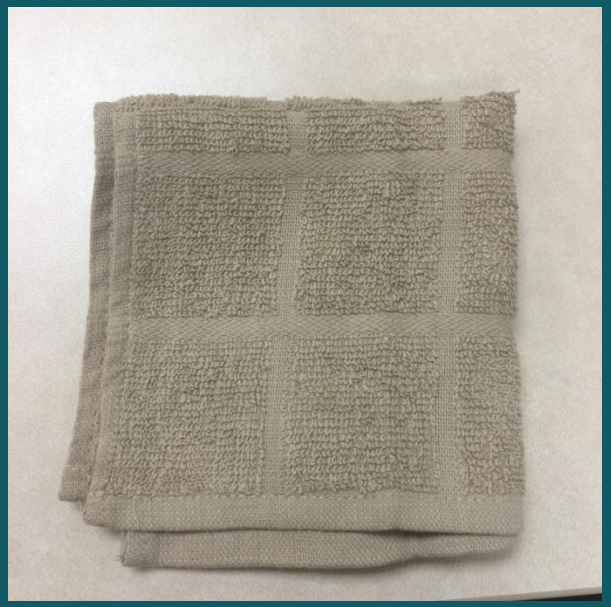
← 200X image of flour sack towel

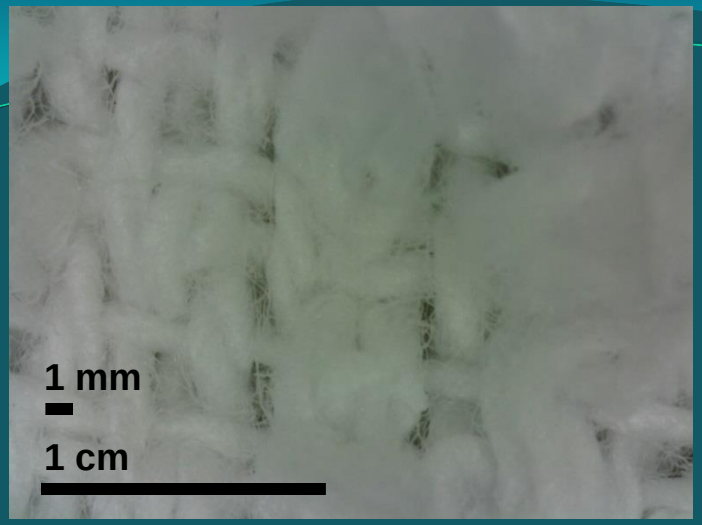
Flour Sack towel →

← 100X image of a dishcloth

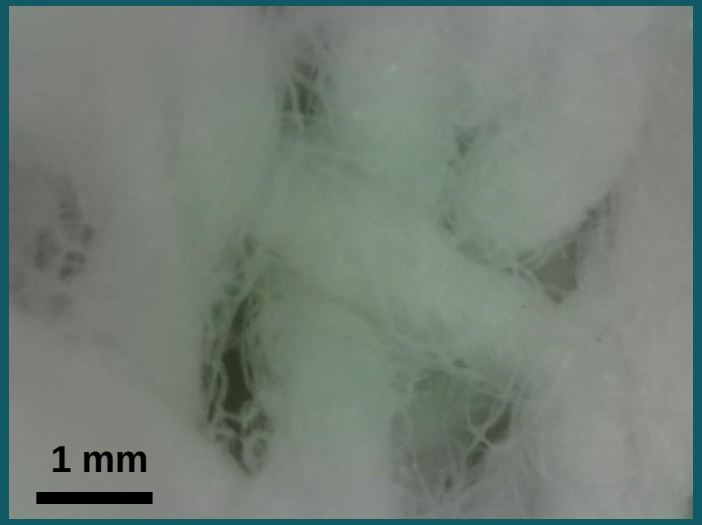
← 200X image of a dishcloth

Dishcloth →



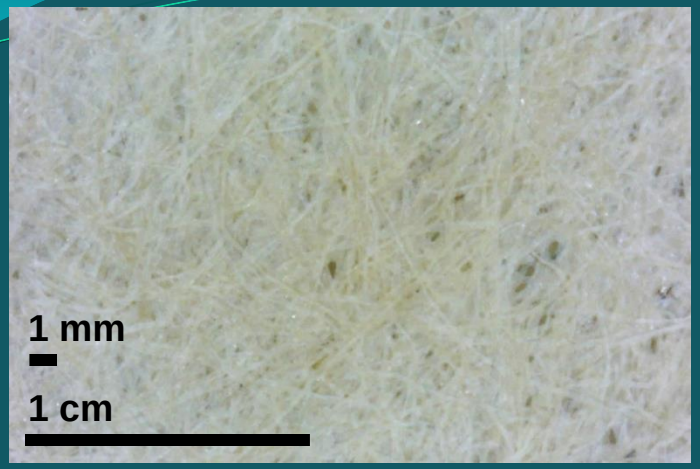


← 100X image of a kitchen towel

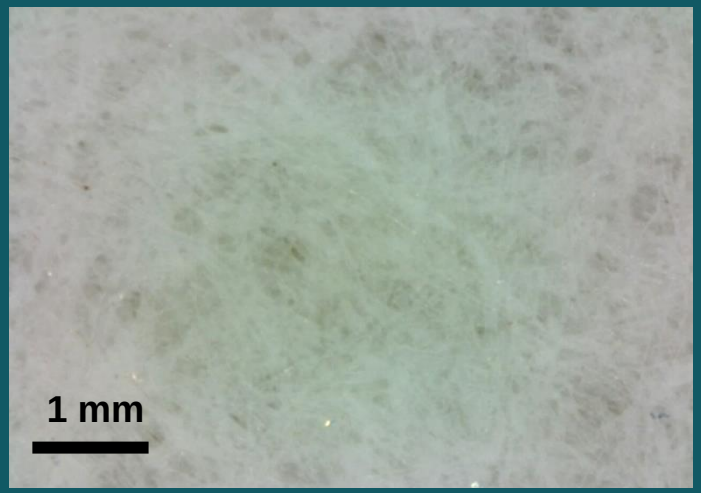


← 200X image of a kitchen towel

Kitchen towel →

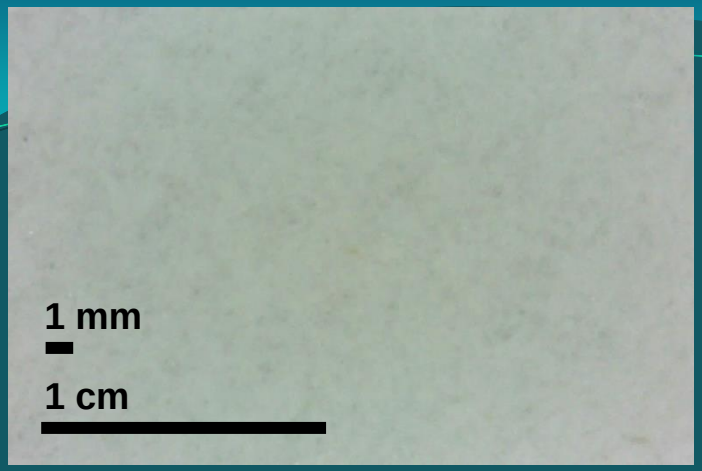


← 100X image of a white coffee filter

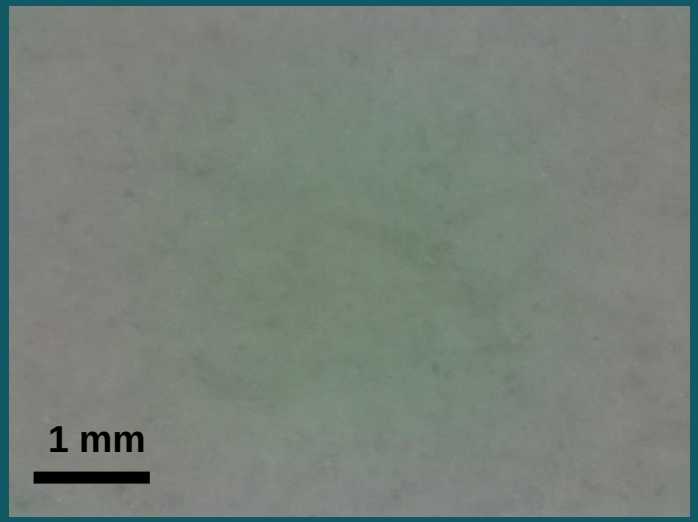


← 200X image of a white coffee filter

White coffee filter →

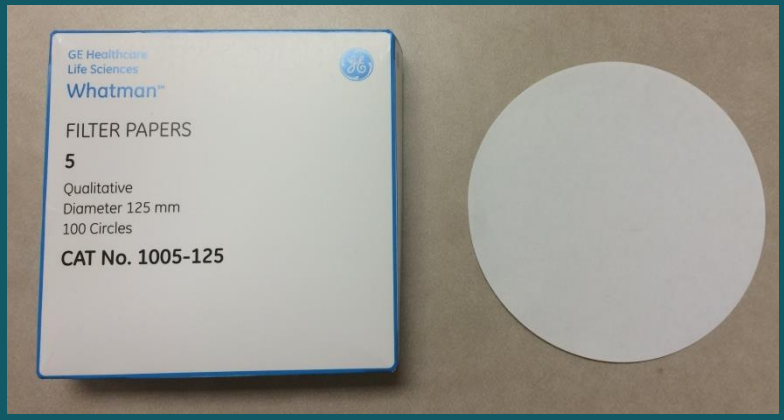


← 100X image of filter paper



← 200X image of filter paper

Filter paper →



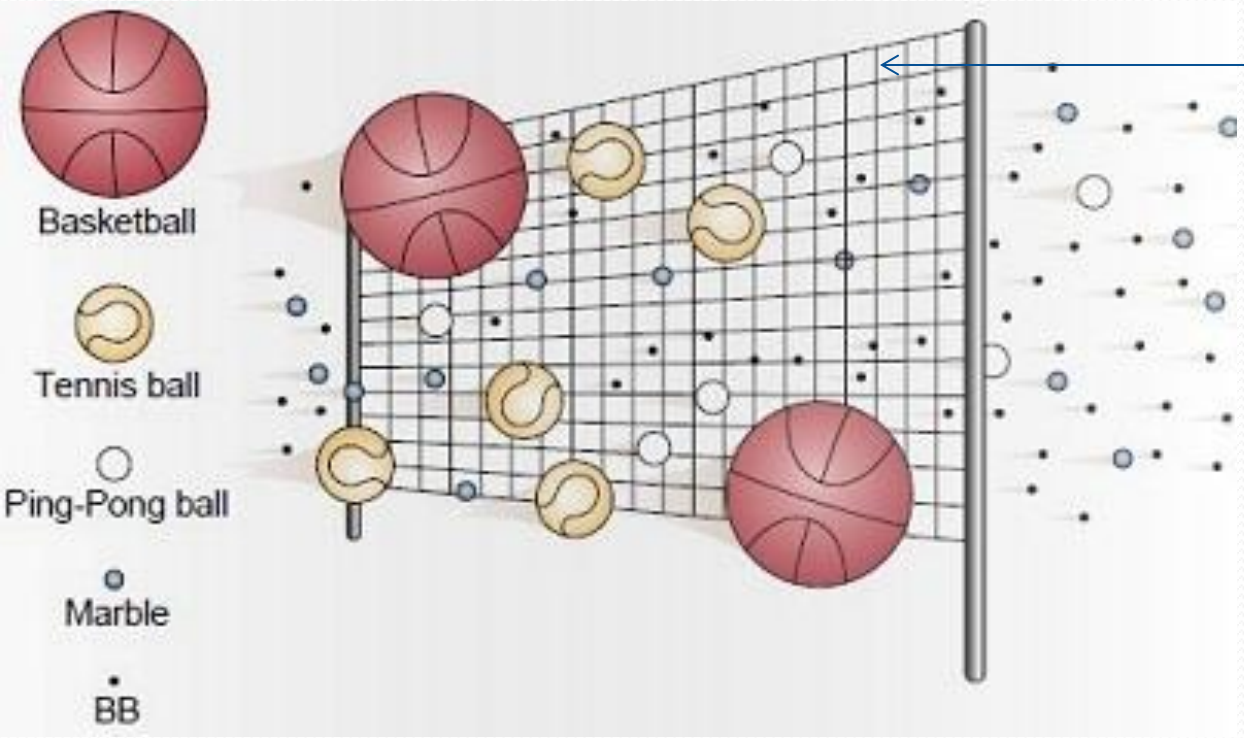
Size Matters!

Why can’t the camel get through the needle?

Camels and Filtration?

- Camels = Particles in the water
- Needle = Pore size
- Can water pass through small holes?
  - YES!
- Filters allow water to pass through but not particles larger than the pore size

Example



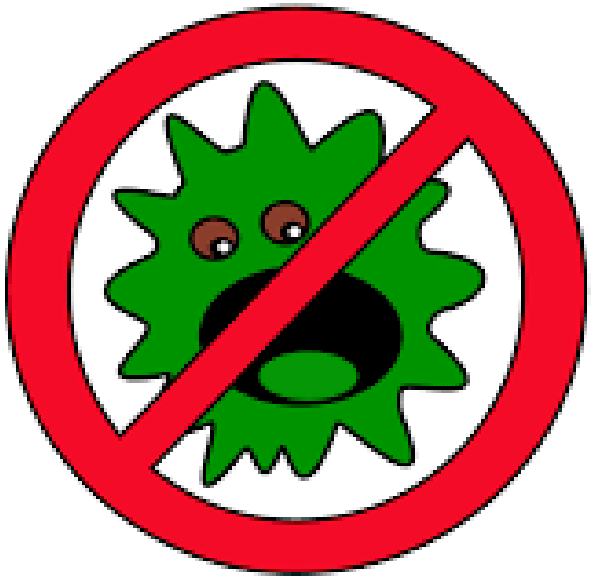
BBs, marbles, and ping pong balls can fit through the net **BUT** tennis balls and basketballs **cannot**

- **Holes** in net= pore size
- **Basketballs** and **tennis balls**= large particles
- **Ping pong** balls, **marbles**, **BBs**= small particles

Bacteria

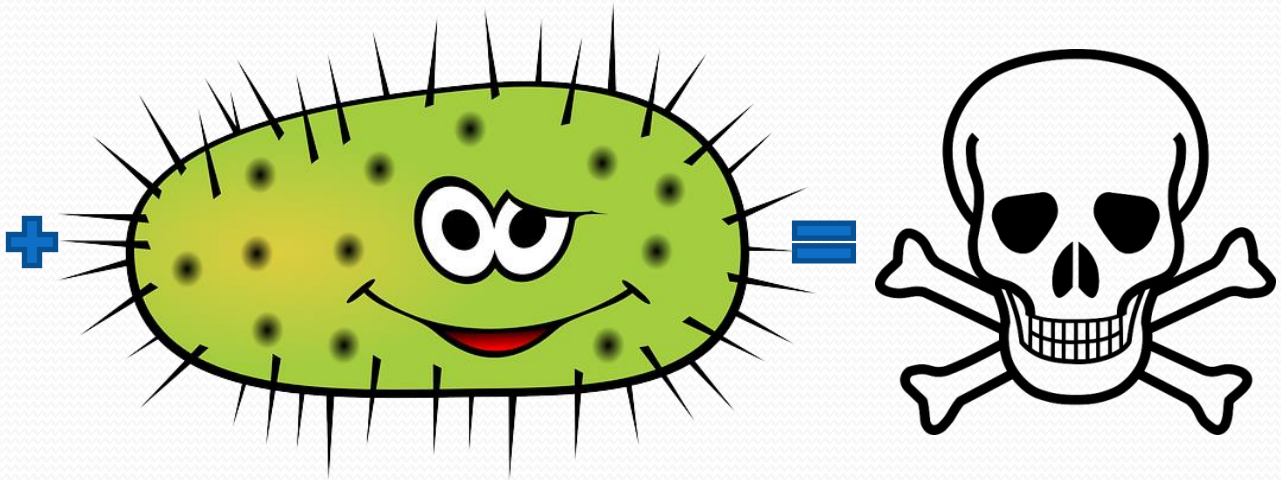
- How small is bacteria?
  - http://learn.genetics.utah.edu/content/cells/scale/
- How small of a hole can bacteria fit through?
- But bacteria is dangerous!
  - So what can we do?

KILL IT!



Killing Bacteria

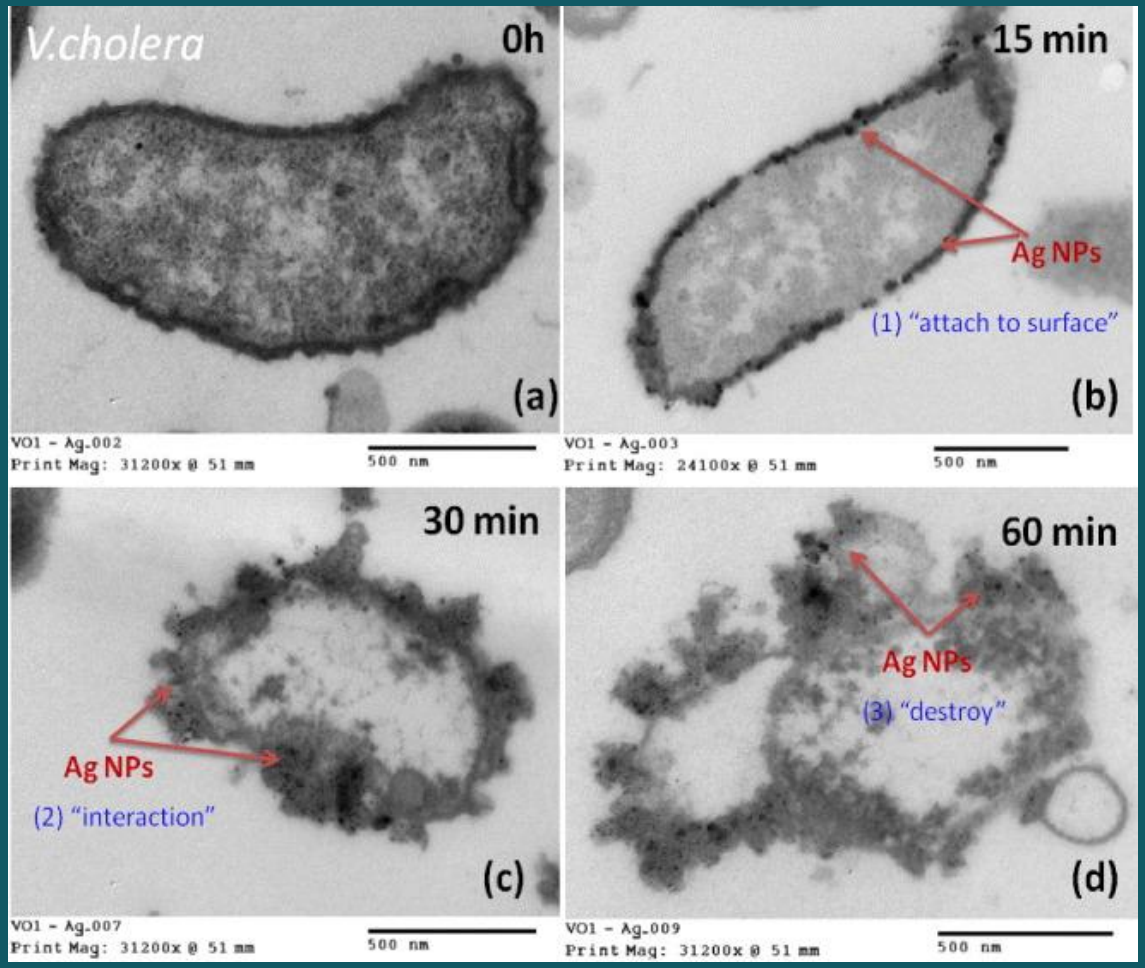
- Did you know silver can kill bacteria?!



Nano-Silver Kills Bacteria

- https://www.youtube.com/watch?v=hhOwSQriB8E

Silver Killing Cholera Bacteria

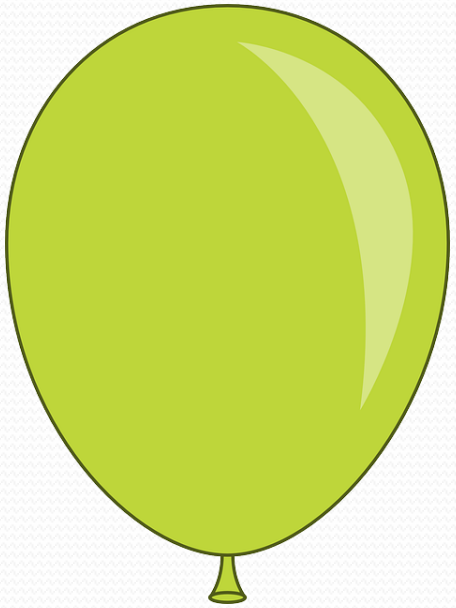


Two ways silver attacks bacterial cells

- 1st Way: It makes the cell membrane more **permeable**
  - **Permeable**= allowing liquids or gasses to pass through

Mylar and latex balloons and garlic

- Mylar balloons= before silver
- Latex balloons= after silver
- Can you smell the garlic??



Two ways silver attacks bacterial cells…

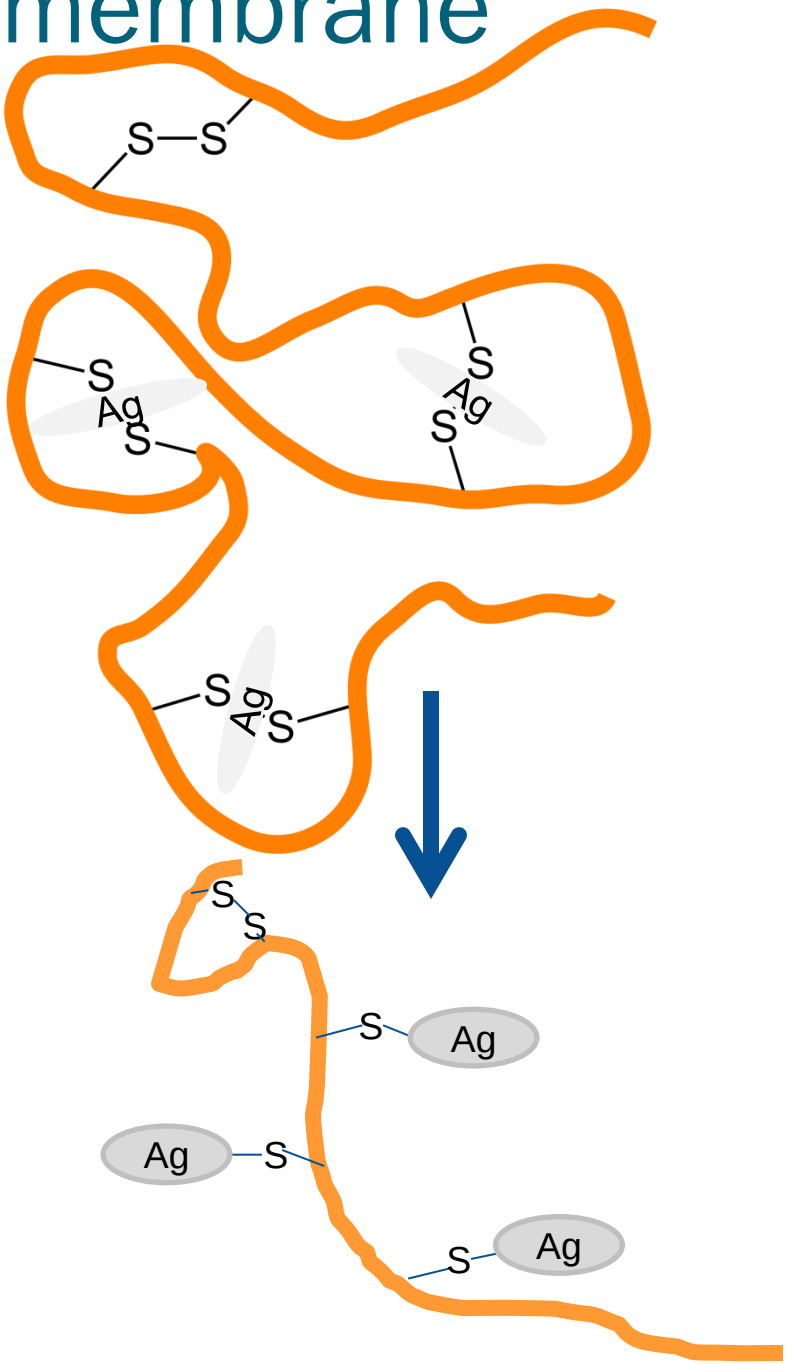
- 2nd Way: It interferes with the cells **METABOLISM**, leading to the overproduction of reactive and toxic oxygen compounds
  - **Metabolism**= converting the fuel in the food we eat into the energy needed to power everything we do, from moving to thinking to growing.

1) Silver makes the cell membrane more permeable

- Bacterial membrane proteins contain sulfur that helps them fold.
- The way it folds gives the bacteria its shape.
- The shape of the protein tells it what to do.

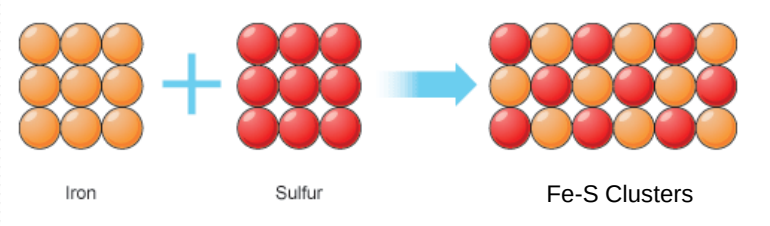
1) Silver makes the cell membrane more permeable

- Silver binds to the sulfur
- When silver binds to sulfur, proteins cannot fold correctly, therefore they cannot do their job!
- When the proteins are not folded correctly, they make the bacteria **cell wall weaker**.



2) Silver interferes with the cells metabolism

- Because silver has interacted with sulfur, iron cannot bind to it.
- This interferes with the bacteria's **metabolism**, which are the chemical processes that occur within a living organism to maintain life.



After silver stops the bacteria's metabolism…

- Now silver causes bacteria to produce toxic substances
  - Toxic substances= Reactive Oxygen Species
    - These cause damage to the inside of bacteria cells which harm the DNA, proteins, and the membrane!
- Now bacteria cannot defend itself

For example, if a quarterback's offensive line was tackled, he would get sacked!

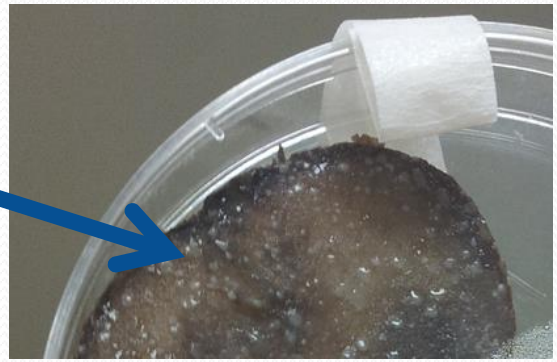
Possible Review Questions

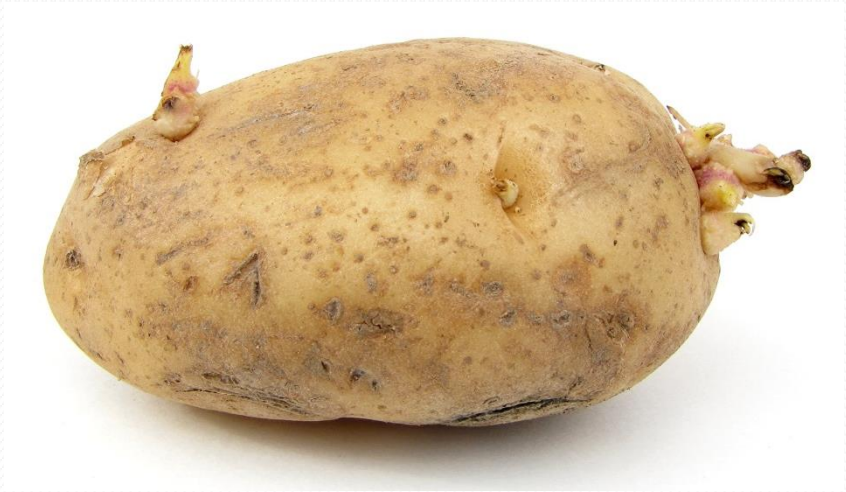
- How is water filtered?
- How does pore size relate to water filtration?
- What role does silver play in water filtration?

Potatoes and Bacteria??

- Scientists often use culture plates to grow bacteria because the plates are made with nutrients that bacteria can use.
- We can also find those nutrients in potatoes!
  - So we can use potatoes to grow bacteria instead of using culture plates!

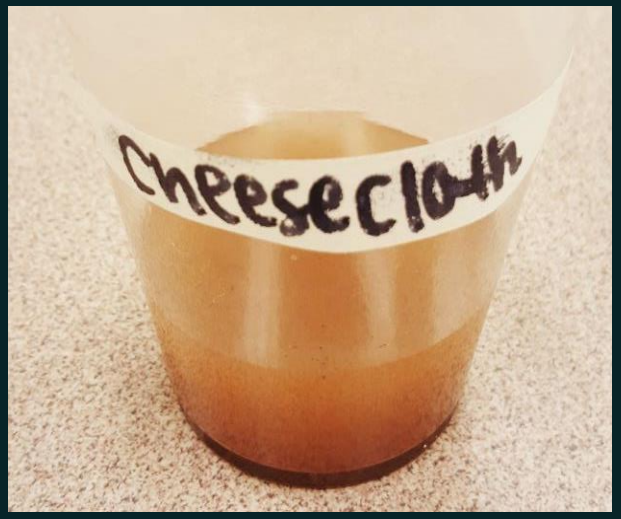
Colonies!





Water Filtration and Bacterial Growth on Potatoes

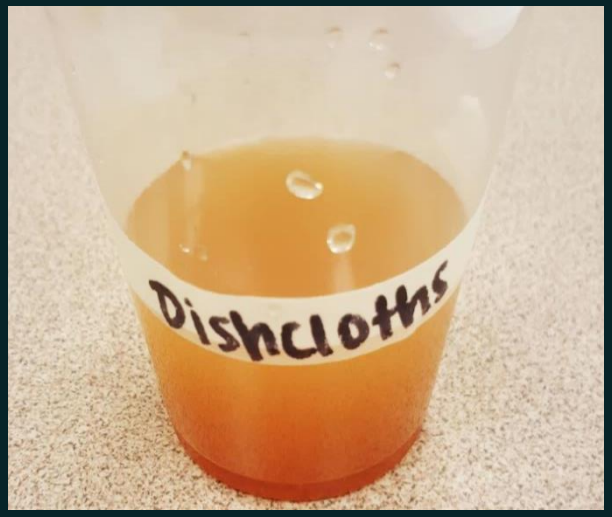
Expected Outcomes After Filtration....



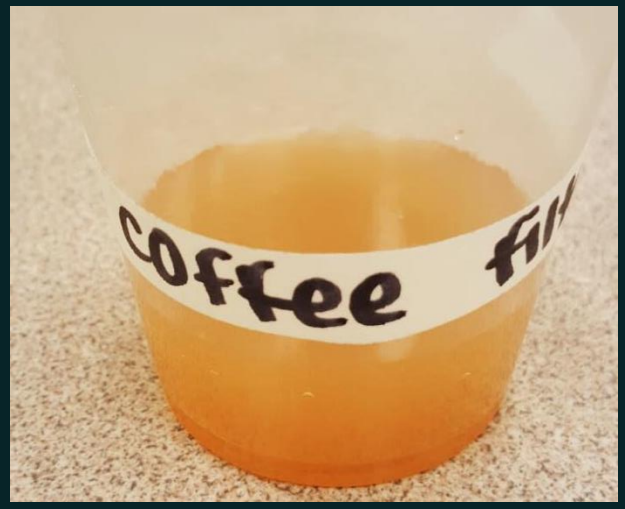
Cheesecloth Filter

Flour Sack Filter

Kitchen Towel Filter



Dishcloth Filter



Coffee Filter

Filter paper

What do we see?

- What kind of differences do we see in each of these filters?
- Do some cloths seem to filter more of the dirt out?
- Has any of the color changed?
- What do you think we would need to do to see a more dramatic change?


ntreated potato - 1 min
Untreated potato - 2 min

Resources

- Information about drinking water: http://www.cdc.gov/healthywater/drinking/public/water_treatment.html
- Information on China and their drinking water: http://www.naturalnews.com/045089_industrial_pollution_China_drinking_water.html# ; http://www.chinatravel.com/facts/drinking-water.htm
- Video about the drinkable book: https://drinkablebook.tilt.com/the-drinkable-book
- Interactive nanoscale graphic: http://learn.genetics.utah.edu/content/cells/scale/
- Nano silver killing bacteria video: https://www.youtube.com/watch?v=hhOwSQriB8E

Additional Helpful Links

- Silver Antimicrobial Ions & Bacteria video: https://youtu.be/NYDOZzpH99E
- How Silver Kills Bacteria Webpage: http://www.bullionstreet.com/news/how-silver-kills-bacteria-finally-revealed/5042
- NiseNet Water Filtration Lesson Plan: http://www.nisenet.org/catalog/programs/cleaning_our_water_nanotechnology
- Flocculation: Making clean water: https://www.khanacademy.org/partner-content/mit-k12/mit-k12-materials/v/flocculation
- The water cycle: http://climate.ncsu.edu/edu/k12/.watercycle
- Nanotechnology for clean water: Facts and Figures: http://www.scidev.net/global/water/feature/nanotechnology-for-clean-water-facts-and-figures.html
- Water Filtration and Purity of Water (Middle and High School curriculum lesson): http://nisenet.org/catalog/water-filtration-and-purity-water-middle-and-high-school-curriculum-lesson
- Eliminating water-borne bacteria with pages from The Drinkable Book could save lives: https://www.youtube.com/watch?v=BeS9y6Qffc4
- Microwave-assisted incorporation of silver nanoparticles in paper for point-of-use water purification (Theresa A. Dankovich)

Photo Citations

- Cover photo of water fall: https://unsplash.com/photos/kDj82KFbRvU/download
- Photo of dirty and clean water: http://diyprepping.com/tag/clean-water/
- Photo of tap water: http://www.distilledwaterassociation.org/bottled-water-vs-tap-water-drink-it-with-or-without-poop/
- Photo of bacteria in dirty water: http://dirtywaterintheworld.weebly.com/illness-and-disease.html
- Water fountain photo: http://coloradobip.sgm-inc.com/
- Fishing in a dirty river picture: http://en.mercopress.com/2009/12/04/china-attacks-water-pollution-and-plans-massive-investments
- Chart about contaminated water in China: http://www.100smarterlivingideas.com/drinkable-book/
- China smog picture: http://news.asiaone.com/news/business/chinas-smog-driving-top-foreign-talent-away-us-business-survey ; http://www.cnn.com/2014/01/06/opinion/china-pollution-opinion-taoxie/index.html
- Chart about U.S. and China relations: http://www.americanmanufacturing.org/blog/entry/the-u.s.-imports-a-lot-of-food-from-china-and-you-might-be-surprised-whats
- The drinkable book picture: http://waterislife.com/clean-water/new-technology
- Picture of President Obama drinking water: http://www.zimbio.com/pictures/tR_OFqNkpP7/Gordon+Brown+President+Obama+Hold+Talks+Foreign/1ZKzlHBd7Jc/Barack+Obama
- Nanotechnology chalkboard photo: http://www.nanotechproject.org/topics/nano101/
- Fingernail photo: https://commons.wikimedia.org/wiki/File:Ongle_du_doigt_de_la_main_-_Fingernail_hand.jpg
- Earth photo: http://www.solstation.com/stars/earth.htm
- Tennis ball picture: http://www.clipartbest.com/tennis-ball-picture
- Magnifying glass photo: http://www.clipartpanda.com/categories/magnifying-glass-clipart-transparent-background

Photo Citations

- Camel in needle pictures: http://wilfullyobscure.blogspot.com/2011/01/brian-eno-needles-in-camels-eye.html ; http://www.worth1000.com/entries/561671/eye-of-a-needle
- Filtration with different sporting balls: http://encyclopedia.lubopitko-bg.com/movementacrossPM.html
- Killing bacteria clipart: http://www.clipartsheep.com/stop-germs-clipart/
- Silver picture: https://commons.wikimedia.org/wiki/File:Silver-nugget.jpg
- Bacteria clipart: https://pixabay.com/en/bacteria-virus-illness-bacterium-156869/https://sgshock.wordpress.com/
- Skeleton clipart: https://pixabay.com/en/photos/danger%20of%20death/
- Mylar balloon picture: https://de.wikipedia.org/wiki/Luftballon
- Garlic picture: https://commons.wikimedia.org/wiki/File:Opened_garlic_bulb_with_garlic_clove.jpg
- Latex balloon picture: https://pixabay.com/en/balloon-green-circus-floating-150128/
- Permeability picture: https://en.wikipedia.org/wiki/Permeable_paving
- Iron and Sulfur image: http://www.bbc.co.uk/bitesize/ks3/science/chemical_material_behaviour/compounds_mixtures/revision/2/
- Toxic clipart: https://en.wikipedia.org/wiki/Workplace_Hazardous_Materials_Information_System
- Quarterback being sacked picture: https://www.flickr.com/photos/keithallison/15566643088
- TSA plate photo: https://upload.wikimedia.org/wikipedia/commons/7/73/Ecoli_colonies.png
- Potato clipart picture: https://en.wikipedia.org/wiki/Potato