

# Let's Get Small

Below is an overview of the activity Let's Get Small (MicrobeWorld Experiments) to incorporate information learned from Dr. Kerkhof's presentation and subsequent discussion.

## Lesson Overview

Students use and draw models to understand the comparative sizes of microbial life.

## Lesson Rationale

Microbial life makes up the majority of life on the planet and our existence is directly connected to microbes. Yet, by definition, because we cannot see microbes students have a hard time understanding microbes and their role on our planet. This activity helps students understand the size of microbial life.

## Key Concept

While all microbes are too small to see with the naked eye, there is large diversity within the microbial community in terms of size and shape.

## Overview

In this activity students will learn about how small microbes really are...

Bigger is better, right? Well, if we are talking about desserts and bank accounts many people would probably agree with that statement. But what about things that are small – really small? Are they ever important, valuable, or interesting? If we're talking about living organisms on our planet then the answer is yes. And if we're talking more specifically about life in the ocean, then the answer is definitely YES.

What comes to your mind when you think of life in the ocean? Many people immediately think of whales, dolphins, sharks, sea turtles, seals, sea otters or other animals. Sure, these animals are cute and/or cool, but they all have something else in common, they're all

**MACRO**organisms. This means they're big and visibably seen by the human eye. But what about the **micro**organisms, all the living things so small you can't see them with your normal vision? What about life in the sea that you can't see? How small do organisms really get and if you can't see them do you really know how many there are? Microbes (both those on land and in the water) are organisms that cannot be seen with the unaided eye.

Anything much thinner than a piece of hair becomes difficult for humans to see without some type of visual aid. Usually, we use a magnifying glass or light microscope to enlarge whatever it

is we are trying to see. Some things are so small that traditional microscopes can't even see them.

Scientists then use what is called a scanning electron microscope (SEM for short) that creates a magnified image by using electrons instead of light waves. Using this method, marine microbes and other microscopic objects can be magnified more than 200,000 times! Another advantage of the SEM is that it creates 3-D images, whereas traditional light microscopes allow you only to see the surface of the image you are viewing.

The pictures below are of two common marine microbes taken with a SEM. The image on the left is a diatom, magnified at which is a single celled plant-like protist that is very abundant in both marine and freshwater environments. The image on the right is a photo of a radiolarian magnified 750x, which is a free floating animal-like microbe that feeds on phytoplankton (such as diatoms) and bacteria.

# LET'S GET SMALL



How small is a microbe? Is a virus smaller than a protozoan? Is it bigger than the diameter of a human hair?

## Goal

To develop an understanding of the comparative sizes of microbial life, including viruses, protozoa, bacteria, and very small parts of the human body.

## Activity Time

50 minutes

## Time to Get Ready

15 minutes

## What You Need

Have the following for each team of 2 or 3:

- 1 meter stick or ruler
- 1 measuring wheel (optional)
- 1 box sidewalk chalk
- 1 Microbe Reference Chart
- 1 magnifying glass

## Getting Ready

- Arrange to use a large area like a parking lot, gymnasium, or sidewalk. Bigger is better for this activity. Several of the participants' measurements may not fit in the space available. They will still be able to compare the size differences.
- Measure off a section that is 100 meters (m) long to represent the width of a piece of human hair.
- Have each group draw a different microbe from the Microbe Reference Chart on page 47.

## Useful Information

Many different microbes live all around us and even in us! The smallest of these are viruses, bacteria, and protozoa. Viruses are the smallest of all microbes and hardly can be seen with even the strongest and most expensive microscopes. Because they are so small, they cannot be measured using our usual scales for measurement. Scientists use a different scale to describe the size of microbes. Viruses are measured in nanometers, which are one million times smaller than a millimeter (0.000001 millimeter). Viruses cause the most familiar diseases such as chicken pox, warts, and AIDS. But they also have other roles. Tulips would be dull without them. The white stripes on the petals of many tulip varieties are caused by infection with viruses. Much of our biotechnology, including the development of vaccines and drugs, could not take place without the ability of viruses to transfer genetic information from one organism to another.



Figure 1. Spoon of bacteria (not to scale).

Bacteria are bigger than viruses, although they are still very small. They are found almost everywhere. We find them in the freezing cold of Antarctica and in boiling hot springs. Bacteria also live around and even in us. They are so small that one spoonful of soil contains more than one hundred million bacteria!

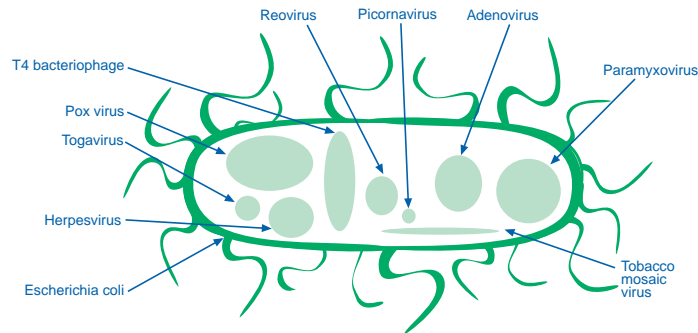


Figure 2. Size comparison of microorganisms.

Most bacteria are measured in micrometers, which are one thousand times smaller than a millimeter (0.001 millimeter). See Figure 2. Bacteria cause many diseases such as strep throat, tuberculosis, sexually transmitted diseases, and food poisoning. However, we could not live without them. They convert energy from the sun into forms we can use. All the bacteria in your body would fill a soup can. Almost all of them are found in your digestive system and on your skin. Among their most important tasks is making several vitamins that you need to survive, as well as helping you digest food.

Most protozoa are also microscopic, but a few can actually be seen without a microscope. Most protozoa move around very easily. Some have hundreds of tiny leg-like parts. Some protozoa eat bacteria, and some make their own food using the sun's energy. They live all around us, and we depend on them for many things. Some keep cows alive by changing dry hay into food they can use. Other protozoa cause some of the more common diseases found in the tropics such as amoebic dysentery, malaria, and *Giardia*.



## Suggestions to Modify the Activity for Those Who Are Exceptional

Specific modifications for this activity are found here. For common considerations when modifying activities for exceptional participants, see page V of the **Introduction**.

### Blind or Visually Impaired

- Use a large space, such as a gymnasium, for this group activity. Mark the 100-meter distance with bright textured tape. If the participant has any residual sight, the bright color of the tape will contrast with the color of the floor. The participant will be able to feel along the length of the measured area. This will provide the participant an understanding of the length and enable him/her to relate to the discussions of "size."
- Refer to the discussions that are outlined in **Useful Information** and **Introducing the Activity**. They are excellent in developing a comprehension of the material and purpose.
- Construct a tactile diagram of a microbe to provide the participant with an understanding of the language references to "microbe." Detailed descriptions of each microbe will be useful.
- Have the participant relate the size of the microbe to a cup, bowl, or basket as an alternative to the one suggested in the activity.

### Deaf or Hard-of-Hearing

- See the **General Modifications** for *Blind or Visually Impaired* listed in the **Introduction**, page V.

### Mobility Impaired

- Use a floor that is smooth and with a lot of room to maneuver in and around, such as a gymnasium.

### Physically Impaired

- Use a floor that is smooth and with a lot of room to maneuver in and around, such as a gymnasium. Set up some seating prior to the meeting time to allow participants to be seated while group discussions occur.
- Offer crayons that are flat on one side and larger in size to allow the participant more control when coloring. The crayons will not roll off the table.

### Cognitively Impaired

- See the **General Modifications** for *Cognitively Impaired* listed in the **Introduction**, page V.

## For More Information

Freeman, B.A. (1985). *Textbook of Microbiology*. Philadelphia, PA: W.B. Saunders Company.  
Pelczar, M.J., Chan, E.C.S & Krieg, N.R. (1993). *Microbiology: Concepts and Applications*. New York: McGraw Hill Inc.  
Rainis, K.G. & Russell, B.J. (1996). *Guide to Microlife*. Danbury, CT: Grolier Publishing.  
Ruppert, E.E. & Barnes, R.D. (1994). *Invertebrate Zoology*. Fort Worth, TX: Saunders College Publishing.  
Trimble, J.M. (1991). Classroom debate: Are viruses living organisms? *Favorite Labs from Outstanding Teachers, Volume I*. Reston, VA: NABT Publications, 20-23.

## How to Start the Activity

- Discuss the use of models with the participants. Models are often used in science to compare and study subjects that are difficult to see.
- Explain that sometimes models are larger than the real item and sometimes they are smaller. Remind them of models they are familiar with such as model cars, planes, and game pieces. Explain that these models help us when the real item is very large. Other models, especially those used by scientists, are used when the real item is very small.
- Discuss different units of measurement.
- Have participants pull a single piece of hair and hold it between their thumb and index finger. Explain that the space between their thumb and finger is the width of a piece of hair. Be sure they understand the difference between the width and length of the piece of hair.

## Let's Make a Hypothesis

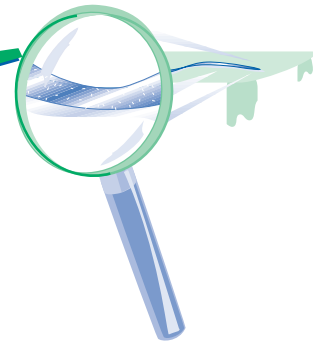
This activity does not lend itself to making hypotheses.

## What the Data Mean

There are no data for this activity.



# LET'S GET SMALL



## Questions to Think About

While diseases caused by microbes are very important, are there more microbes that actually help us? Yes! Oceanic plankton are microscopic plants and animals that form the beginning of the food chain in the ocean. Many produce the very oxygen we breathe. Pond water is also full of such organisms. Lichens and corals depend on microscopic algae to live. The white stripes on many tulip petals are caused by a virus that infects the plant. People could not survive without intestinal bacteria creating essential vitamins and helping digest food. We would not have cheese, wine, or antibiotics without microbes. However, can you see organisms as small as bacteria and viruses? Why are models often used to study and compare very small subjects? In this activity, you will use a model to help you "see" the size of viruses and bacteria.

## Safety Notes

- No running or playing with the equipment.
- Food, drinks, and gum are not allowed.
- Wash hands at the end of the activity.

## What to Do

1. Take the piece of hair you looked at earlier and examine it with the magnifying glass. Does it look larger when you look at it under the glass? Examine a piece of hair from another participant with the magnifying glass. Compare its thickness, or width, to your own hair. If you were going to make a model of a piece of human hair, would you make it larger or smaller than a real piece of hair? Do you think microbes are smaller than the width of a piece of hair? If you needed to make a model of a microbe, would you make it larger or smaller than the original?
2. Lay your meter stick or ruler out in front of you. What kinds of things do you measure in meters? Viruses, bacteria, and protozoa are so small that we use much smaller measurements for them. They are even so small that we cannot use any sort of "stick" to measure them at all.
3. Move to the area set aside for your group to create models to compare the sizes of viruses, bacteria, and protozoa with the width of a human hair and a human red blood cell. The marked off area is 100 meters. It represents the width of a piece of hair. That would be the tiny space between your fingers where you held a

piece of hair earlier. Select one of the microbes from the first column of the Microbe Reference Chart and draw what you think it might look like in the marked off area. See Figure 1. Decide how its size might compare to the width of a human hair.

4. Now go back to the Microbe Reference Chart and see what size the microbe you selected really is. Return to your drawing and make another drawing the proper size. How does it compare to your original?
5. Circulate among the drawings made by the other groups. Compare the microbe sizes and shapes. Are you surprised by the different sizes of microbes? How could you see these microbes? Did you create a good model of microbial size? Why do viruses, bacteria, and protozoa have such different shapes? How many bacteria do you think could fit into a teaspoon?
6. Why do scientists need to use models? Why can't they just look under a microscope to see what they need to see?

## What Did You Find Out By Doing the Activity?

Before doing "Let's Get Small," did you know:

- anything about microscopes?
- anything about what bacteria do?
- whether or not you could see bacteria?
- if small organisms like bacteria vary in shape and size?
- if bacteria are useful to your life?

From this activity, did you discover:

- how you could find out the relative size of bacteria, viruses, and microbes?
- how models are used to study and compare small microbes?
- why scientists need models instead of visual drawings?
- some ways that you encounter microbes in your everyday life?
- ways that bacteria can be helpful or harmful?
- how viruses cause illness?




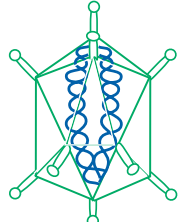

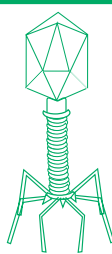
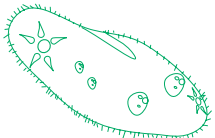
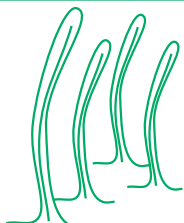
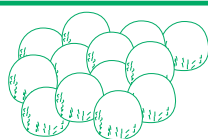
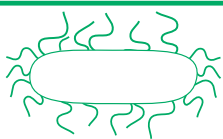


| Organism                                      | Effect on Body                                                                          | Actual Size                                               | Model Size                               | Shape <small>not to scale</small>                                                     |
|-----------------------------------------------|-----------------------------------------------------------------------------------------|-----------------------------------------------------------|------------------------------------------|---------------------------------------------------------------------------------------|
| Poliovirus                                    | Diseases of digestive tract, brain, and spinal cord                                     | 20 nm<br>(0.02 $\mu\text{m}$ )<br>(0.00002 mm)            | 2 cm                                     |    |
| Adenovirus                                    | Diseases of respiratory tract and digestive tract                                       | 90 nm<br>(0.09 $\mu\text{m}$ )<br>(0.00009 mm)            | 9 cm                                     |    |
| Vaccinia virus                                | Cowpox                                                                                  | 200 nm<br>(0.20 $\mu\text{m}$ )<br>(0.0002 mm)            | 20 cm                                    |    |
| Bacteriophage                                 | Useful, transfers genes from one organism to another helping survival and biotechnology | 60nm<br>(0.06 $\mu\text{m}$ )<br>(0.00006mm)              | 6 cm                                     |    |
| Paramecium                                    | Common protozoa important in the food chain                                             | 200 $\mu\text{m}$<br>(0.20 mm)<br>(you can almost see it) | 200 m<br>(more than two football fields) |   |
| Cilia of Paramecium                           | Leg-like hairs                                                                          | 200 nm wide<br>(0.2 $\mu\text{m}$ )<br>(0.0002 mm)        | 20 cm                                    |  |
| Staphylococcus                                | Causes food poisoning                                                                   | 0.5 $\mu\text{m}$<br>(0.0005 mm)                          | 0.5 m                                    |  |
| <i>Escherichia coli</i><br>( <i>E. coli</i> ) | Causes diseases and helps digestion                                                     | 2.0 $\mu\text{m}$<br>(0.002 mm)                           | 2.0 m                                    |  |
| Human hair                                    |                                                                                         | 0.1mm wide                                                | 100 m                                    |  |
| Human red blood cell                          | Carries oxygen in our bodies                                                            | 10.0 $\mu\text{m}$<br>(0.01 mm)                           | 10 m                                     |  |

Figure 1. Microbe Reference Chart.

