Teacher's Preparatory Guide

Shrink Me!

Overview: This activity gives students a sense of size and scale using objects that cannot be seen with the naked eye. This activity focuses on measuring length, for this is the most common feature when presenting nanoscale structures or nanoscale science. Understanding size and scale is fundamental to learning about nanotechnology as size defines the nanoscale (1-100nm in one dimension). Size is often divided into scales – macro, micro, nano and atomic. Helping students understand these "worlds" is an important part of their science knowledge and will help them to understand the relatively small size of the nanoscale. It can be introduced into K–12 curriculum by discussing scientific measurement.

Purpose: This activity is designed to help students understand the size and scale of objects that are shrunk by orders of 10.

Time Required: ~35 minutes

Level: Elementary, middle school, and high school; general science, life science, mathematics

Big Idea: Size and Scale

Teacher Background: Students often have trouble understanding size and scale in science, due to the different measurement units taught (metric and English), the different types of units used for length and volume, and the lack of consistent practice through their educational career. These lessons are aimed at presenting size and scale to students from kindergarten to high school. Common student misconceptions[1] include:

- mixing units such as centimeters and inches
- not realizing the connection between relative and absolute sizes of two objects
- the inability to use measurement tools accurately
- believing that objects that cannot be seen with the naked eye are approximately the same size

If a student does not have an idea of what shrinking 1000 times looks like, then in their mind, a cell is about the same size as a DNA strand or an atom.

This lesson demonstrates scales as powers of ten by shrinking an object by orders of 10. Since metric units use a decimal system, it is easy to discuss powers of ten. *Centi-me* shrinks the height by 100 times. *Milli-me* shrinks the height by 1000 times. This facilitates discussion of interesting small objects that are difficult to see with the naked eye such as:

- Cells, which are 100 times smaller than a millimeter[2]
- a DNA strand or molecules which are 1000–10,000 times smaller than cells[2]

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Sources:

1. Stevens, S., Sutherland, L., Krajcik, J., *The Big Ideas of Nanoscale Science and Engineering*. NSTA Press, 2009.
2. Northwestern University: DiscoverNANO. "How Small is Small?" (accessed August, 2011) http://www.discovernano.northwestern.edu/whatis/index_html/howsmall_html

Materials per class:

- sheet of blank paper for each student
- 10 meter sticks
- class set of metric rulers
- class set of scissors
- class set of Elmer's glue
- class set of Shrinky Dink template
- toaster oven
- fine point permanent markers
- Shrinky Dink material
- class set of markers or crayons
- magnifying lens or microscope

Advance Preparation: Purchase Shrinky Dink sheets, which are Item Number: D300–10A at: http://www.shrinkydinks.com. Print and cut out Shrink templates on Shrinky dink sheets, so that each student has one template. Tape meter sticks to the wall (so that they are 2 meters high) to set up 5 measuring stations around the room. Mark them with paper flags, so that they are easy to spot. Buy a toaster oven at a discount department or thrift. For the lower grades, photocopy the *deci–me* and *centi–me* figures onto blank paper to pass out to the students. These figures were scaled from a student who is 1.2 meters tall. The students can then color the figures to reflect themselves and then cut them out.

Teaching Strategies: Show the 5 measuring stations taped to the walls, and point out that there are two meter sticks on top of each other, and to keep this in mind when they measure their partner. After their Shrinky Dink has been shrunk, encourage students to look at the *milli-me* figure under a magnifying glass or a microscope. Introduce the metric prefixes: *deci = 1/10, centi = 1/100, milli = 1/1000, kilo = 1000*.

Kindergarten–Grade 2	Grades 3–12
1. Measure the height of each student in meters and record on a class record sheet. 2. Distribute *Deci–me* and *Centi–me* figures for each student to color—preferably with their own clothes—and cut out, and glue onto the Shrink Me worksheet. 3. Have students write their name and decorate the *Milli–me* Shrinky Dink template before placing it in toaster oven to shrink. Follow the instructions on the Shrinky Dink package. 4. When the Shrinky Dink has cooled, students can use a magnifying lens to view *Milli–me,* and glue it onto the Shrink Me worksheet. 5. *Homework:* Students use the prompt from the *Shrink Me Homework* sheet, to write a story and/or illustrate it.	1. In pairs, have students measure the height of each other in meters. 2. Have students calculate how tall they would be if they were shrunk to 1/10 of their height, then if they were shrunk to 1/100 of their height. 3. Have students use metric rulers to draw *Deci–me* and *Centi–me* pictures onto the Shrink Me worksheet. 4. Have students write their name and decorate the *Milli–me* Shrinky Dink template before placing it in toaster oven to shrink. Follow the instructions on the Shrinky Dink package. 5. When the Shrinky Dink has cooled, students can use a magnifying lens or microscope to view *Milli–me,* and glue it onto the Shrink Me worksheet.

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	6. *Homework:* Students use the prompt from the *Shrink Me Homework* sheet, to write a story and/or illustrate it.

Going Further: Extensions to the homework assignment:

- Choose a machine, such as a toaster or a hair dryer, to shrink to 1/100 its original size (like a Centi-toaster) and explain how that machine might be useful to us.
- Imagine shrinking to 1/1000 your original size, what would you like to explore at that size? For instance, a computer, the human body, a seashell?

Assessment: Use stories to evaluate the student's understanding of size and scale.

National Science Education Standards (Grades K–4, 5–8, 9–12)

Content Standard B: Physical Science

- Properties of objects and materials (Grades K–4)
- Properties and changes of properties in matter (Grades 5–8)
- Structure and properties of matter (Grades 9–12)

Content Standard E: Science and Technology

- Understandings about science and technology

Principles and Standards for School Mathematics

Measurement

- Understand measurable attributes of objects and the units, systems, and processes of measurement
- Apply appropriate techniques, tools, and formulas to determine measurements

Numbers and Operation

- Understand numbers, ways of representing numbers, relationships among numbers, and number systems
- Compute fluently and make reasonable estimates

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