EITC Engineers in the Classroom

NATIONAL GEOGRAPHIC + LOCKHEED MARTIN

Level E Elementary | Grades K-4

How SMALL is small?

Courtesy of FEI and Marcos Rosado

ACTIVITY: HOW SMALL IS SMALL?

Big Idea
Show students the vast size differential of nanoscale compared to visible scale objects.

Guiding Question
How big a difference is there in size between nanoscale and visible scale objects?

Materials
1. Paper
2. Pencil
3. Image Cards
4. Book: "What's Smaller Than a Pygmy Shrew?"
5. Ultra-Ever Dry® Treated Lexan Square
6. Glass of Water

Set Up
Arrange the desks so students can alternate between small-group work and all-class discussions and demonstrations.

TIP: Print and cut out enough sets of the image cards so students can work in groups of 3 or 4. Laminate them so you can use them for future classroom visits.

Introduction
Teacher introduces the engineer/classroom visitor.

Setting the Stage
- Show the introductory video.
- Tell students who you are, what you do, and what it's like to work in your career (3 minutes).
- Tell them a story about how you got interested in engineering/your career or something that happened in your work that was really exciting—something that truly made a difference in your life (3 minutes).

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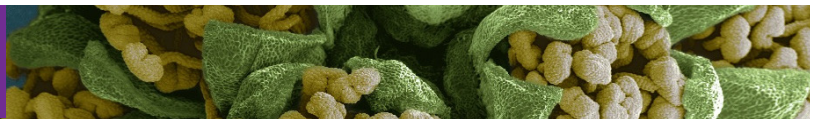

Hands-on Activity

Read-a-loud

Read the book "What's Smaller Than a Pygmy Shrew?" by Robert E. Wells. Discuss size comparisons of the macro, micro, and nano scales. Emphasize that the book includes very small things that humans ordinarily do not see. Have students draw the largest and smallest objects they can think of. Explain that macro means an object can be seen with the unaided human eye; micro is smaller than macro and requires the use of an optical (light) microscope to be seen with the human eye; and nano is extremely small and requires the use of a very powerful electron microscope to be seen. Elicit from the students examples from the book that fall into the three categories. (Example: macro/elephant, micro/protozoa, nano/atom.)

Nanotechnology Demonstration

Hold up the pretreated polycarbonate (Lexan) square for students to see. Gently pour a cup of water onto the center of the Lexan sample. Show students how the water stays in the center of the treated square. Point out the absence of water on the treated edges. Place a few drops of water on top of the treated area for the students to observe how it sheds off the surface. If time allows, ask a student volunteer to manipulate the pool of water in the center of the sample with a pencil to further explore the hydrophobic properties of Ultra-Ever Dry®.

Ask: *Have you ever seen something like this—where there seems to be some sort of invisible barrier holding water in an area?* (Most likely they haven't seen anything like this, so you can move on. But listen to any responses students might have.) Ask: *What do you think is going on here? Why do you think this is happening?*

After students offer a few possible explanations (if they provide any), explain that the area around the edges of the Lexan surface has been treated with a product called Ultra-Ever Dry but that the square in the center has been left untreated. Tell students that Ultra-Ever Dry is a hydrophobic coating, meaning that it that repels liquid. (Make sure students understand the meaning of the word "repel.") This product uses nanotechnology to coat an object and create a barrier of air on its surface. The layer of air molecules on top of the coating repels water making it hydrophobic, which causes water to move away from treated areas. Explain that this coating was created using nanotechnology. Nanotechnology is when scientists work with individual or small groups of atoms and molecules. Remind students that atoms and molecules are some of the smallest things that were explained in the book you just read.

Create a Size Sequencing Pictorial Timeline

Have students work in small groups of 3 or 4. Distribute one complete set of size image cards to each group. Have students line the cards up from largest object to smallest object. Develop terms such as: bigger, smaller, bigger than, smaller than, large, small, and length. Ask students to look at their cards and discuss which object is the smallest. After all of the groups have completed sorting their cards, show the students the correct order.

Go through each card and ask students if there is anything in the classroom that would be the same size as that object. When you get to the cards on the atomic level, explain that all the objects in the classroom are made up of smaller objects called atoms and molecules and that these are made up of even smaller things called electrons, protons, neutrons, and quarks, as mentioned in the book.

Wrap-Up

Have students draw the largest and smallest object they can think of after learning more about size and scale. Prompt the students to compare their original drawings to their final drawings and discuss any differences that they notice.

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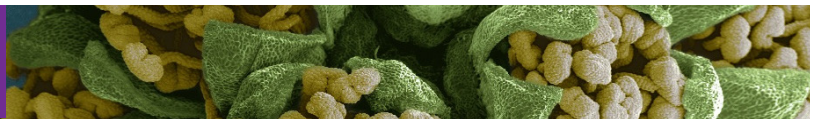

SUPPORT MATERIALS – FOR THE CLASSROOM VISITOR

Background Information

Nanoscale – Things that are very, very small; too small to see with a standard microscope.

S.E.M. (Scanning Electron Microscope) – This is a sophisticated microscope that enables scientists to view objects at the nano level.

Nanotechnology is the precision placement, measurement, manipulation, and modeling of individual or small groups of atoms or molecules.

National Standards Alignment

- National Science Education Standard: (K-4) Standard A-1: Abilities necessary to do scientific inquiry
- National Science Education Standard: (K-4) Standard E-2: Understandings about science and technology
- Math Standard: Measurement: (preK-4) Standard 2: Apply appropriate techniques, tools, and formulas to determine measurements

Preparation For Your Classroom Visit

Once a classroom visit has been established, check in with the host educator to make sure students are prepared and have some prior knowledge about the topic you have selected to share with the class.

An educator guide has been created for you to share with the host educator before your classroom visit. This guide includes pre- and post-visit resources and suggested activities that support the content you will be presenting during your classroom visit. Some of the information in the educator guide has been provided in the "Support Materials—For the Educator" section at the end of this document. Share the educator guide for this activity with the classroom educator as soon as you have a date for your visit. The educator guide can be found in the educator version of the Engineers in the Classroom website (www.classroomengineers.org)

Prior Knowledge

Familiarize yourself and the educator with the following terminology: pygmy shrew, protozoa, molecule, atom, quark, hydrophobic, nanotechnology, macro, micro, nano, sequence, nanoparticle

Other Resources To Explore:

National Geographic: Mysteries of the Unseen World
http://education.nationalgeographic.com/education/mysteries-unseen-world/?ar_a=1

National Geographic: Encyclopedic Entry—Nanotechnology
http://education.nationalgeographic.com/education/encyclopedia/nanotechnology/?ar_a=4

Merriam-Webster: Visual Dictionary Online—Molecule
http://visual.merriam-webster.com/science/chemistry/matter/molecule.php

National Nanotechnology Infrastructure Network—Nanoscale Activity:
http://www.nnin.org/sites/default/files/files/Lesson%2B3%20v2.pdf

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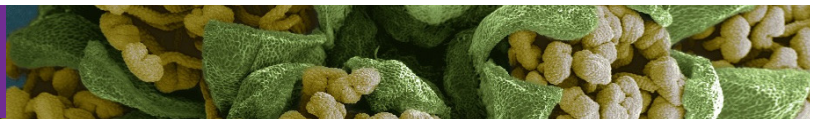

Classroom Management Tips

1. **Use a normal, natural voice:**

   The students will mirror your voice level, so keep it neutral and soft. If you want students to talk at a normal, pleasant volume, you must do the same. You also want to differentiate your tone. If you are asking students to put away their notebooks and get into their groups, be sure to use a declarative, matter-of-fact tone. If you are leading a classroom discussion, use an inviting, conversational tone.

2. **Use hand signals and other non-verbal communication:**

   Holding one hand in the air and making eye contact with students is a great way to quiet the class and get their attention on you. Have the students raise their hand along with you until all hands are up. Then lower yours and talk.

   Flicking the lights on and off is a helpful cue to let the students know a transition is coming up. At that point let them know they have 3-5 minutes to finish up their current task.

   Another helpful tool to gather attention is to clap or sing a certain rhythm for the students to repeat.

3. **Address attention needs quickly and wisely:**

   Always take a positive approach while addressing an interruption to your instruction. Say, “It looks like you have a question,” or, “Is there something that I might clarify for you?”

   When students have conflicts with each other, use neutral language as you guide the students to a solution.

4. **Use Reflective Questioning:**

   Paraphrase and restate comments. By repeating or reflecting the student’s statement in the form of a question, you will help them gain valuable insight and they will know you are listening to them.

5. **Emphasize Safety:**

   The most important component of any environment is safety. Let the students know it is your job to keep them safe and it is their job to help keep it that way.

   Review classroom safety rules:

   - Keep hands to self.
   - Use the correct voice volume for the task (0-5 scale):
     0=silent, 1=whisper, 2=conversational, 3=small group, 4=presentation, 5=outside
   - Listen to the speaker.
   - Share when it’s your turn.

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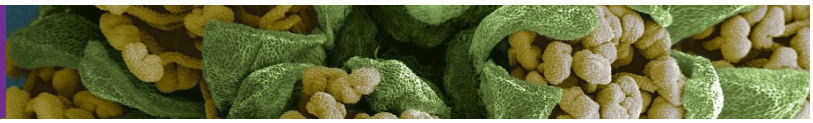

SUPPORT MATERIALS – FOR THE EDUCATOR

Tips

- Additional relevant concepts and physical properties that could be presented before/after the activity include pygmy shrew, protozoa, molecule, atom, quark, hydrophobic, nanotechnology, macro, micro, nano, sequence, silicon dioxide, and nanoparticle.
- Show and discuss some comparison examples from the nanoscale:
  http://www.nano.gov/sites/default/files/nanoscale7_0.jpg
- Provide examples of current nanotechnology:
  http://www.nanoprotect.co.nz/what-is.htm
  http://www.nanotech-now.com/current-uses.htm

Pre-Visit Resources and Activities

- Use the National Geographic Mysteries of the Unseen World collection
  http://education.nationalgeographic.com/education/mysteries-unseen-world/?ar_a=1
  to engage students and provide some context and relevant background information:
  - Media Spotlight: National Geographic: Nanoscience—A New Frontier
    http://education.nationalgeographic.com/education/media/nanoscience/?ar_a=1
  - Media Spotlight: National Geographic: Nano World—Try These Particles on for Size
    http://education.nationalgeographic.com/education/media/nano-world/?ar_a=1
  - Activity: National Geographic: Properties of Matter—Macro to Nano Scale
    http://education.nationalgeographic.com/education/activity/properties-matter-macro-nano-scale/?ar_a=1
  - Article: National Geographic: Smart Shirts
    http://education.nationalgeographic.com/education/news/smart-shirts/?ar_a=1
- Pre-teach relevant vocabulary: pygmy shrew, protozoa, molecule, atom, quark, hydrophobic, nanotechnology, macro, micro, nano, sequence, and nanoparticle.

Post-Visit Resources and Activities

- Review relevant vocabulary/concepts: pygmy shrew, protozoa, molecule, atom, quark, hydrophobic, nanotechnology, macro, micro, nano, sequence, silicon dioxide, and nanoparticle.
- Possible extensions: extend the pictorial timeline with additional macro, micro, and nano images.
- Activity: Butterfly images (1 at macro scale, 1 at micro scale, and 1 at nano scale)
  http://www.nnin.org/sites/default/files/files/Lesson%2B3%20v2.pdf

For Further Exploration

- Future of Nanotechnology
  http://science.howstuffworks.com/nanotechnology4.htm
- Additional hydrophobic resources:
  http://www.youtube.com/watch?v=i4J6uC22Hwo

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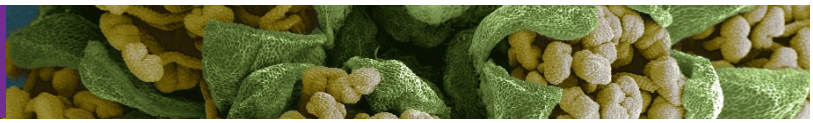
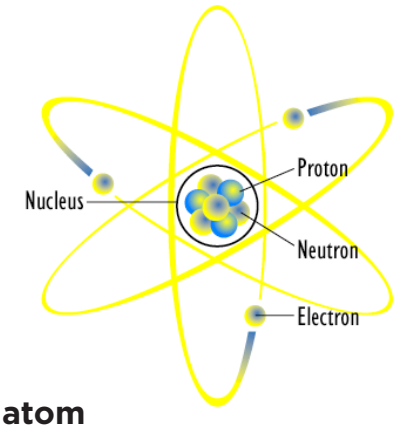
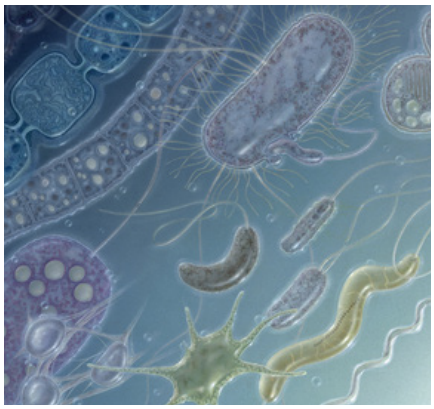




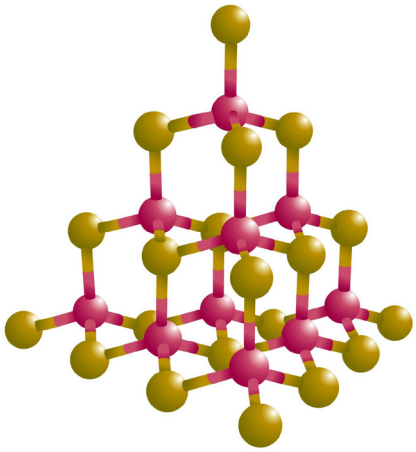
atom
Photo Credit: Photograph by Magnus Manske/ Wikipedia. This image was licensed under the Creative Commons Attribution-Share Alike 3.0 Unported license.



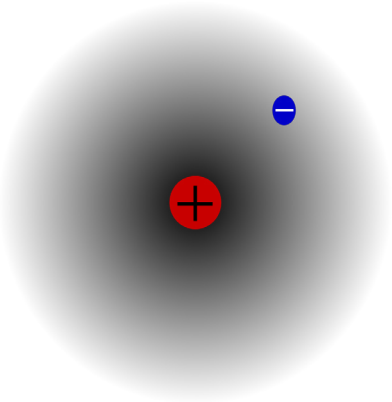
bacteria
Photo Credit: Jane Hurd

elephant
Photo Credit: Frank and Helen Schrieder

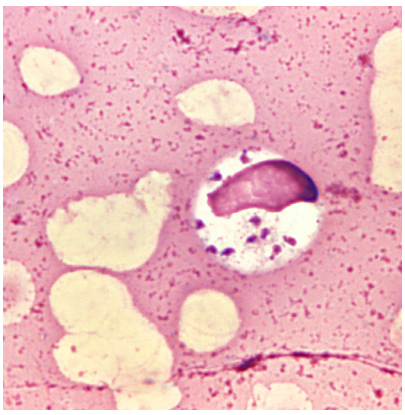
ladybug
Photo Credit: Photograph by Mark Thiessen, National Geographic



molecule
Photo Credit: NASA/Marshall Space Flight Center

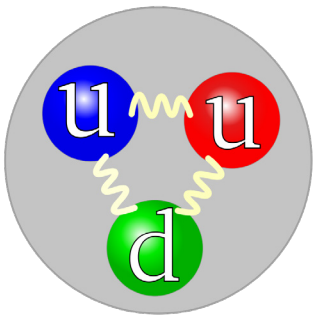


proton
Photo Credit: Photograph by Mets501/Wikipedia. This image was licensed under the Creative Commons Attribution-Share Alike 3.0 Unported license.



protozoa
Photo Credit: Fed Gov - Public Domain. CDC/Dr. L.L. Moore, Jr

pygmy shrew
Photo Credit: Photograph by Flickr user polandeze. This file is licensed under the Creative Commons Attribution-Share Alike 2.0 Generic license.



quark
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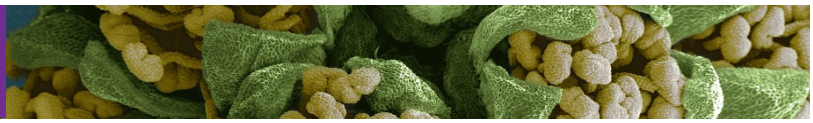

Answer Key

Answer key for size sequencing pictorial timeline. Objects are listed in order from largest to smallest.

1. elephant
2. pygmy shrew
3. lady bug
4. protozoa
5. bacteria
6. molecule
7. atom
8. proton
9. quark