Name:_____Date:_____Class:_____

Student Worksheet
How small is that? Day 1

You just watched a video introducing nanotechnology. Nanotechnology is the science of working with materials at a very, very small scale (the scale of 1 to 100 nanometers.) Scientists have found that when known elements, like gold and silver, are divided into very small particles, they have unique and often useful properties that they don't possess in bulk form. These unique properties are why nanoscientists work with such small particles. Nanotechnology techniques are already being employed in many electrical devices, such as the ones in your cell phones, and in medicine as well. To understand nanotechnology, we first need to understand how small a nanometer is.

What is a nanometer? The prefix "nano" refers to an object's size, and comes from the Greek word for "dwarf." The meter is the unit for measuring length used in science. See the table below for other size prefixes.

Prefix	Deci-	Centi-	Milli-	Micro-	Nano-
Fraction	1/10	1/100	1/1000	1/1,000,000	1/1,000,000,000
Decimal	0.1	0.01	0.001	0.000001	0.000000001
Scientific notation	1×10^{-1}	1×10^{-2}	1×10^{-3}	1×10^{-6}	1×10^{-9}
Phrase	One tenth	One hundredth	One thousandth	One millionth	One billionth

1. Which prefix in the table represents the smallest number? _____

The prefixes are only helpful if you know what they look like. Look at the large pool noodle on your desk. This is one meter. The smaller pool noodle on your desk is a decimeter.

2. How many decimeters does it take to make one meter?_____

A meter can be divided up into smaller and smaller pieces, and as the pieces get smaller, the name changes. As we said, one tenth of a meter is called a decimeter. One hundredth of a meter is called a centimeter.

3. Look at the table. What do you think one thousandth of a meter is called? _____

4. What do you think one millionth of a meter is called?_____

5. What do you think one billionth of a meter is called? _____

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Development and distribution partially funded by the **National Science Foundation**

NNIN Document: NNIN-1387
Rev: 08/2014

Look at the walls around the room. At each measuring station, there are two meter-sticks stacked on top of one another. Please use those to measure the height of one of your group members.

6. Our group member is _____

Let's convert their height into centimeters. A centimeter is $1/100^{th}$ of a meter, meaning that there are 100 centimeters in one meter. To convert their height into centimeters, all you need to do is multiple their height by 100.

7. What is your group member's height in centimeters? _____

8. Look at the table. If you wanted to find your group member's height in **millimeters,** how much would you multiply their original height by?_____

9. What is your group member's height in millimeters? _____

10. Look at the table. If you wanted to find your group member's height in nanometers, how much would you multiply their original height by?_____

11. What is your group member's height in nanometers? _____

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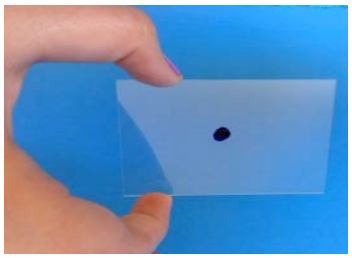
Student Worksheet

How small is that? Day 2

Measuring your height was pretty easy, because you had meter sticks to help you. Now we are going to try to measure something much smaller. We are going to figure out how to measure the size of one of your skin cells!

1. Before we do that, please write down how big you *think* one skin cell is: _____

Follow these steps to observe your skin cell under the microscope.



1. Carefully dip your toothpick into the aniline blue dye. Deposit one *tiny* drop of the dye onto the middle of your glass slide.

2. Gently but thoroughly clean the back of your hand with a wet paper towel. Dry it off.

3. Take a few centimeters of clear adhesive tape and press it onto the back of your hand with your fingertip (to avoid getting a fingerprint on the sticky side of the tape) Pull the tape off your hand with tweezers and mount it on the microscope slide, sticky side down over your dot of blue dye. *Tweezers are useful for doing this to avoid getting your fingerprint on the tape.*

4. Make sure the 4x lens (the shortest lens) is in place over the stage. Place the slide onto the stage of the microscope.

5. Look through the eyepiece and turn the coarse focus knob (the largest knob) until an image comes into focus. It should look like scattered blobs.

6. Move the slide around until a nice cluster of blobs moves into the center of your image. Use the fine focus knob (the smallest knob) to make the image as focused as possible.

7. Observe the slide using the 10x objective.

THIS IS WAY TOO MUCH DYE! DON'T DO THIS!!

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Rev: 08/2014

8. Observe the slide using the 40x objective. Can you see any cells? Draw what you see below.

2. With your group, come up with a way to measure the size of one skin cell. For inspiration, check out the box of items on your desk. Describe your method, using at least three complete sentences, below.

_____

_____

_____

_____

_____

3. We estimate that the size of the cell is: _____

4. Our teacher told us that the size of one skin cell is about: _____

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Student Worksheet

How small is that? Day 3

This week we explored the metric system, and the different prefixes scientist use to measure size. In our exploration, you measured the height of one of your lab group members and analyzed a skin cell. Today, we are going to explore how large and small different objects are compared to one another. Using the table below to help you, please answer the following questions:

Prefix	Deci-	Centi-	Milli-	Micro-	Nano-
Fraction	1/10	1/100	1/1000	1/1,000,000	1/1,000,000,000
Decimal	0.1	0.01	0.001	0.000001	0.000000001
Scientific notation	1×10^{-1}	1×10^{-2}	1×10^{-3}	1×10^{-6}	1×10^{-9}
Phrase	One tenth	One hundredth	One thousandth	One millionth	One billionth

1. Your teacher, a human being, is 1.6 meters tall. A skin cell is about 50 micrometers in size. This means that a skin cell is roughly _____ times smaller than a human being.

a. 1,000
b. 100,000
c. 1,000,000
d. 1,000,000,000

2. A silver nanoparticle is a particle of silver that is about 50 nanometers in size. When silver is that small it has antimicrobial properties that can be used to prevent bacteria from growing. Cerain brands of bandages have silver nanoparticles in them, to prevent cuts from being infected.

How many times smaller is a silver nanoparticle than a human being?_____

a. 10,000
b. 100,000
c. 1,000,000
d. 1,000,000,000

3. A skin cell is 1,000 times bigger than a silver nanoparticle. But what does "1,000 times bigger" really mean?

If you shrunk your teacher down by a factor of 1,000, you would measure them in _____
_____

a. decimeters
b. centimeters
c. millimeters
d. nanometers

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4. Your teacher decided to make a model of herself/himself 1,000 smaller than her actual size. (Each table will get one). You may have to use a microscope to see her! Please write down one observation about milli-teacher:

_____

_____

_____

For reference, your teacher is 1,000 times bigger than the milli-teacher you have on your table, just like a skin cell is 1,000 times bigger than a nanoparticle.

5. If you were trying to look at a silver nanoparticle under a microscope, and one of your skin cells fell onto your sample, what would happen? **Remember that nanoparticles are smaller than visible light so you cannot use an optical microscope to see them. You must use special microscopes such as a Scanning Electron Microscope or an Atomic Force Microscope to see them. These microscopes use electrons and atomic forces to visualize nanoscale objects.**

_____

_____

_____

Comic Project: The only way scientists can work with silver nanoparticles is if there are no big, evil skin cells around to block their view. **What can scientists do to make sure none of their skin cells get on the silver nanoparticles they're trying to work with?** Create a five-scene comic that explains your idea. You will be given a piece of white paper broken into five boxes to help you do this. Each box should have a picture and one full sentence of description. This is due one week from today, and must be in color.

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Title of your Comic:

Created By: _____

Date: _____

Period: _____

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