Objective: The students will produce 9 solutions of diluted food coloring in the following increments: 1/10th, 1/100th, 1/1,000th, 1/10,000th, 1/100,000th, 1/1,000,000th, 1/10,000,000th, 1/100,000,000th, and 1/1,000,000,000th to illustrate the small unit of a nano-which is one part per billion.

Equipment: food coloring, water, micropipette, 9 small test tubes or clear glass well trays

Prerequisite Laboratory Knowledge: micropipetting techniques

Procedure:

1. In nine wells or small test tubes, pipette 9 ml of water in each one. Label the test tubes /wells 1-9.

2. In tube #1, add 1 ml of food coloring. Mix solution well. This is your first dilution which will make the solution 9 parts water and one part food coloring. So you have created a solution that is 1 part in 10 food coloring or 1/10th food coloring.

3. Use the micropipette to obtain one ml of the solution in test tube #1, and add it to the test tube labeled #2. This is your second dilution which is now representing a solution of 99 parts water and one part food coloring which would mean your dilution is 1/100th food coloring.

   (We can use the fact that the first ml we took out of test tube #1 is 1/10th food coloring and we can divide the 9 ml of plain water into increments of 10 per ml, giving us 99 parts of water and 1 part food coloring which is a ratio of 1 to 100 or 1/100th.)

4. Continue with the dilutions, taking one ml from the previous tube to add to the following tube until you have made the nine dilutions. Fill out the student worksheet as you work to determine the increments of dilutions. Record the color of the solution in the bottom row of the student worksheet using a color pencil to illustrate the color of each solution as you do your dilutions.

Conclusion: A nano is one part in a billion, which is a very small increment that is even smaller than a photon of light-making it impossible to see with our eyes.

Extensions: Same lab but use one part sugar/salt/lemon juice to illustrate taste in units per billion-it can be set up as a mystery dilution to have the students guess how many dilutions the solution may be.
Lab Module 3-Inquiry Nano Worksheet

Name___________________________________________________

Nanoparticles are very small. Write down three of the smallest objects you can think of.

_________________________ ___________________________ ___________________________

Do you think these are as small as one nanometer?

Why or why not?

How many nanometers do you think the following objects measure?

Length of a dust mite_______________________

Width of a human hair_______________________

Red blood cell_____________________________

Width of DNA double helix ______________________

Width of one sugar molecule ____________________

If the width of one sugar molecule is approximately 1 nanometer---predict how many sugar molecules would be in one sugar cube?

______________________________ sugar molecules

Before you begin your dilutions, predict during which dilution you would no longer see any color or if you think that color will always be visible.

I will see color until test tube #____________ which is 1 part per ______________.

Scientists aren’t able to weigh out one nanogram on a scale. Why?

What is the smallest increment that the triple beam balances in the lab weigh to?