Mixtures, Solution, & Colloids- What's the Difference?

For ages: 7-11
Should take about 15 minutes to complete (excluding gelatin preparation).
Please have adult supervision, as you will be working with lasers and using the stove.

Nanogold is essentially a colored suspension or colloid of gold nanoparticles in a solvent (something which dissolves). The solvent is generally water. Nanogold in solution has been used for centuries to stain glass, windows and pottery. The preparation of nanogold particles must occur in a laboratory; however, in these series of activities you will learn the basic principles of colloidal systems. You may not be familiar with the term colloid; however I'm sure you have heard of the terms mixture and solutions. In the following activities we will explore the differences between a solution and a mixture to better understand the behavior of a colloidal system.



Colloidal gold can be used in the production of electronic components, in cosmetics, cancer detection and drug delivery, in devices which rapidly detect miniscule quantities of biological substances for medicinal and terrorism-prevention purposes. Due to the fact that gold nanoparticles behave very differently from bulk gold, scientists are in debate about the possible unknown side effects and social impacts.

What the difference between a mixture and a solution?

Materials

- Three (3) drinking glasses
- Sugar
- Water
- Tweezers
- Sand
- Iron fillings or any small piece of metal

Activity

1. Mix a small amount of sand into a glass of water.
2. Using tweezers remove a *single* grain of sand from the water.
3. Repeat steps 1 & 2 using the iron fillings and sugar, in separate glasses.

Question: What is the difference between the removal of the sugar and the removal of the iron fillings?

What's going on?

It is quite simple to remove an iron filling with the tweezers from the water. Also, the removal of sand from water is fairly simple. However, it is impossible to remove sugar from the water. No matter how hard you try to remove a single grain of sugar, it will not happen. What's the difference?

The sand and the iron fillings mixed with water can be defined as mixtures. A mixture is the combination of two or more substances that can

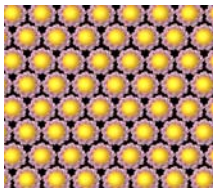
be separated by mechanical means (tweezers). A common example of a mixture is a salad. After a salad is made, it is possible to separate the tomatoes from the lettuce. The sugar and the water represent a solution. A solution is a homogenous mixture (same throughout). In other words the sugar dissolves in the water, and therefore it is impossible to separate out one grain of sugar.

Remember…

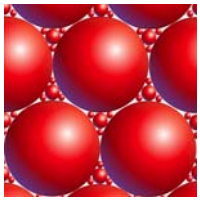
Solutions are formed by small particles and mixtures are formed by large particles.

So what's a colloid?

The term colloid refers to substance with a glue-like consistency. In general colloids are liquids; however, some colloids take the form of smokes and aerosols, and even solids. Colloids have unusual properties, for example gelatin. Colloidal systems have a high ratio area/volume among the surface of the particles and their volume. In other words, colloids contain a very large amount of particles. The overall surface area of the system is extremely large. When particles are nano and micro size, they have a very large surface area. Particles with large surface areas react with other substances much faster than bulk-sized particles.



nano-sized



bulk-sized

Gelatin is neither a solid or a liquid but a colloid system. It is very elastic and if deformed it returns to its original shape. In the following activity we will explore the properties of the interaction of light with a colloidal system.

Materials

- Gelatin

- Red and blue food coloring
- Jello molds; make Jigglers™ approximately 1 inch thick (optional)
- Red laser

Activity

1. Prepare the gelatin according to package instructions, add red food coloring to half and blue food coloring to the other half.
2. Shine the laser through the red gelatin; for best results place white paper in back of gelatin as you shine the laser.
3. Note observations on a piece of paper.
4. Perform steps 1 & 2 using the blue (blueberry) gelatin.

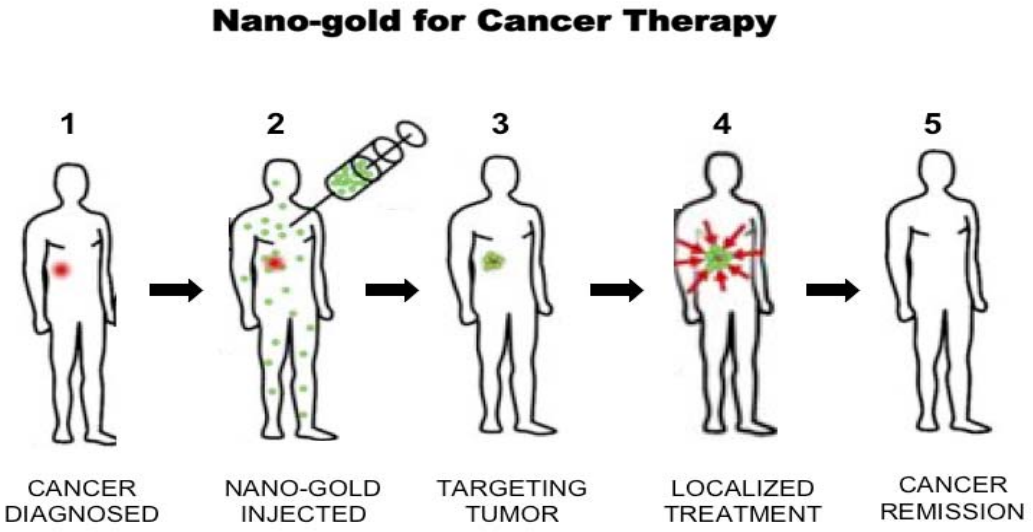
What's going on?

You should notice that the laser beam does not easily pass through the blue gelatin but easily passes through the red gelatin. Red objects appear red because they don't resonate at red frequencies. The red wavelength energy is either reflected or transmitted. Due to the fact that gelatin is colloidal; it scatters enough of the laser beam to make it visible. The blueberry gelatin is actually cyan, a mixture of blue and green. Cyan is the complementary (opposite) color of red. The blueberry color transmits green and blue, but changes red wavelengths into heat.

This is a great model to explain how nanogold for cancer therapy works. Nanoparticles can be injected into a tumor. The patient will then be exposed to a specific wavelength; the correct wavelength will heat up the nanogold, ultimately destroying the tumor. A wavelength of 700-622 nm, red in color, is a perfect choice because it can pass through human skin and body tissue but it can be absorbed by the nanogold.

In order for the nanogold to absorb the red wavelength the nanogold must be the right size. Large sized nanogold particles will be able to absorb the red light; whereas, small sized nanogold particles will not be able to

absorb the red light. Doctors will want to inject nanoparticles that can absorb the red light. Large nanogold particles are blue in color. In the following diagram the red laser is represented by the localized treatment.



In this particular activity the blue gelatin represents the blue nanogold particles and the red laser represents the high-powered red laser (700-622 nm) that would be used by the doctors. While this procedure in humans is still in clinical trials it has high hopes because gold is non-toxic to the body.

The Importance

In using nanogold for cancer therapy doctors should inject nanoparticles that appear blue in color. Once the nanogold particles are adhered to the tumor, a wavelength of 780-622nm, red in color, is directed at the tumor. The nanogold is consequently heated destroying the tumor.

References

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