Supplementary Information – Instructor Resources

You can find a quick tutorial at these websites:

Blood vessels <https://www.youtube.com/watch?v=whtNDBIhczQ> or <https://www.khanacademy.org/science/health-and-medicine/circulatory-system/blood-vessels/v/layers-of-a-blood-vessel>

Nanoparticles <http://www.ausetute.com.au/nanotech.html>

Background information for instructors:

To create a size scale comparison to your state, multiply the size of a small object by 10,000,000 (for example, a 1 cm wide object would be 10,000,000 cm or 100 km wide). (e.g. ‘Imagine a 1 nm particle is increased in size to that of a marble, how large would a ping pong ball be?’ answer: Larger than Nebraska).

The Buckyball formation contains only 60 carbon atoms. The carbon nanotube contains a varying amount of carbon atoms depending on its length. The arrangement of the carbon atoms affects both the shape and function of the nanoparticles. An easy demonstration for the students is to tell them that a piece of printer paper represents a sheet of carbon. First roll a piece of paper so that the two short ends are touching and then roll the same piece of paper so that the two long sides are touching. Even though the same piece of paper is used for each configuration the resulting properties would be vastly different if this was a sheet of carbon rolled at the nano scale.

Many students can relate to seeing an ultrasound image of a baby– an innovation developed by biomedical engineers working with medical professionals in the 1950s.

If the nanoparticles get stuck in the blood vessels they can stop blood flow, causing problems similar to what happens when a person has a stroke or heart attack caused by a blood clot getting stuck in their vessels.

In the example shown in Figure 2 the nanoparticles that were used were carbon nanotubes and the reason that they were getting ‘stuck’ in the blood vessel was that they were binding to the proteins within the blood to create large nanoparticle/protein masses. It is possible for nanoparticles to also bind to the endothelial cell surface receptors. They type of binding that occurs would be related to the characteristics of the nanoparticle including charge, polarity, etc.

The interior surface of the blood vessel model is not smooth like a straw because blood vessels are made of layers of endothelial cells that result in layers and multiple dimensions. A visual of the different types of cells found in a blood vessel and showing the buildup of cholesterol within the vessel wall helps students understand the model, as well as a little bit of anatomy.

When discussing failure of a design we like to ask the students if they have ever failed at anything. Most students will share an experience in which they failed. We ask the students if they learned anything from their failure and if they made changes for their next attempt. If the students answer ‘yes, they did make changes’ then we declare that they are engineers since engineers learn from their failures and make improvements.