Curing Cancer with Light and Gold

Cancer is a complicated disease and scientists are constantly working on new ways to treat it. Recently, researchers have been injecting incredibly small pieces of gold into patients as part of a cancer treatment. These gold pieces are really, really tiny—about 100 nanometers long (a nanometer is one billionth of a meter)—and are called gold **nanoparticles** (yes, it is not a very creative name). After they are injected, the gold nanoparticles float through the patient's bloodstream. This is where it gets interesting. Cancer tumors have leaky blood vessels, so the nanoparticles leak out of the blood vessels and into the tumors. That is how the nanoparticles find all the tumors!

Next is the really amazing part. Since the nanoparticles are metal, they have some electrons that are not stuck to a particular atom but are free to roam throughout the nanoparticle, as shown in **Figure 1.** The electrons are negatively charged and are attracted to the positively charged protons in the gold atoms. That means if the electrons are pushed away from the protons, the electrons will spring back toward the protons. The electrons overshoot the protons and then turn back toward the protons and overshoot them again, then turn back and overshoot again…and again, just like a vibrating spring.

The researchers shine a specific frequency of light on the patients around the area where the tumors are. When the light waves hit the electrons in the gold, the electric field of the light forces the electrons to move quickly up and down, like an ocean wave moving a resting seagull up and down. **Figure 2** shows a diagram of how the electrons in a nanoparticle can be affected by light.

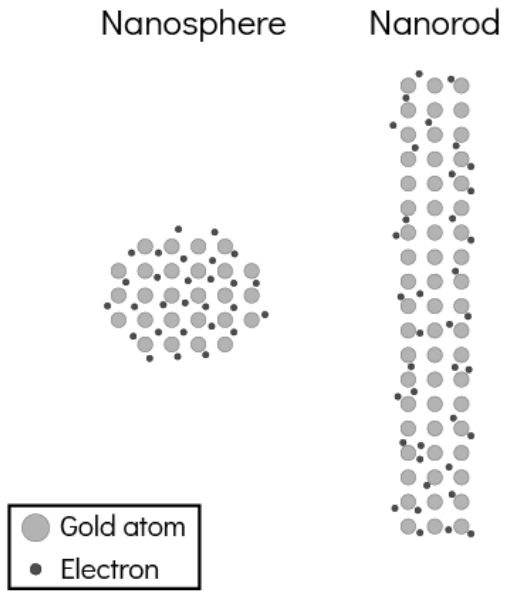

Figure 1. Gold Nanoparticles. A diagram of gold nanoparticles, which can be made in different shapes such as the nanosphere and nanorod shown. The gold atoms contain positively charged protons. Although the diagram does not show many atoms, a real gold nanoparticle contains roughly 100 million gold atoms (but atoms are so small that the whole gold nanoparticle is still too small for us to see with the naked eye)

Figure 2. Gold Nanoparticles Hit with Light. Snapshots of a gold nanoparticle as it is exposed to light. The electric field of the light pushes negatively charged particles in the opposite direction from the direction of the field.

These oscillating electrons bump into gold atoms in the nanoparticles, which bump into nearby molecules inside the tumor, such as water molecules. So now lots of molecules are bumping around fast. What does it mean when there are fast-moving molecules? It means that it is hot! (Recall that temperature is a measure of particle speed.) The tumor gets overheated and is destroyed. In other words, by shining light on the gold nanoparticles, the researchers cook the cancer. This is called **photothermal therapy** since *photo* means light and *thermal* refers to the heating that results from the light interacting with the nanoparticles. In the first clinical trial in people in 2019, the gold nanoparticles cured 14 out of 16 of the prostate cancer patients!

References

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BiteScientist Profiles

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Shannon Morey teaches physics at Abbott Lawrence Academy in Lawrence, Massachusetts. She is a 2015 Knowles Teacher Initiative Fellow and 2022 MA STEM Teacher of the Year. In her free time, she enjoys spinning, cooking, and yarn crafts. She also loves to travel for fun and to learn more about the world. She is pictured here on Isabela Island in the Gálapagos Islands as part of a Knowles Teacher Initiative professional development.