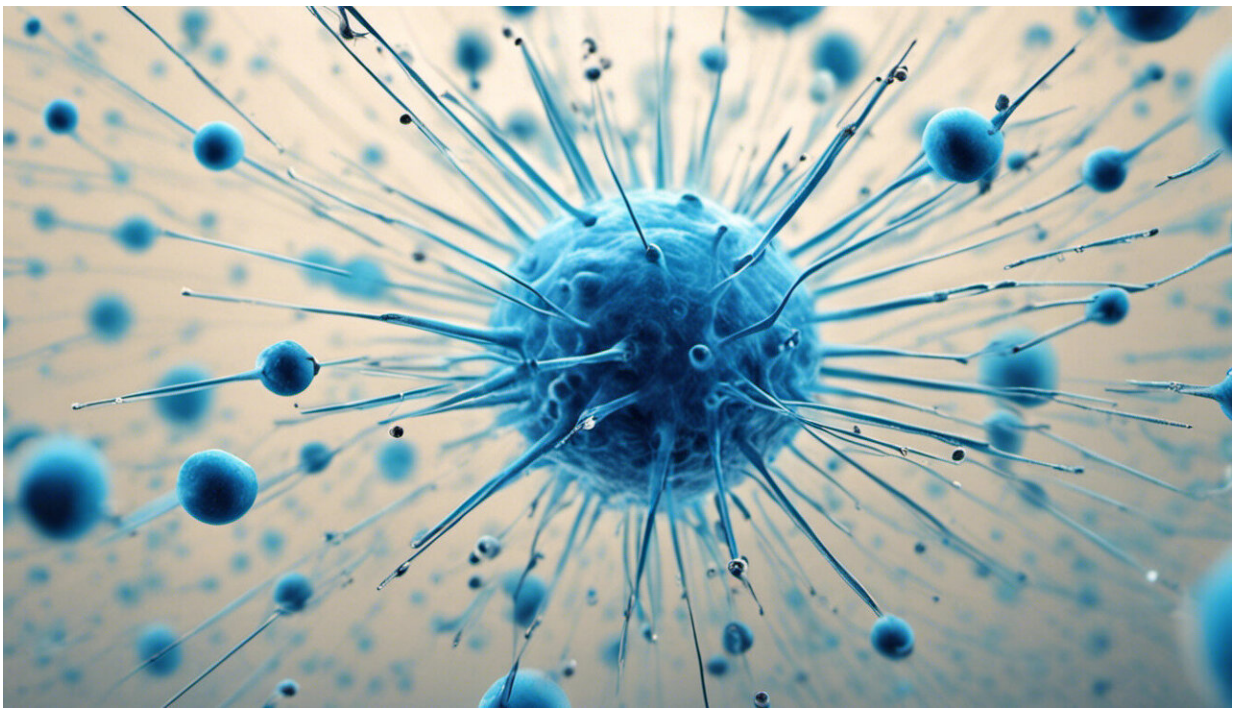
The nanoparticles in mRNA vaccines are nothing to fear: We interact with many useful, tiny particles every day

December 21 2021, by Keroles Riad, Sylvie Ouellette



Credit: AI-generated image (disclaimer)

Let's be honest: there are many ways in which size matters, and for some purposes small is beautiful. However, sometimes very small things, like nanoparticles, are misunderstood.

In recent months, many people have had difficult conversations with friends and family members who were hesitant about taking the COVID-19 vaccine. In some cases, this hesitance arose because they have been led to believe that vaccines can't be trusted because they contain nanoparticles. It is lipid nanoparticles—called liposomes—that carry the mRNA molecule in the COVID-19 mRNA vaccines.

The nanoparticles in mRNA vaccines

Those liposomes act as vehicles delivering the viral protein template to where it can interact with the immune system and trigger the production of antibodies. Their small size allows them to do that job faster and more effectively.

Liposomes are minuscule droplets of fat that mimic the membranes of our cells. This allows the particles to not only travel to their destination in the body without triggering an immune reaction, but also to fuse with our cells that can then uptake the mRNA molecule and synthesize the protein for which it codes. Once delivery is complete, these lipid nanoparticles are degraded by our body just like any other lipid.

This technology has been made possible through years of concerted efforts by the scientific community. These types of nanoparticles are a potentially useful vehicle for all sorts of other medicines. These include other vaccines, and also promising cancer treatments.

As scientists who *make* nanoparticles, we had hoped that at least our loved ones would be less fearful of our work. Thankfully, they are all now fully vaccinated, but vaccine hesitancy stemming from the novelty of the terms nanoparticles and nanotechnology leaves us concerned.

With the rise of COVID cases due to the Omicron variant, efforts to address vaccine hesitancy across the globe need to be ramped up,

including information about nanoparticles. The terms nanoparticles and nanotechnology may be uncommon to a lot of people, but humans have been interacting with nanoparticles for millennia, and each one of us comes into contact with nanotechnology-based products every single day.

Nanoparticles

One of the authors—Keroles Riad—mass-produces nanoparticles by literally setting chemicals on fire (very satisfying). This process—called flame spray pyrolysis—can produce special nanoparticles called quantum dots, which are used in lithium batteries and gas-sensing devices. But nanotechnology has uses in every aspect of our lives, affecting things like our wine, our guts and our climate.

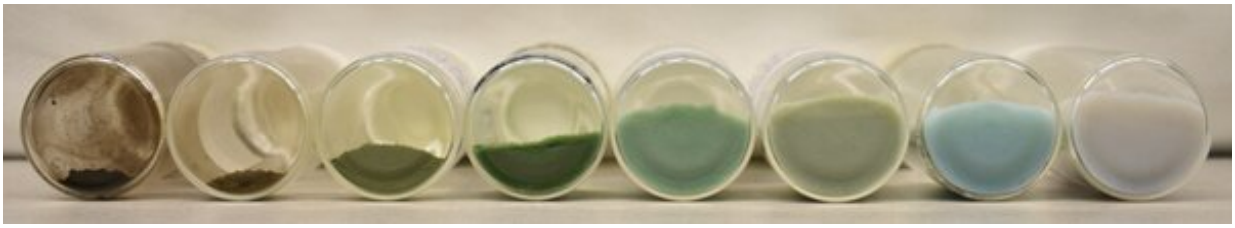
The nanoparticles in mRNA vaccines are not the first nanoparticles used for health applications. For instance, co-author Sylvie Ouellette is currently synthesizing lipid nanodiscs in her lab. This consists of breaking down the lipid layer of *E. coli* bacteria into small pieces, to study the proteins it contains as if they were still in their natural environment. Since these proteins are involved in antibiotic resistance, lipid nanodiscs are an important tool in the fight against infection.

Sylvie has also studied gold nanoparticles to assess their usefulness in diagnosing and treating cancer and other health conditions.

Nanoparticles have been used for centuries. In fourth century China, nanoparticles were made via flame and used as inks.

Gold nanoparticles have been at the core of Ayurveda, a traditional Indian healing practice, for thousands of years. Although the jury is still out as to whether these gold nanoparticles in and of themselves confer healing properties, the method by which they are synthesized has paved

the way for their use in modern medicine. They are now studied as a vehicle to target medically active compounds to tissue or cells involved in various diseases such as cancer.



Different coloured copper oxide quantum dots from Keroles's lab. Credit: Andrew Kingsley Jeyaraj

How small is a nanometer?

"Nano" comes from a Greek word meaning "dwarf." In essence, it means "very small." A nanometer is 70,000 times smaller than the thickness of a human hair. A nanoparticle is anything that is so small that its size ranges from one to a few hundred nanometers. If you cut a block of wood to pieces that are about 0.0000001 centimeters (one nanometer), you will have made nanoparticles.

Nanoparticles can be made out of almost anything, from metals to fat. They can form naturally or inadvertently, and can also be synthesized in research or industrial laboratories.

Perhaps one of the most common nanoparticles today is carbon black, which is used to reinforce our car tires and improve their wear resistance, constituting a US$17.5 billion dollar industry in 2018. We paint the walls in our homes with titanium white nanoparticles. The pills

we swallow to treat our headaches or serious illnesses are usually coated with silica or titanium nanoparticles.

More recently, several brands of anti-aging creams have boasted higher efficacy thanks to their active compounds being contained in liposomes—the same type of nano-sized fat particles that are at the core of the mRNA COVID vaccines.

Given the broad incidence and wide variety of nanoparticles, there are also some that are not beneficial. For example, the nano-sized soot particles from cigarettes that smokers inhale are very harmful to the lungs.

Other types of soot nanoparticles enter the atmosphere when planes and cargo ships burn fuel, where they are the third major contributor to the climate crisis. However, unlike other greenhouse gases, soot's stay in the atmosphere is only a few weeks long (compared to a hundred years in the case of carbon dioxide). That means that if we were to stop emitting soot today, the benefits would be immediate.

Small is good when used beneficially, but nanoparticles can sometimes trigger fear or mistrust. Just like the conversations we've had with our own families, helping people understand how nanoparticles are part of our everyday lives may help dissolve some of those fears.

Provided by The Conversation