Speeding COVID-19 Drug Discovery with Quantum Dots

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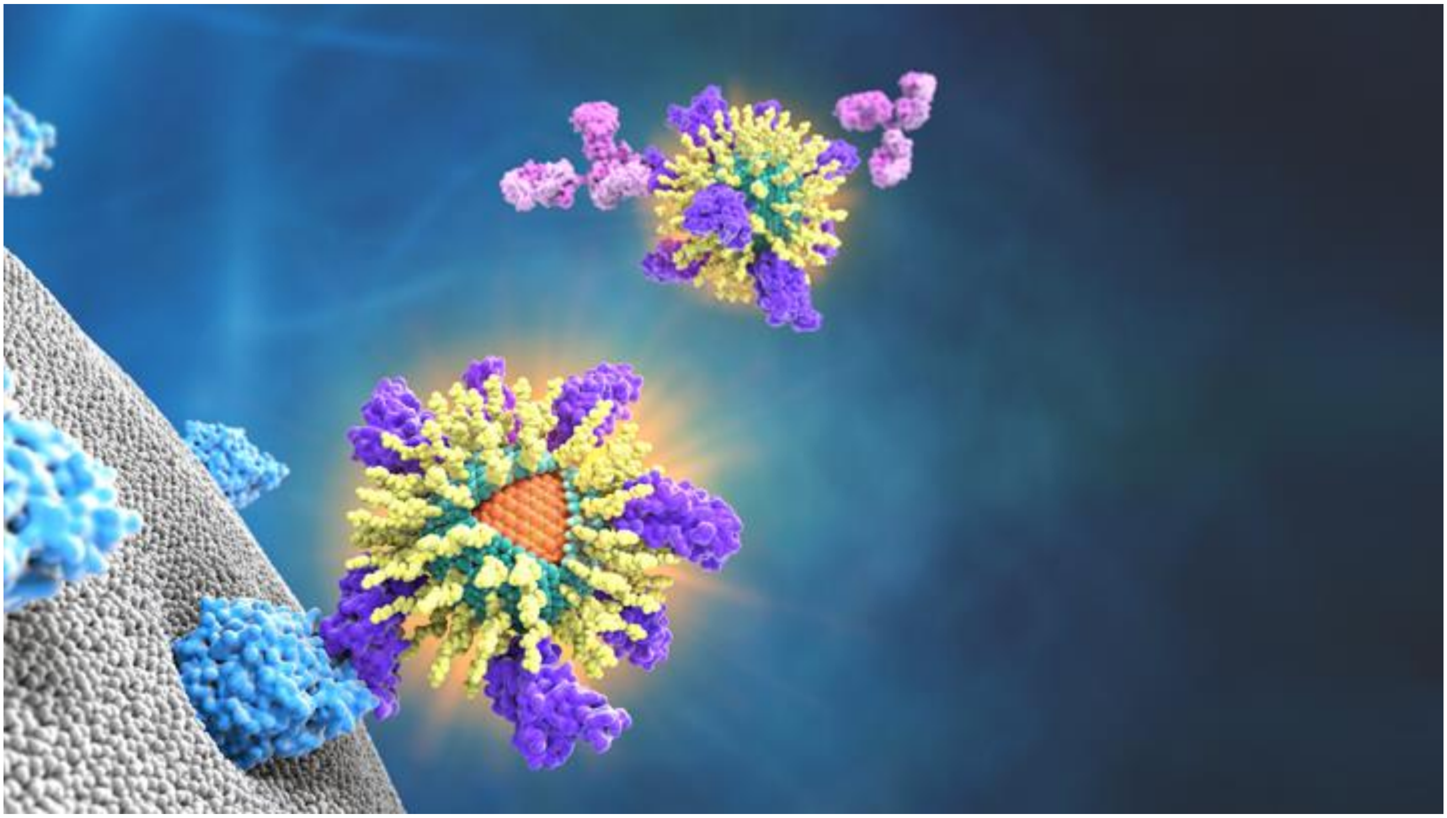

Credit: Ethan Tyler and Alan Hoofring/NIH Medical Arts

These round, multi-colored orbs in the illustration above may resemble SARS-CoV-2, the coronavirus responsible for COVID-19. But they're actually lab-made nanocrystals called quantum dots. They have been specially engineered to look and, in some ways, act like the coronavirus while helping to solve a real challenge for many labs that would like to study SARS-CoV-2.

Quantum dots, which have been around since the mid-1980s, are designed with special optical properties that allow them to fluoresce when exposed to ultraviolet light. The two pictured here are about 10 nanometers in diameter, about 3,000 times smaller than the width of a human hair. The quantum dot consists of a semi-conductive cadmium selenide inner core (orange) surrounded by a zinc sulfide outer shell (teal). Molecules on its surface (yellow) allow researchers to attach the viral spike protein (purple), which SARS-CoV-2 depends on to infect human cells.

To the left is a human cell (gray) studded with the ACE2 receptors (blue) that those viral spike proteins bind to before SARS-CoV-2 enters and infects our cells. In the background, you see another spike protein-studded quantum dot. But human neutralizing antibodies (pink) are preventing that one from reaching the human cell.

Because SARS-CoV-2 is so highly infectious, basic researchers without access to specially designed biosafety facilities may be limited in their ability to study the virus. But these harmless quantum dots offer a safe workaround. While the quantum dots may bind and enter human cells just like the virus, they can't cause an infection. They offer a quick, informative way to assess the potential of antibodies or other compounds to prevent the coronavirus from binding to our cells.

In work published in the journal *ACS Nano*, a team that included Kirill Gorshkov, NIH's National Center for Advancing Translational Sciences (NCATS), Rockville, MD, along with Eunkeu Oh and Mason Wolak, Naval Research Laboratory, Washington, D.C., demonstrated how these quantum dots may serve as a useful new tool to speed the search for new COVID-19 treatments. The dots' fluorescent glow enabled the researchers to use a microscope to observe how these viral mimics bind to ACE2 in real time, showing how SARS-CoV-2 might attach to and enter our cells, and suggesting ways to intervene.

Indeed, imagine thousands of tiny wells in which human cells are growing. Imagine adding a different candidate drug to each well; then imagine adding the loaded quantum dots to each well and using machine vision to identify the wells where the dots could not enter the cell. That's not science fiction. That's now.

With slightly different versions of their quantum dots, the NCATS researchers and their colleagues at the Naval Research Laboratory will now explore how other viral proteins are important for the coronavirus to infect our cells. They also can test how slight variations in the spike protein may influence SARS-CoV-2's behavior. This work provides yet another stunning example of how scientists with widely varying expertise have banded together—using all the tools at their disposal—to forge ahead to find solutions to COVID-19.

Reference:

[1] Quantum dot-conjugated SARS-CoV-2 spike pseudo-virions enable tracking of angiotensin converting enzyme 2 binding and endocytosis. Gorshkov K, Susumu K, Chen J, Xu M, Pradhan M, Zhu W, Hu X, Breger JC, Wolak M, Oh E. ACS Nano. 2020 Sep 22;14(9):12234-12247.

Links:

What are Quantum Dots ? (National Institute of Biomedical Imaging and Bioengineering/NIH)

Coronavirus (COVID-19) (NIH)

I Am Translational Science: Kirill Gorshkov (National Center for Advancing Translational Sciences/NIH)

U. S. Naval Research Laboratory (Washington, D.C.)

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