Editorial

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Editorial Note on Nanotechnology versus Coronavirus

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Editorial

It is time for the nanotechnology community to shine in the face of the coronavirus pandemic and draw upon its expertise with Nano scale materials and drug delivery to provide information and resources for the development of COVID-19 vaccines and therapeutics.

Although many parts of the world remain in lockdown and universities are closed, over the last few months, numerous nanotechnology research laboratories have remained open to channel their efforts towards the production of a COVID-19 therapeutic vaccine and/or Nano formulations. Excellence in nucleic acid and drug delivery, Nano vaccines for cancer, immunoengineering, sensors based on nanotechnology and platform technologies puts nanotechnology in a unique position to tackle some of the main issues in pre-clinical and clinical COVID-19 study. After all, viruses are naturally occurring nanoparticles, and indeed, for a long time, the nanotechnology community has been trying to capitalize on the properties of viruses and imitate their behaviour, such as developing virus-like nanoparticles for targeted drug delivery and gene editing.

Nanotechnologists from various fields explore on going efforts in the creation of COVID-19 vaccines, the possible benefits of Nano formulations for the most promising therapeutic candidates, Nano technological instruments that can accelerate the manufacture and delivery of vaccines worldwide, and viral disinfectants and detection platforms centered on nanomaterials in this Focus problem.

The most promising approach for mitigating the spread of the SARS-CoV-2 coronavirus is vaccines. In all aspects of the design, delivery and administration of vaccines, nanomaterials play a significant role. Nanoparticles enable the presentation and stabilization of antigens by multivalent antigen upon administration and can serve as adjuvants to improve the immune response, And for the targeted distribution of antigens, they may serve as carriers. Indeed, among the candidates currently in clinical trials against SARS-CoV-2 is the mRNA vaccine provided by a liposomal nanoparticle. While no mRNA or DNA remains a reality, The vaccine is currently approved for any disease, nucleic acid delivery involves some form of modification or Nano device to avoid degradation in the body, and liposomal devices have already been approved for the delivery of RNA, but not yet for vaccines. In recent years, the nanotechnology community has also acquired immense knowledge of the production of cancer Nano vaccines to improve and/or reprogram host immunity, which can now provide a strong starting point for SARS-CoV-2 immune-mediated approaches.

Importantly, in resource-poor or densely populated developing countries, nanomaterial-based platform technologies can also play a key role in the distribution and administration of vaccines by enabling self-administration through, for example, micro needle patches, single-dose slow-release implants, Documentary vaccines, or by using antigen-delivering plant viral nanoparticles, which do not require cold chains. Such self-administration technologies can prove to be extremely useful in a global pandemic in which healthcare systems operate at the edge. By introducing alternative processing platforms, such as molecular farming in plants, the specifications of the cold chain can also be circumvented. Vaccines are also manufactured in edible leaf tissue to vaccinate humans and livestock.

From a clinical point of view, due to a lack of new therapeutic treatments against COVID-19, the repurposing of existing medicines is currently at the centre of study. Just a few drugs have shown efficacy against COVID-19 in clinical trials so far. In a clinical trial, the anti-inflammatory corticosteroid dexamethasone was recently shown to have life-saving efficacy. Dexamethasone has been previously developed for the treatment of other diseases as a Nano medicine; liposomal dexamethasone, for example, has shown effectiveness in multiple myeloma. In the case of COVID-19, the formulation of Nano medicine can enable the targeting after intravenous administration of alveolar macrophages upon pulmonary delivery or of phagocytes at inflammation sites. In addition, by reformulating it as a Nano medicine, the anti-fibrotic effects of dexamethasone can be potentiated. Of course, the point can be made that a Nano formulation will make the

procedure much more costly (not even talking about the need for additional clinical trials); However, if such Nano formulation improves health outcomes and thereby encourages critically ill patients to leave the intensive care unit sooner, it could be well worth the expense of reducing hospitalization and quicker recovery of patients.

The lack of time is a key explanation for the on going drug repurposing and fast-tracking of preclinical and clinical testing of COVID-19 vaccine formulations. It typically takes years for the development, clinical testing and approval of new drugs. It will therefore be necessary to invest scientifically and financially in platform technology in the future, which can then be easily repurposed on demand, in order to be better prepared for future outbreaks, a lesson learned (hopefully) from the current pandemic. Such platform technologies are provided by Nano devices and Nano formulations, and an in-depth analysis of their fundamental science and biological interactions would be of great benefit for the future production of vaccines and therapeutics.

The nanotechnology group has joined together in the face of the SARS-CoV-2 pandemic, supplying the COVID-19 research efforts with its resources and expertise. The clinical effect of nanotechnology has been criticized, but the time has now come to highlight the expertise and previous experience of nanotechnologists in the production, delivery and distribution of vaccines and drugs. In order to further open the way for the clinical translation of nanotechnology, the current research activities and partnerships with clinics and industry will hopefully have an impact on the future of our profession. Although lockdowns are beginning to be eased, however, let us not forget that a vaccine may still be far from clinical reality and that the journey from preclinical testing to clinical effectiveness may be long and bumpy, a truth well established to the nanotechnology community.