

Editorial

Nanotechnology for making a paradigm shift in COVID-19 vaccine

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The boon of biomedical research is vaccine. Vaccine is an economical means of protecting people's life from infectious diseases. The vaccines must be safe, stable and effective in developing required level of immunity for a long period of time with minimum doses¹. Many approaches have been applied in developing vaccines for COVID-19, which are as follows.

- Attenuated virus devoid of virulence with sufficient antigenicity.
- Vaccines containing parts of protein or protein shell, simulating COVID-19 virus, and producing immune response safely.
- Viral vector vaccines, work as a stage for protein synthesis of coronavirus mediating immune response safely.
- RNA and DNA vaccines, genetically engineered nucleic acids, which synthesizes protein mediating quick immune response safely.

RNA and DNA vaccines are capable of developing immunity against specific pathogen with less chance of infection economically. Many challenge lies in delivering them to the site of action along with other immunogens as a part of vaccination regimen.

They are like untimely destruction of molecules and failure in converting into working immunogen². Protein containing vaccines are effective against infectious caused by Haemophilus influenza type b, diphtheria, tetanus, acellular pertussis, meningococcus and pneumococcus³ but need adjuvant to fortify their immunogenicity, and suffer from early destruction. The aforementioned drawbacks can be encountered with the use of effective delivery system, that can deliver the vaccine at the target site along with adjuvant if needed, protecting it from the degradation in hostile environment. The delivery system should produce lingering immunogenic effect without any side effects. Nano delivery systems could fulfill the above requirements and can exhibit sustained release of the vaccine molecules without getting harmed by proteases. Surface adsorption enables cognate surface receptor interaction⁴. Using nanocarriers for vaccine molecules enhances cellular uptake leading to potentiation of innate, humoral, cellular and mucosal immune responses⁵. Currently approved Covid-19 vaccine for use are given in table 1.

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Table 1 Approved list of COVID-19 vaccine (Jan et al, 2021)

Manufacturer	Vaccine	Type	Number of dose	Time interval	Efficiency %
Pfizer	BNT162b2	mRNA	2	21 days	95
Moderna	COVID-19 Vaccine	mRNA	2	28 days	94.1
AstraZeneca/SKBio	ChAdOx1-S [recombinant]	Chimpanzee adenovirus	2	12 weeks	82
Serum Institute of India Pvt Ltd	ChAdOx1-S [recombinant]	Chimpanzee adenovirus	2	12 weeks	82
Johnson & Johnson	Ad26	adenovirus	-	-	66
Gamaleya National Research Centre for Epidemiology and Microbiology	(Gam-COVID- Vac)	Heterologous recombinant adenovirus	-	-	91.6
Beijing Institute of Biotechnology	CanSinoBIO Ad5	Adenovirus	-	-	90.07

Nanoparticle vaccine are effective, safe and easy to prepare. Attenuated virus vaccine are more effective in comparison to vaccines containing parts of virus but has a lengthy production time, needs storage at subzero temperature and has the risk of side effects. Nucleic acid(RNA and DNA) containing vaccines are quick to produce but costly and may need more than one dose. There are reports about the successful immune response of nanoparticle vaccines for COVID-19 in mice following a single dose. The researcher are making efforts to ease its storage condition by preparing them in freeze-dried form, which will facilitates its transport⁶.

Nanoparticles of spikes

SARS-CoV-2, spike protein is bigger in size, researchers are attempting to condense it which will be easy and convenient to use. The vaccine has been prepared by combining condensed spike with ferritin nanoparticles tested before in humans.

Researchers have tested the condensed spike nanoparticles along with another four candidates

nanoparticles containing full spike, full or part spikes, part of the spike binding to cells during infection in the mouse.

Solo dose of two nanoparticle vaccines produced antibodies double of that seen in COVID-19 infected people, the condensed spike nanoparticle vaccine shown a significantly greater neutralizing reaction in contrast to the binding spike or the full spike containing vaccines. Following the subsequent dose, mice that got the condensed spike nanoparticle vaccine had the utmost levels of neutralizing antibodies⁷.

COVID-19 rising to unprecedented levels^{8, 9, 10}, preparation of nanoparticle vaccine can offer many solutions to overcome the associated problems of currently approved COVID-19 vaccine.

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