under preclinical trials (297). Similarly, the WHO,

on its official website, has mentioned a detailed list

of COVID-19 vaccine agents that are under

consideration. Different phases of trials are ongoing

for live attenuated virus vaccines, formaldehyde

alum inactivated vaccine, adenovirus type 5 vector

vaccine, LNP-encapsulated mRNA vaccine, DNA

plasmid vaccine, and S protein, S-trimer, and li-Key

peptide as a subunit protein vaccine, among others

(298). The process of vaccine development usually

takes approximately ten years, in the case of

inactivated or live attenuated vaccines, since it

involves the generation of long-term efficacy data.

However, this was brought down to 5 years during

the Ebola emergency for viral vector vaccines. In the

urgency associated with the COVID-19 outbreaks,

we expect a vaccine by the end of this year (343).

The development of an effective vaccine against

COVID-19 with high speed and precision is the

combined result of advancements in computational

biology, gene synthesis, protein engineering, and the

invention of advanced manufacturing platforms

(342).

The recurring nature of the coronavirus outbreaks

calls for the development of a pan-coronavirus

vaccine that can produce cross-reactive antibodies.