

A microscopic view of several cells with prominent nuclei and cytoplasm, rendered in a blue color scheme. The cells are interconnected by thin filaments, suggesting a network or tissue structure. The background is dark, making the blue cells stand out.

COVID-19 vaccines

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introduction

The COVID-19 pandemic has infected millions of people with no clear signs of abatement owing to the high prevalence, long incubation period and lack of established treatments or vaccines.(1)

Although physical distancing, quarantine, and isolation were effective in limiting the number of people becoming infected during the pandemic in the short term, the absence of immunity in the population leave them susceptible to further waves of SARS-CoV-2 infection.

Consensus among experts is that only an effective COVID-19 vaccine will end the pandemic , various vaccine platforms and strategies in parallel is essential because little is known of the nature of protective immune responses to COVID-19 and which vaccine strategies will be most successful is unclear.(4)

Since much of the pathology of COVID-10 is outside the airway due to systemic viral infection, a vaccine that elicits IgG antibodies could protect patients from systemic circulation of the virus, IgG antibodies opsonize the targeted antigens presenting the opsonized products to phagocytes while also activating the complement system.(5)

Another hallmark of vaccine development is T-cell involvement, and differences in T-cell responses can influence generation of high affinity and neutralizing antibodies (NABs) as well as elimination of infected cells, immune memory and generation of high affinity class-switched antibodies are highly dependent on T-cells and normally do not develop without proper T-cell involvement.(6)

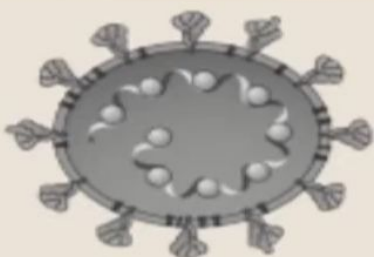
There are over a hundred vaccines being developed throughout the world, and the race to be the first effective vaccine has fueled the rapid development of both preclinical and currently utilized vaccine approaches.(7)

Company	Vaccine Type	Vaccine Name	Vaccine Description	Contemporary /Unestablished Vaccine
Moderna	mRNA	mRNA-1273	mRNA vaccine encoding for the prefusion form of the S antigen that includes a transmembrane anchor and an intact S1-S2 cleavage site. Two proline substitutions keep protein stable in its prefusion form. Encapsulated within an LNP.	Unestablished
BioNTech, Pfizer	mRNA	BNT162b1	mRNA vaccine encoding for the RBD of the S1 protein. Single nucleoside incorporations of 1-methyl-pseudouridine. RBD antigen contains a T4 fibrin- derived "foldon" trimerization domain. Encapsulated within an LNP.	Unestablished
University of Oxford, AstraZeneca	Non-replicating viral vector	AZD1222	Ad derived from chimpanzee with E1 and E3 deletions encoding for the full-length S protein with a tissue plasminogen activator signal peptide	Unestablished
CanSino Biologics	Non-replicating viral vector	Ad5-nCoV	Ad5 with E1 and E3 deletions encoding for the full-length S protein. Gene was derived from the Wuhan-Hu-1 sequence for SARS-CoV2 and contains a tissue plasminogen activator signal peptide	Unestablished
Inovio Pharmaceuticals	DNA	INO-4800	Optimized DNA plasmid-based vaccine administered intradermally using a CELLECTRA® 2000 device encoding for the full-length S protein of SARS-CoV-2	Unestablished
Sinovac Biotech Ltd.	Inactivated	Coronavac	Formalin-inactivated whole virus particles	Contemporary
Sinopharm	Inactivated	N/A	Inactivated vaccine of SARS-CoV-2	Contemporary
Gamaleya Research Institute	Non-replicating viral vector	Gam-Covid-Vac Lyo or Sputnik-V	Adenovirus based vaccine combining two adenoviruses: Ad5 and Ad26	Unestablished
Anhui Zhifei Biological Products, Institute of Microbiology of the Chinese Academy of Sciences	Subunit	N/A	RBD-dimer recombinant subunit vaccine administered with adjuvant	Unestablished
Novavax	Subunit	NVX-CoV2373	Stable, pre-fusion, full-length S protein made from Novavax's proprietary VLP nanoparticle technology given with Novavax's proprietary saponin-based adjuvant, Matrix-M™	Unestablished
Vaxine	Subunit	Covax-19	Used computer modeling and cloud computing techniques to develop vaccine of S subunit that blocks the S from binding to the ACE-2 receptor <i>in vivo</i> and administered with Advax™ adjuvant	Unestablished
Zydus Cadila	DNA	ZYCoV-D	DNA plasmid vaccine	Unestablished
Institute of Medical Biology, Chinese Academy of Medical Sciences	Inactivated	N/A	Inactivated vaccine	Contemporary

Classical platforms

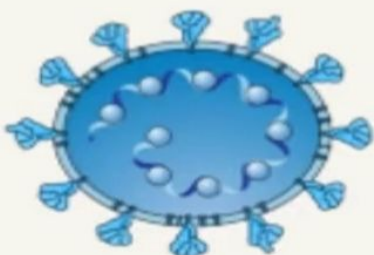
Whole-inactivated virus

Example: Polio vaccine
COVID-19:
PiCoVaoc in phase 1
clinical trials



Live-attenuated virus

Example: MMR vaccine
COVID-19:
in preclinical stage



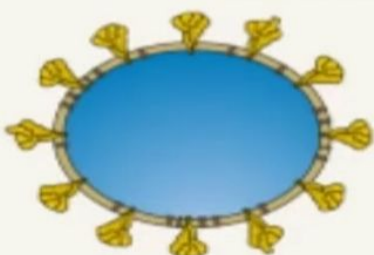
Protein subunit

Example: Seasonal
influenza vaccine
COVID-19:
NVX-CoV2373 in
phase 1/2 clinical trials



Virus-like particle

Example: Human
papillomavirus vaccine
COVID-19:
in preclinical stage



Next-generation platforms

Viral vector

Example:
VSV-Ebola vaccine
COVID-19:
AZD1222, Ad5-nCoV
in phase 1/2/3 clinical trials



DNA

Example:
Not currently licensed
COVID-19:
INO-4800 in phase 1
clinical trials



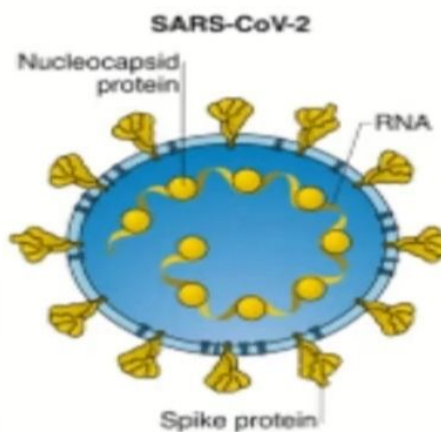
RNA

Example:
Not currently licensed
COVID-19:
mRNA-1273, BNT162
in phase 1/2 clinical trials



Antigen-presenting cells

Example:
Not currently licensed
COVID-19:
LV-SMENP-DC,
COVID-19/aAPC
in phase 1/2 clinical trials



Inactivated SARS-CoV-2 vaccine (Corona Vac)

CoronaVac (Sinovac Life Sciences, Beijing, China) is an inactivated vaccine candidate against COVID-19 that has shown good immunogenicity in mice, rats, and non-human primates with vaccine-induced neutralising antibodies to SARS-CoV-2, which could neutralise ten representative strains of SARS-CoV-2.

Moreover, the results indicated CoronaVac provided partial or complete protection in macaques from severe interstitial pneumonia after a SARS-CoV-2 challenge, without observable antibody-dependent enhancement of infection, which support progression to clinical trials in humans.(8)

