

# The Science Behind Leading COVID-19 Vaccine Candidates

Indian Country COVID-19 ECHO Presentation

September 23, 2020

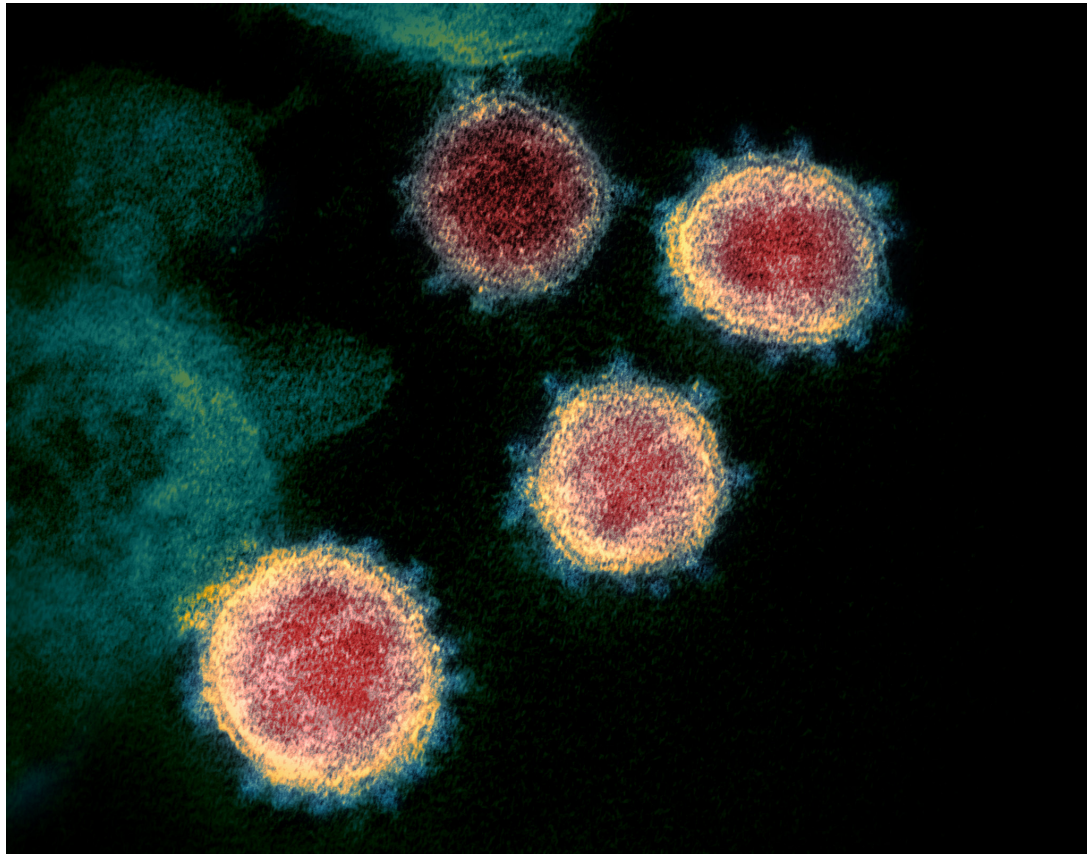
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# Day 197 of the COVID-19 Pandemic



- Review of immunology and vaccine science
- New (and old) vaccine technologies
- Current leading COVID-19 vaccine candidates
- Resources

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# Increased Life Expectancy in the 20<sup>th</sup> Century

- 1) Safe food and clean water
- 2) Vaccines

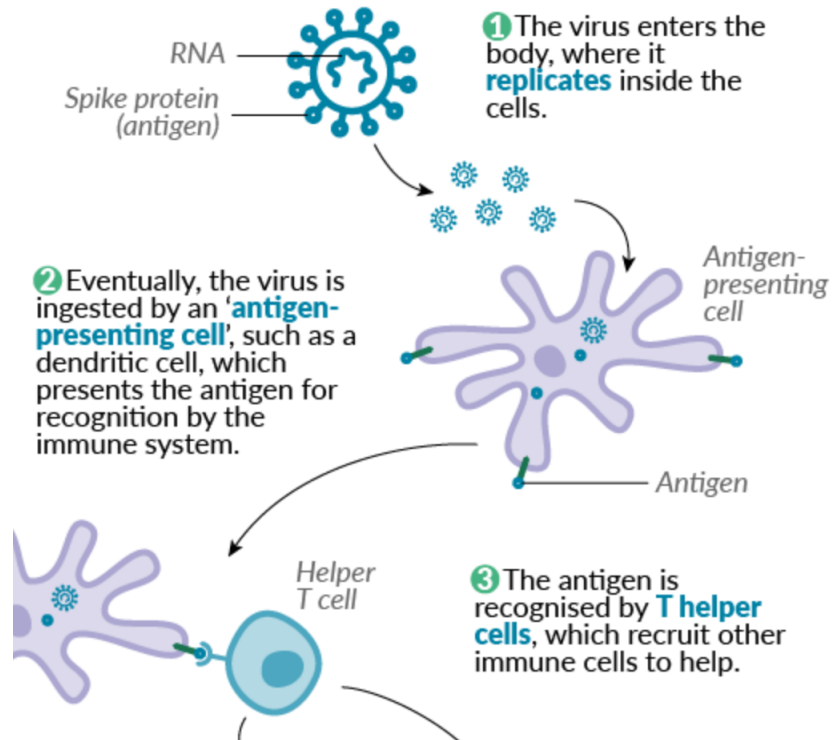
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# Immunology in Brief

## Adaptive immunity

Vaccines work based on the body's **adaptive immune response**. This simplified graphic shows the principles of the adaptive response to **SARS-CoV-2**, the virus that causes COVID-19.

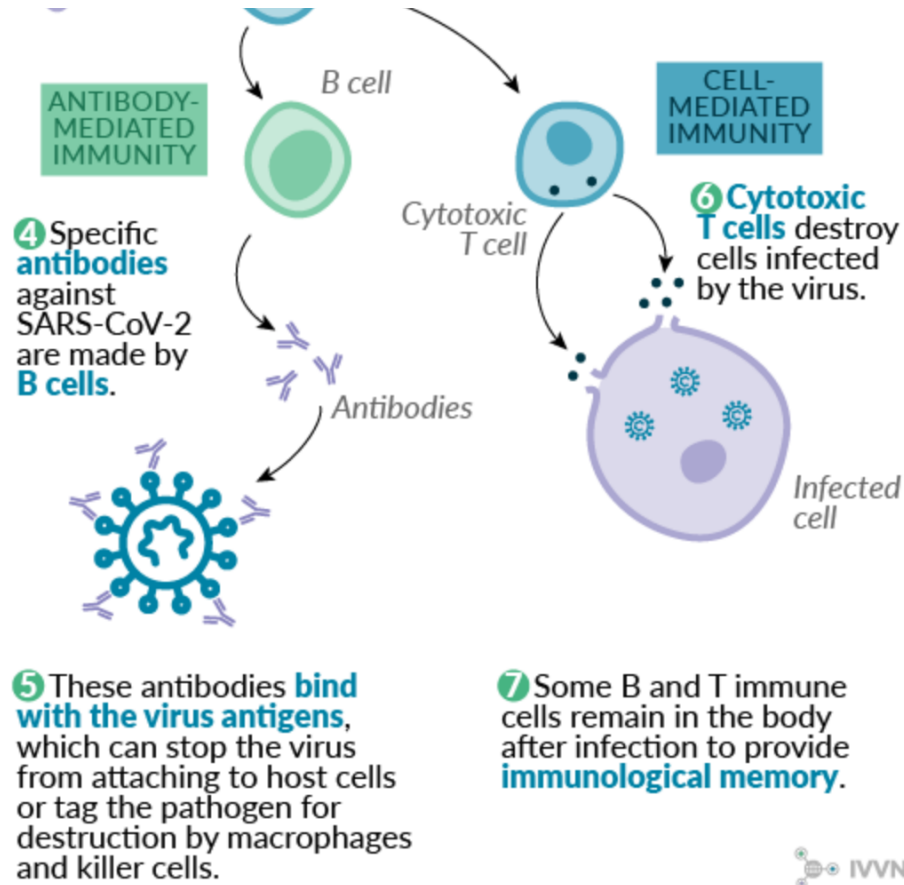


- Virus enters the body, attaches to and enters cells, and replicates
- The virus is taken up by an Antigen Presenting Cell (APC), which presents the virus for recognition by the immune system as foreign
- T helper cells recruit other immune cells

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# Immunology in a Nutshell

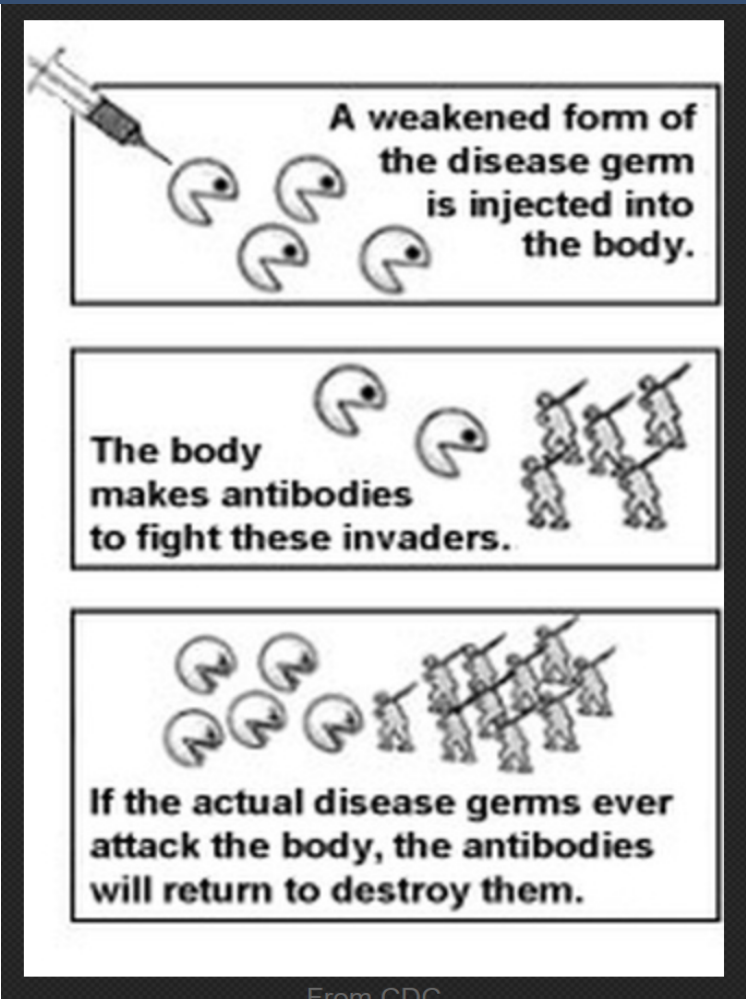


- B cells make antibodies that can bind to viral antigens
- Cytotoxic T cells recognize viral antigens and destroy cells infected by virus
- Memory cells remain to provide humoral immunity (B cells) and cellular immunity (T cells)

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# How do viral vaccines work?



- A weakened virus (“live attenuated”), or inactivated virus, or a part of a virus is made into a vaccine
- The vaccine is injected
- The immune system responds to make antibodies (and sometimes a T cell response)
- Immune memory is created



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# Desired Vaccine Characteristics

- Safe
  - No serious adverse effects
  - Minor adverse effects acceptable and expected
- Effective – produce neutralizing antibodies and T cell response
- Inexpensive
- Easy to manufacture in large quantities
- Easy to administer to large populations
- Proven efficacy in diverse populations
  - At least 50% efficacy for FDA approval

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# Current Major Vaccine Technologies

- Inactivated Virus
- Live Attenuated Virus
- Protein Subunit
- Viral Like Particle (VLP)
- Replicating Viral Vector
- Nonreplicating Viral Vector
- DNA
- RNA

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# Current Vaccine Development for COVID-19

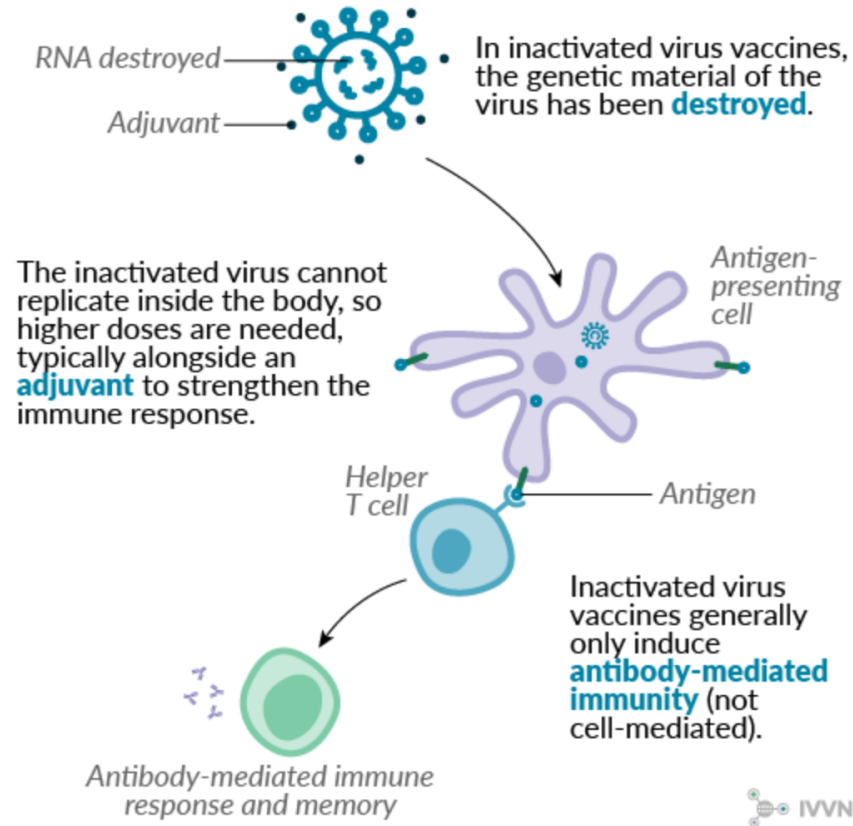
- As of September 21<sup>st</sup>, WHO listed 187 vaccine candidates
- 38 vaccine candidates in human trials
- 9 are in Phase 3:
  - 3 Inactivated Viral Vaccines
  - 4 Non-replicating Viral Vector Vaccines
  - 2 mRNA Vaccines

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# Inactivated Viral Vaccines

## Inactivated virus vaccines



- Heat or chemically treated whole virus
- Old technology
- Usually does not induce cellular immunity
- Requires multiple doses and adjuvants for good immune response

<https://www.intvetvacnet.co.uk/blog/covid-19/vaccine-eight-types-being-tested>

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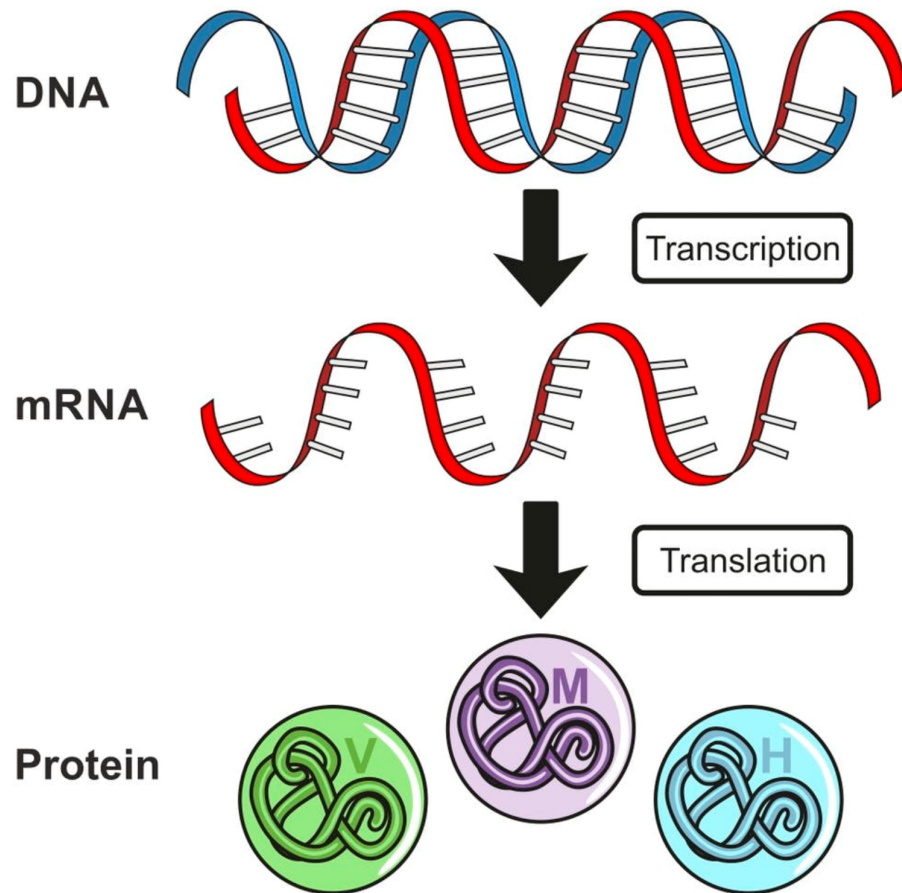
# COVID-19 Inactivated Vaccine Candidates

- Sinovac (*CoronaVac*)
- Sinopharm/ Wuhan Institute of Biological Products
- Sinopharm/ Beijing Institute of Biological Products
  
- 12 more candidates in Phase 1 or 2 trials

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# Review of Genetics



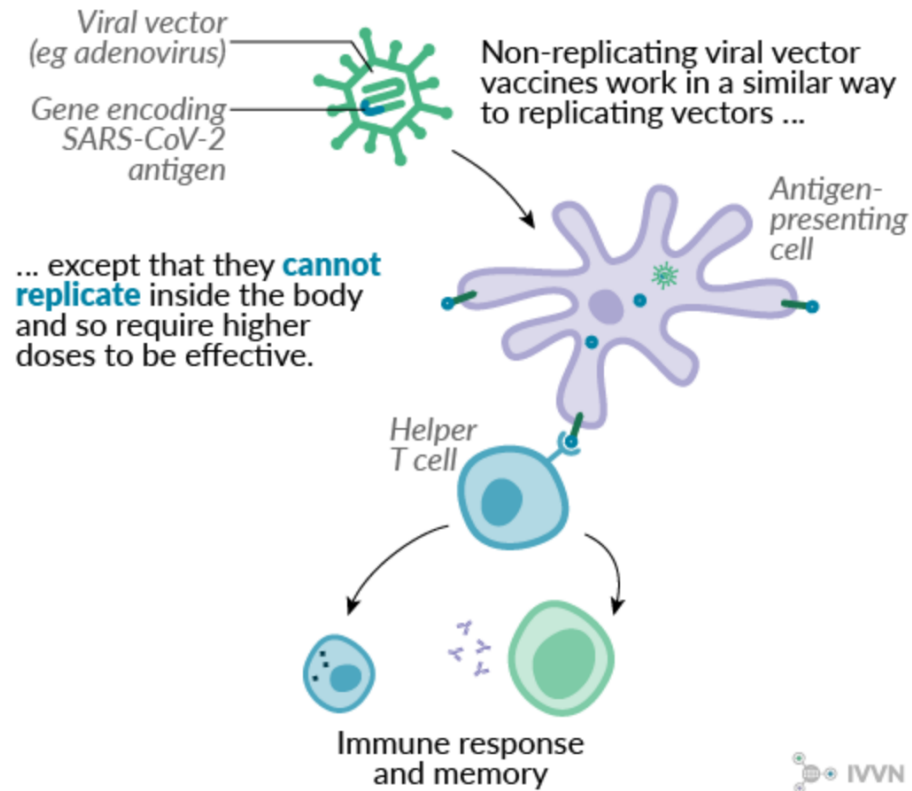
- In cellular organisms, the genetic code is carried in DNA
- DNA is **transcribed** into mRNA
- mRNA is then **translated** in the ribosomes to make proteins
  
- Viruses are much more genetically diverse!

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# Non-replicating Viral Vector Vaccine

## Viral vector vaccines (non-replicating)



- The vector virus is genetically modified to carry a gene for a SARS-CoV-2 antigen (typically the spike protein)
- Our own cells make the antigen
- The antigen provokes an immune response
- Disadvantage – previous immunity to vector?

<https://www.intvetvacnet.co.uk/blog/covid-19/vaccine-eight-types-being-tested>

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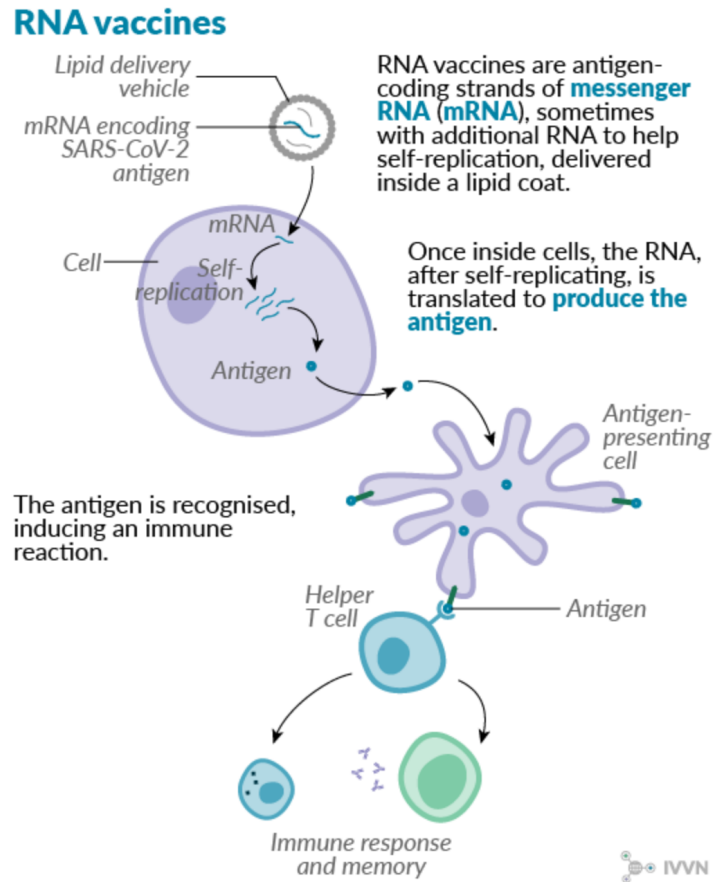
# Non-replicating Viral Vector Vaccine Candidates

- Oxford/AstraZeneca (ChAdOx1-S, or AZD1222)
- CanSino (Ad5)
- Gamaleya Research Institute (Ad5 + Ad26) – “Sputnik V”
- Janssen (Ad26)
  
- 2 more in Phase 1 or 2 trials

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# RNA Vaccines



- mRNA encoding viral antigen (spike protein) delivered to cells in lipid nanoparticles
- Inside our cells, mRNA is translated to antigen protein
- Immune system reacts to antigen
- Gives both antibody (B cell) and cellular (T cell) response

<https://www.intvetvacnet.co.uk/blog/covid-19/vaccine-eight-types-being-tested>

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# mRNA Vaccine Candidates

- Moderna/NIAID (m1273)
- Pfizer/BioNTech (BNT162)
- 4 more in Phase 1 or 2 trials

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# Closing Thoughts

- With so many potential vaccine candidates, there should be at least a few that are safe and effective
- Speed of development has been astounding
- Reason to believe that any approved vaccines will meet normal safety standards
- WHEN???

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# A Few Resources:

- Vaccine Tracking Websites:
- Milken Institute: <https://covid-19tracker.milkeninstitute.org/>
- London School of Tropical Medicine: [https://vac-lshtm.shinyapps.io/ncov\\_vaccine\\_landscape/](https://vac-lshtm.shinyapps.io/ncov_vaccine_landscape/)
- WHO: <https://www.who.int/publications/m/item/draft-landscape-of-covid-19-candidate-vaccines>
- NY Times: <https://www.nytimes.com/interactive/2020/science/coronavirus-vaccine-tracker.html>

Basic Vaccine Technology Article:

“Covid-19: the eight vaccine technologies being tested” – from the *International Veterinary Vaccinology Network*:

<https://www.intvetvacnet.co.uk/blog/covid-19/vaccine-eight-types-being-tested>

US Vaccination Distribution Framework:

<https://www.hhs.gov/sites/default/files/strategy-for-distributing-covid-19-vaccine.pdf>

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# Thank You for Your Time and Attention!

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Have a great weekend!

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