The Status of COVID-19 Vaccine Research – an Overview

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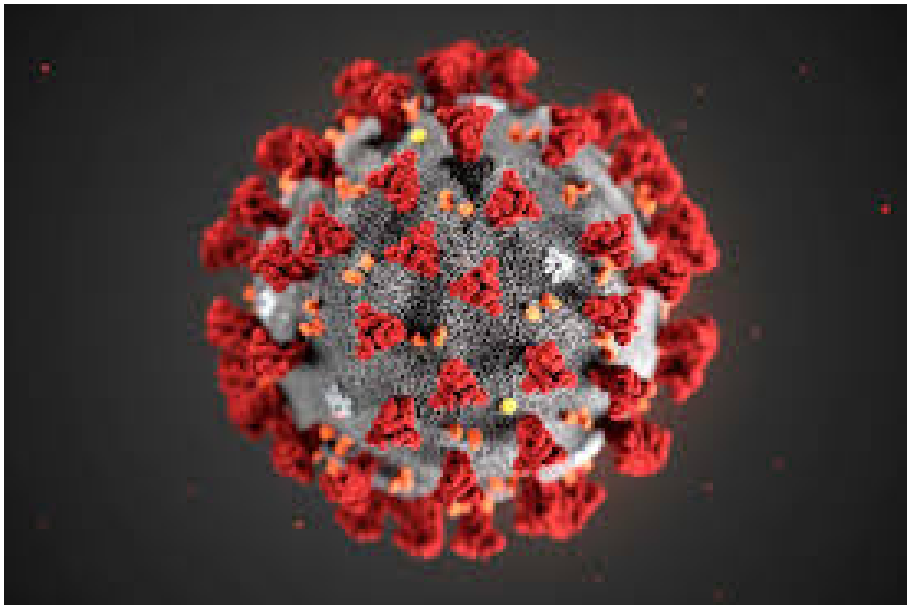

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Why do we need a vaccine?

- SARS-CoV-2 has infected >24 million people worldwide (US: >6 million [August 27, 2020])
- Global deaths: >830,000 (US >183,000 [August 27, 2020])
- Lockdown etc. is a temporary solution
- Rigorous testing, contact tracing and quarantine will help
- But there is always the risk new outbreaks emerge
- SARS-CoV-2 immunity in the human population is critical
- Herd immunity is not acceptable via natural routes- will lead to excess deaths
- **Vaccination is the way forward**

Where are we?

Coronavirus Vaccine Tracker

By Jonathan Corum, Denise Grady, Sui-Lee Wee and Carl Zimmer
Updated August 21, 2020

"Sputnik V", Russia
CanSinoBio, China

PRECLINICAL TESTING: Scientists give the vaccine to **animals**
PHASE 1 SAFETY TRIALS: Scientists give the vaccine to a **small number of people**
PHASE 2 EXPANDED TRIALS: Scientists give the vaccine to **hundreds of people** split into groups
PHASE 3 EFFICACY TRIALS: Scientists give the vaccine to **thousands of people** and wait to see how many become infected, compared with volunteers who received a placebo.
APPROVAL: Regulators in each country review the trial results and decide whether to approve the vaccine or not.

NYT, 2020

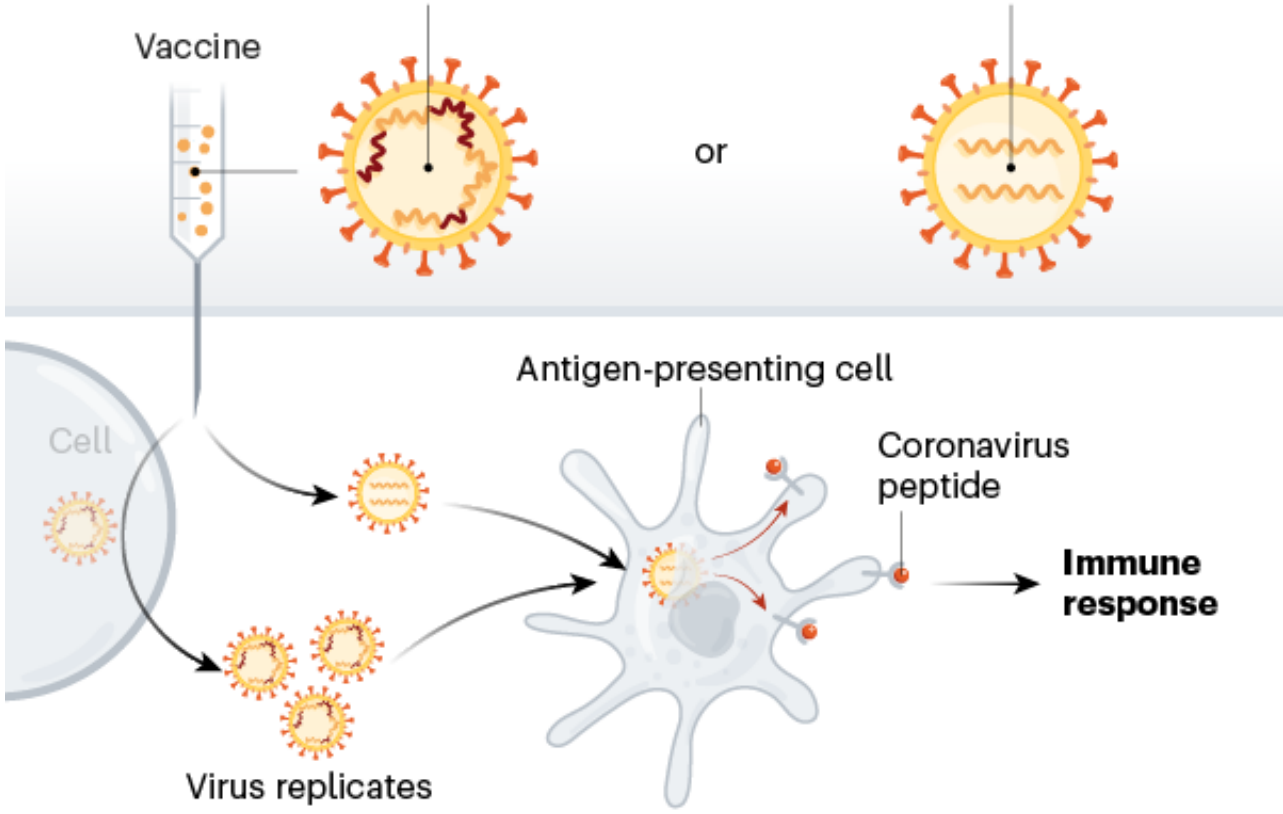
VIRUS VACCINES

Weakened virus

A virus is conventionally weakened for a vaccine by being passed through animal or human cells until it picks up mutations that make it less able to cause disease. Codagenix in Farmingdale, New York, is working with the Serum Institute of India, a vaccine manufacturer in Pune, to weaken SARS-CoV-2 by altering its genetic code so that viral proteins are produced less efficiently.

Inactivated virus

In these vaccines, the virus is rendered uninfectious using chemicals, such as formaldehyde, or heat. Making them, however, requires starting with large quantities of infectious virus.



Nature, 2020

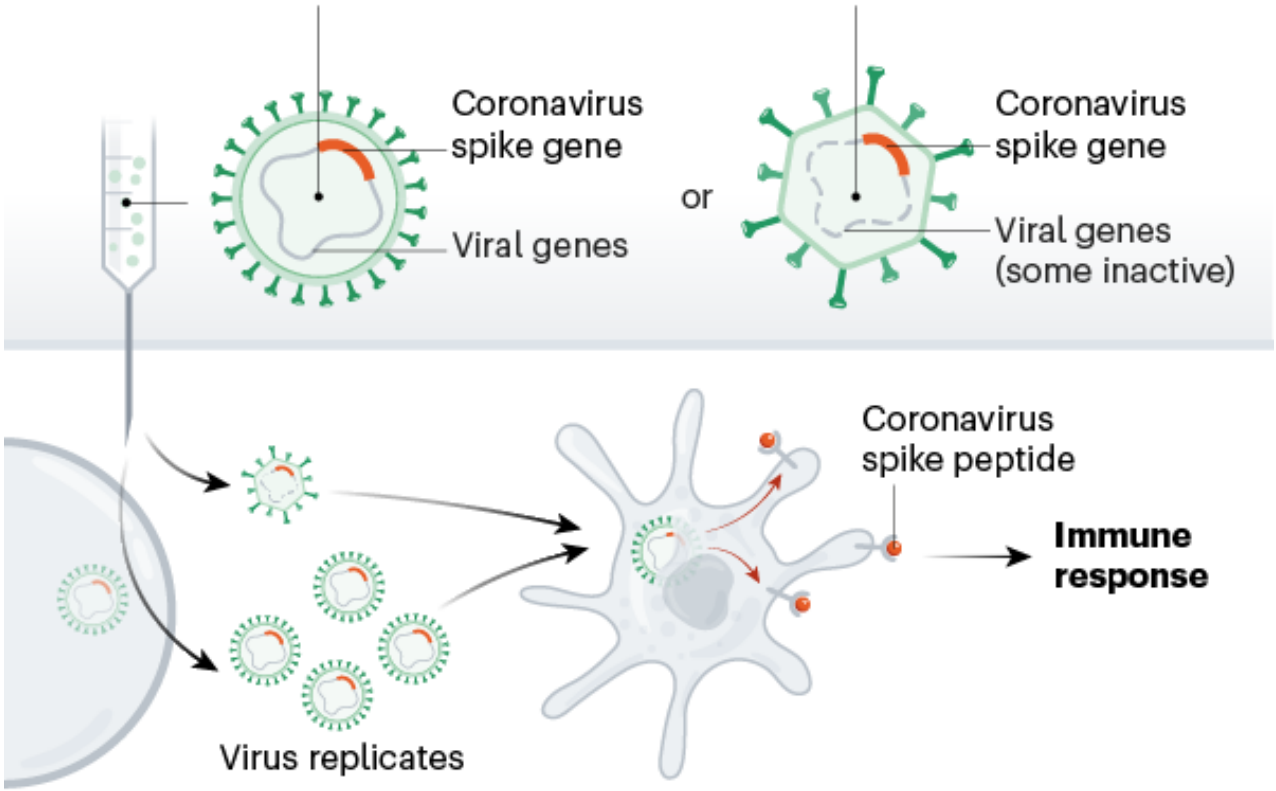
VIRAL-VECTOR VACCINES

Replicating viral vector (such as weakened measles)

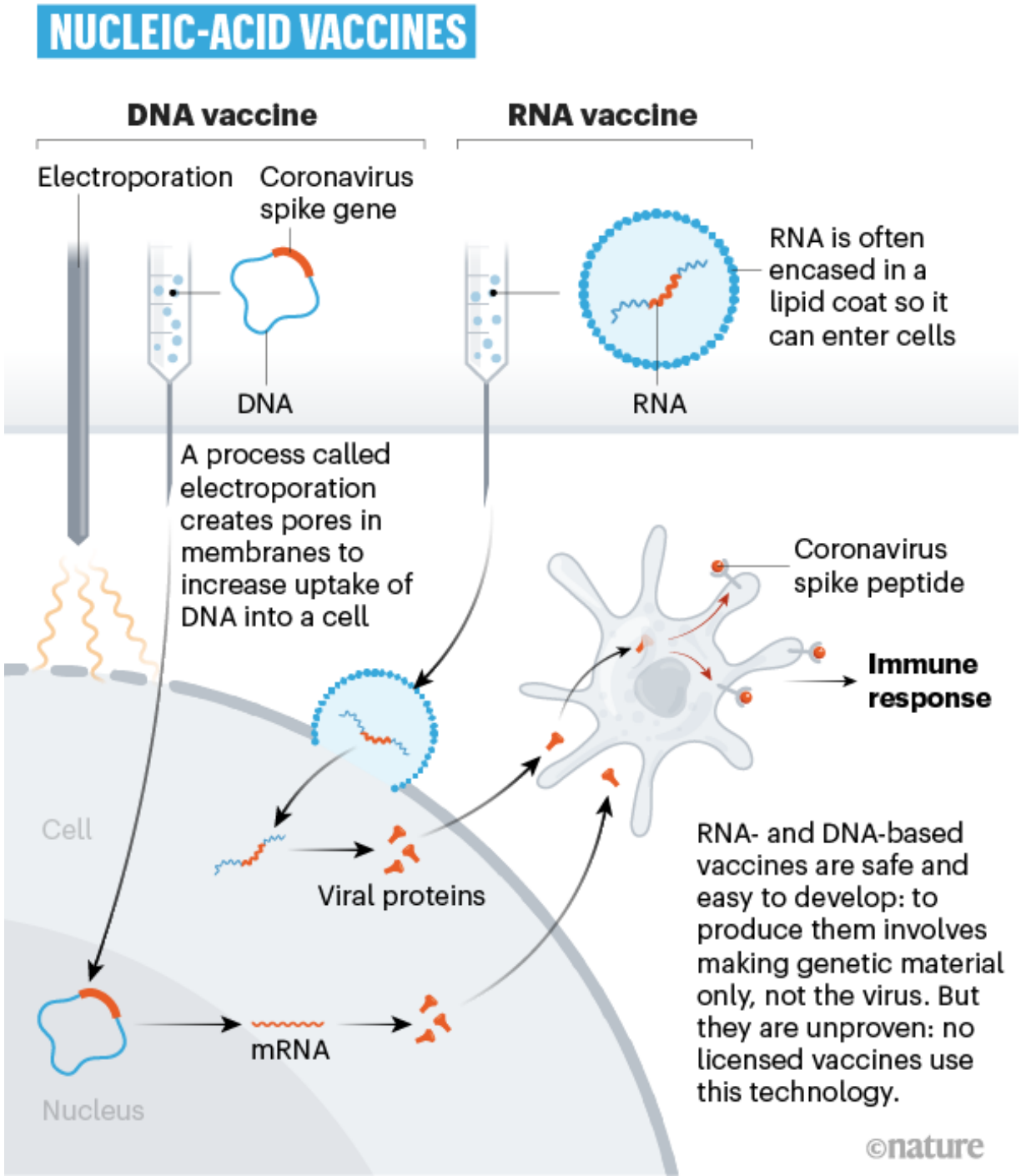
The newly approved Ebola vaccine is an example of a viral-vector vaccine that replicates within cells. Such vaccines tend to be safe and provoke a strong immune response. Existing immunity to the vector could blunt the vaccine's effectiveness, however.

Non-replicating viral vector (such as adenovirus)

No licensed vaccines use this method, but they have a long history in gene therapy. Booster shots can be needed to induce long-lasting immunity. US-based drug giant Johnson & Johnson is working on this approach.



Nature, 2020


NUCLEIC-ACID VACCINES
DNA vaccine
RNA vaccine
Electroporation
Coronavirus spike gene
DNA
RNA
RNA is often encased in a lipid coat so it can enter cells
A process called electroporation creates pores in membranes to increase uptake of DNA into a cell
Coronavirus spike peptide
Immune response
Cell
Viral proteins
mRNA
Nucleus
RNA- and DNA-based vaccines are safe and easy to develop: to produce them involves making genetic material only, not the virus. But they are unproven: no licensed vaccines use this technology.
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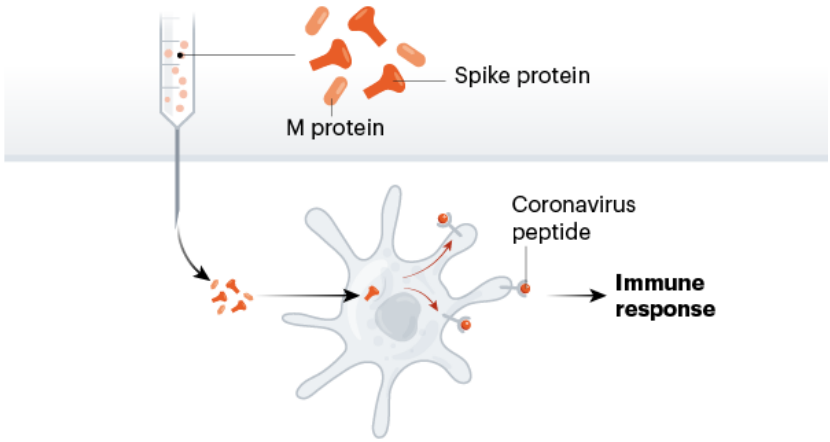
Nature, 2020

PROTEIN-BASED VACCINES

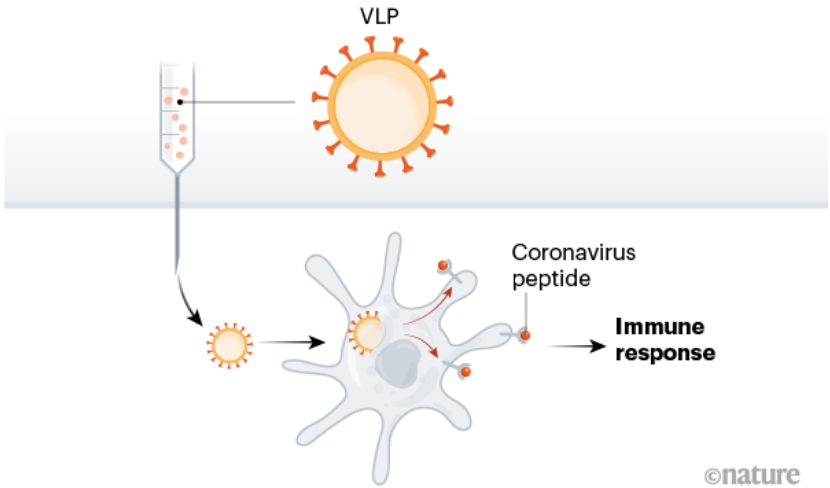
Protein subunits

Twenty-eight teams are working on vaccines with viral protein subunits — most are focusing on the virus's spike protein or a key part of it called the receptor binding domain. Similar vaccines against the SARS virus protected monkeys against infection but haven't been tested in people. To work, these vaccines might require adjuvants — immune-stimulating molecules delivered alongside the vaccine — as well as multiple doses.



Virus-like particles

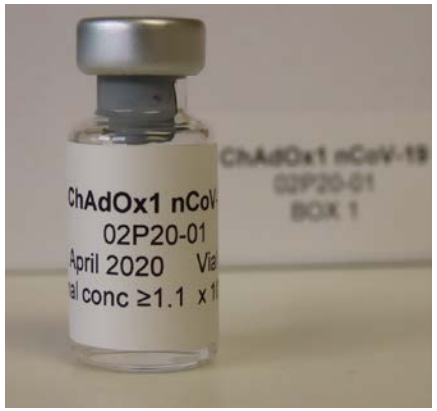
Empty virus shells mimic the coronavirus structure, but aren't infectious because they lack genetic material. Five teams are working on 'virus-like particle' (VLP) vaccines, which can trigger a strong immune response, but can be difficult to manufacture.



Nature, 2020

Conclusion

- Many vaccines in development – different stages!
- Initial data is promising
- Partially/fully protective vaccine? Long-term Immunity?
- Immune response in older/immunosuppressed individuals?
- Timeline US: 2020?



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