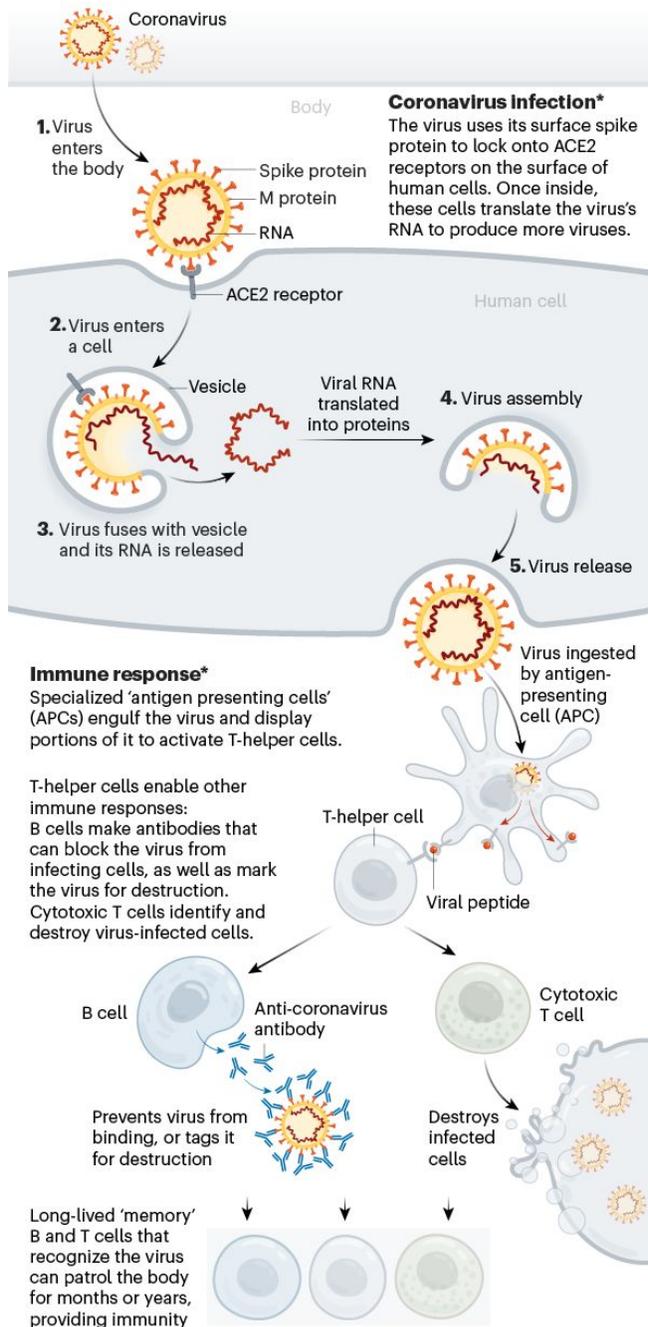


# Vaccine

## for COVID-19 (SARS-CoV-2)

### VACCINE BASICS: HOW WE DEVELOP IMMUNITY

The body's adaptive immune system can learn to recognize new, invading pathogens, such as the coronavirus SARS-CoV-2.



### BioNTech-Pfizer Vaccine

The BNT162b2 vaccine is an RNA vaccine. The vaccine works by telling our cells how to recognise and fight the distinctive spike protein of Coronavirus. It does this using much the same mechanism of introducing RNA which the virus uses, as can be seen in stages 2-4 of the diagram on the left. Crucially, the vaccine RNA encodes only the spike protein and not the full repertoire of viral genes.

### Moderna Vaccine

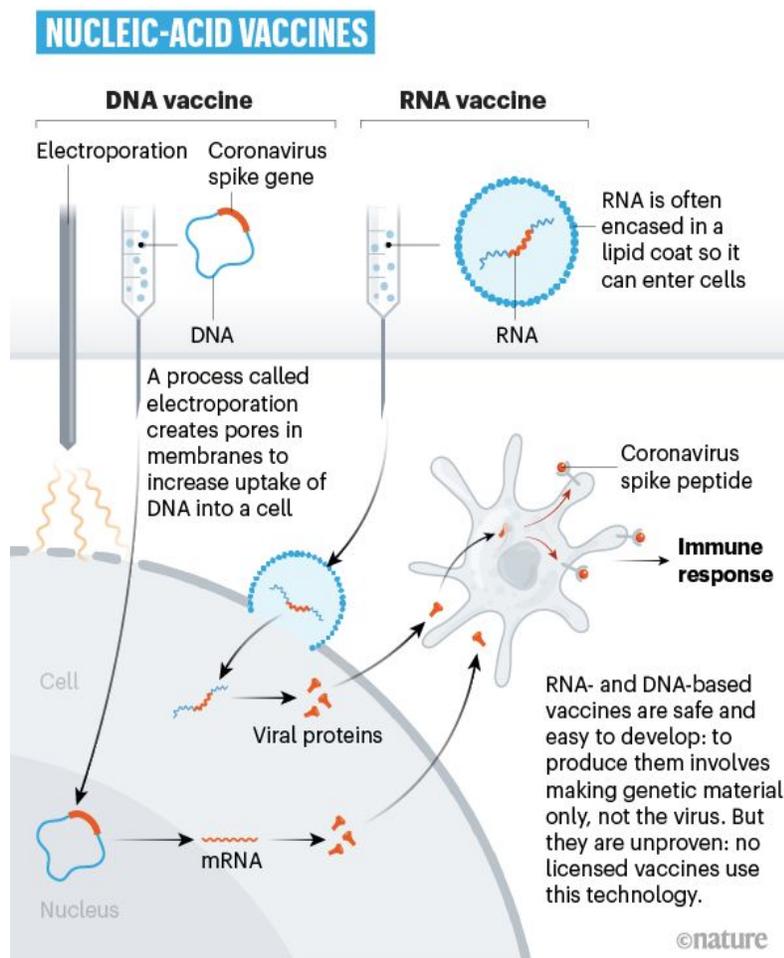
The mRNA-1273 vaccine is also an mRNA vaccine which works in the same way as the BNT162b2 vaccine. In both cases the RNA can be produced synthetically in a lab meaning that no cell lines are used.

### Oxford Vaccine

The ChAdOx1 vaccine is a modified adenoviral vector into which the gene for the spike protein of the Coronavirus has been cloned. When this vaccine is introduced, our cells produce multiple copies of the spike protein which elicits an immune response attacking and destroying infected cells. Memory cells are developed which can produce antibodies and other killer cells if an individual gets infected.

# In Detail

## BioNTech-Pfizer/ Moderna mRNA Vaccines



Usually messenger RNA (mRNA) acts as an intermediary between our DNA and protein production. The mRNAs are messages, normally produced by DNA. In this case mRNA is produced synthetically for the spike protein of the Coronavirus and introduced into the cell in a lipid droplet. The vaccine then instructs the cells' protein factories how to make the spike protein of the coronavirus which, as with the Oxford vaccine, elicits an immune response which attacks and destroys the infected cells. Memory cells are developed which can then produce antibodies and other killer cells if an individual gets infected.

Note that unlike DNA vaccines, the injected mRNA molecules will not enter the cells' nucleus or interact with the cells' DNA.

Although RNA vaccines are unproven in the sense that they are the first technology of this kind, they are comparatively easy to produce. This is done by making the RNA sequence on a computer.

Common vaccines such as the flu vaccine inject a safe virus with the distinctive viral proteins to train the immune system response. The key difference is that mRNA vaccines cause our own cells to produce the proteins, rather than injecting them.

# Cell Lines

## Ethical Issues

The practice of developing vaccines using fetal cell lines is controversial for those who oppose abortion. Alternative vaccines which do not use any fetal cell lines, even in confirmatory tests, are preferable. However, the following ethically significant facts must be highlighted:

→ No fetal tissue is used, only the very distant descendants of a sample of fetal cells, so-called 'immortal cell lines'. Cells which, for some reason, do not stop dividing, see [here](#).

→ No new abortions are being used: the HEK293/PER.C6 cells are derived from two historical abortions which took place in the 1970s and 1980s respectively. In the case of HEK293, it is *unknown* whether this was an induced abortion or a spontaneous abortion e.g. a miscarriage due to lost hospital records (hence the '?' mark status).

→ The cells are not intended to form any part of the final vaccine; they are used either to *produce* the vaccine in the process of producing protein, or to *test* the vaccine.

Sponsor/s	Vaccine Type	Production	Testing
<b>University of Oxford &amp; AstraZeneca</b>	Viral vector adenovirus carrier	? HEK293 abortion derived cell line	? HEK293 abortion derived cell line
<b>Moderna with NIAID</b>	mRNA	✓ No cells used	? HEK293 abortion derived cell line
<b>Pfizer and BioNTech</b>	mRNA	✓ No cells used	? HEK293 abortion derived cell line
<b>Janssen and Johnson &amp; Johnson</b>	Viral vector adenovirus carrier	✗ PER.C6 abortion derived cell line	✗ PER.C6 abortion derived cell line
<b>Novavax</b>	Protein	✓ Sf9 insect cells	? HEK293 abortion derived cell line
<b>CureVac Germany</b>	mRNA	✓ No cells used	✓ HeLa cell line

For source and updates on abortion-derived cell lines and other vaccine candidates see [here](#).

# Further Information

<https://doi.org/10.1038/d41586-020-01221-y>

<https://doi.org/10.1038/d41586-020-01136-8>

<https://lozierinstitute.org/update-covid-19-vaccine-candidates-and-abortion-derived-cell-lines/>

<https://geneticliteracyproject.org/2020/10/06/infographic-5-different-ways-covid-vaccines-work/>

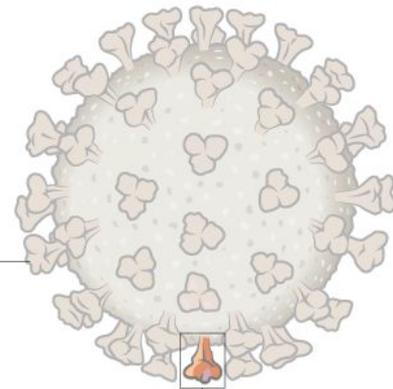
<https://www.youtube.com/watch?v=KMc3vLMIeo>

<https://dnascience.plos.org/2020/09/10/how-the-various-covid-vaccines-work/>

## THE KEY CORONAVIRUS PROTEINS

Researchers are racing to visualize and understand the proteins used by SARS-CoV-2 to enter cells and replicate. That information could be crucial for making drugs and vaccines to stop the virus.

The virus shell is covered in spikes each made of three identical proteins. At the end of each spike is a small binding region that locks onto human cells.



The spike protein (closed)

