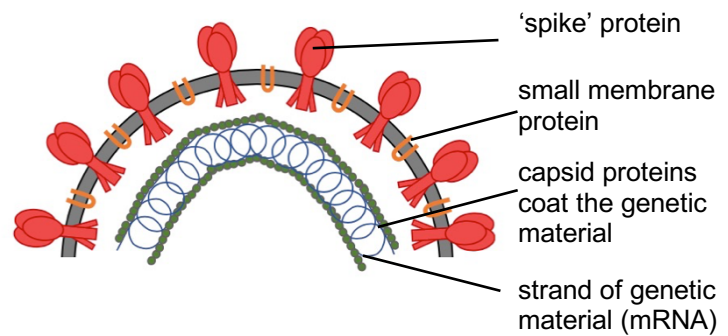


Vaccines

A **vaccine** can stop someone getting a certain **communicable disease**. Many vaccines work by putting part of a disease-causing organism into the body. This part is an **antigen**. For the SARS-CoV-2 virus (in the diagram) the 'spike' protein is a good antigen to use in a vaccine.



Different vaccines

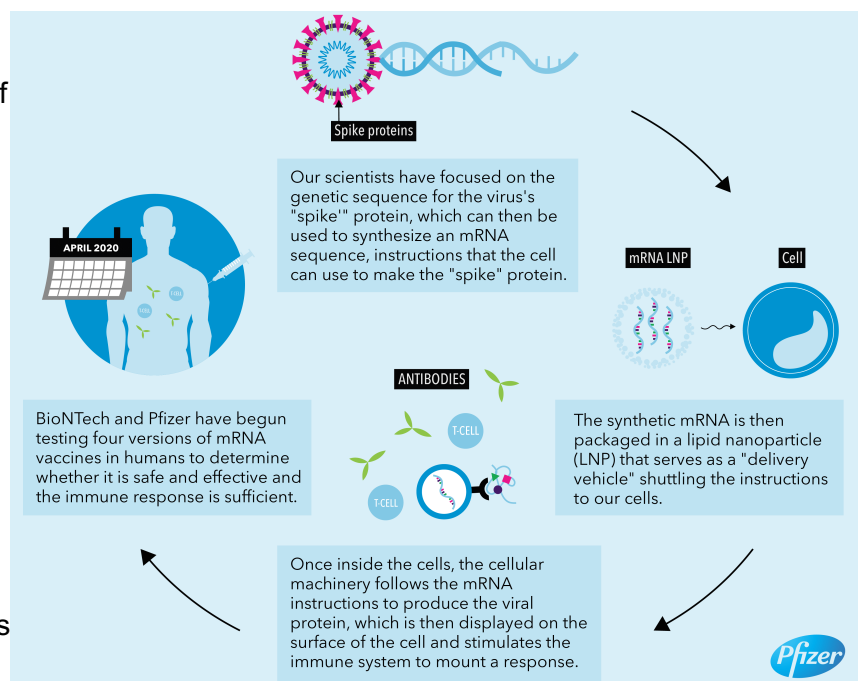
One type of vaccine, called a 'subunit vaccine', just contains many antigen molecules. Other vaccines get the body's own cells to produce the antigen, using genetic material from the virus. Genetic material contains instructions for producing proteins. In humans it is DNA. In a human cell nucleus, the instructions on DNA molecules are copied onto strands of a similar substance called mRNA. The mRNA leaves the nucleus and enters the cytoplasm where its instructions are used to make proteins.

The genetic material of SARS-CoV-2 is mRNA. When a SARS-CoV-2 virus particle enters a human cell, the virus mRNA in the cytoplasm fools the cell into mass producing the virus proteins and new copies of its mRNA. These are assembled into new virus particles, which burst out of the cell.

Pfizer and BioNTech have made an 'mRNA vaccine'. They make copies of the section (gene) of the virus mRNA with the spike protein instructions. They then coat the mRNA copies in cell membrane. When injected, the membrane combines with a human cell membrane and the spike protein mRNA enters the cell.

A vaccine made by the University of Oxford and AstraZeneca uses an adenovirus as a **vector**. Adenoviruses contain DNA. When they infect a cell,

their DNA enters the nucleus of the cell. mRNA is then produced, with the instructions for the virus proteins. For this 'vector vaccine', the scientists genetically modified the adenovirus so that it cannot cause disease. They then made DNA with instructions for the SARS-CoV-2 spike protein. This artificial DNA was then genetically engineered into the adenovirus DNA.



Find out

- I. 1. What disease do adenoviruses commonly cause in humans? _____
2. Go to <https://bit.ly/2KPw6MF>. This shows a 'map' of the genetic material from SARS-CoV-2 that has been converted from mRNA to DNA. Scroll over the diagram to find the answers.
 - a. What letter is given to the section of DNA (the gene) for the spike protein. _____
 - b. DNA is made of pairs of substances called bases (bp). How many base pairs (bp) are in the spike protein gene. _____
 - c. DNA contains four bases, each represented by a letter. What are the letters? _____
 - d. mRNA contains a base that is not found in DNA. What is its name? _____

Test yourself

3.
 - a. Where is DNA found in human cells? _____
 - b. What do human cells use mRNA for? _____
4. Compare the genetic material in SARS-CoV-2 and an adenovirus. _____

5. A **vector** transfers material from place to place. Explain why the adenovirus is a vector.

6. Explain why the Pfizer vaccine cannot cause COVID-19. _____

7. Suggest what would be found in a subunit vaccine against COVID-19. _____

8. The SARS-CoV-2 mRNA contains a gene for the spike protein. Describe two other genes that the virus must contain.

Check-up

- I. Check your answers.
- II. Companies often produce 'infographics', such as the one from Pfizer shown above. These are simple diagrams to explain their products. Design an infographic for the University of Oxford/AstraZeneca vaccine.

