**WHAT ARE RNA VACCINES?**

**SARS-CoV-2**

- **Viral RNA**: The virus's genetic material. Contains instructions for making proteins.
- **Spike protein**: Protein which helps the virus penetrate cells and initiates an infection.

The genetic code of the SARS-CoV-2 virus is made up of RNA. Scientists isolated the part of this genetic code that contains the instructions for making the virus's spike protein.

**LIPID NANOPARTICLES**

Synthetic RNA which codes for the virus spike protein is packed in lipid nanoparticles (very small fat droplets). This stops our bodies' enzymes breaking it down and helps our cells take it in.

**RNA INSTRUCTIONS**

- **Synthetic RNA**: Inside one of our cells, the cell follows the RNA instructions to produce the virus spike protein. Its production then triggers an immune response in our bodies.

**VACCINE SHOT**

**RNA VACCINES: BENEFITS AND CHALLENGES**

**VACCINE PRODUCTION**

RNA is easy to make in a lab, so RNA vaccines can be developed quicker than other vaccines.

**SAFETY OF THE VACCINES**

RNA can't cause infection and is broken down by normal processes in our cells. An RNA vaccine hasn't been licensed for use in humans before but they've been under development for several years for other viruses, including influenza, HIV, and Zika.

**STORAGE AND TRANSPORT**

Some RNA vaccines must be stored at low temperatures to remain stable, which makes storage and transport more challenging.

**RNA VACCINES FOR COVID-19**

- Several proposed vaccines for COVID-19 are RNA vaccines. They can be based on two different types of RNA.
  - **mRNA vaccines**: Moderna, Pfizer & BioNTech, CureVac
  - **saRNA vaccine**: Imperial College, Arcturus

**mRNA AND saRNA: WHAT'S THE DIFFERENCE?**

The structures of mRNA and saRNA are similar but have a key difference, as the diagrams below show.

**mRNA**

- **mRNA stands for messenger ribonucleic acid**

  - **Untranslated regions**: Regions which don't contain code for proteins.
  - **RNA cap**: Stops RNA breaking down; helps start protein synthesis in human cells.
  - **Poly-A tail**: Long chain of adenine (A) bases which help stabilise the RNA.

**saRNA**

- **saRNA stands for self-amplifying ribonucleic acid**

  - **Code for viral replicase enzyme**: Once in human cells, the creation of the viral replicase enzyme helps make multiple copies of the viral RNA.

As saRNA produces more copies of itself once it's in a cell, it can be given in smaller doses than mRNA vaccines. This makes the cost per dose lower and means higher numbers of doses can be produced from the same volume of vaccine.