COVID-19 mRNA vaccines: how they work and why they are safe

**First, the basics!**

The nucleus of your cells houses all of the instructions (DNA) to make the molecules (proteins) that allow your cells to function. However, the fact that make proteins (ribosomes) are outside of the nucleus (cytoplasm)! To get the information where it needs to go, cells copy pieces of the DNA (transcription) into messenger RNA molecules (mRNA, get it?), which leave the nucleus to find the ribosomes and make proteins (translation). Scientists call this process The Central Dogma. The coronavirus is different than your cells; it is made of proteins and genetic information, but not in the form of DNA! Scroll on to find out why that is important!

**How coronavirus hijacks your cells**

1. **Coronavirus enters the cell.**
   - The proteins covering coronavirus (spike proteins) attach to proteins on the outside of cells (cell receptors), like a lock and key, allowing the virus to enter the cell.

2. **The newly-made coronaviruses exit the cell to go on and infect more cells, repeating this same process over and over.**
   - Upon entry, the virus sheds its protein coat, releasing the RNA genome in the cell’s cytoplasm. The cell’s ribosomes can’t tell the difference between the virus mRNA and cell mRNA, so it makes a viral protein (polymerase) necessary to make copies of the virus.

3. **The polymerase protein makes copies of the RNA genome and mRNA instructions to make more viral proteins.**
   - The cell’s ribosomes keep making lots of spikes, nucleocapsid, membrane, and envelope viral proteins.

4. **All of the pieces of the coronavirus are now assembled.**
   - The cell makes all the pieces necessary to make more virus particles.

**How mRNA vaccines work**

1. **Injection of the mRNA vaccine.**
   - The mRNA vaccine contains the instructions for only the spike protein; no other pieces of the viral genome are included.

2. **The mRNA is in the vaccine decodes the mRNA message for the spike protein.**
   - Once made, the antibodies wait for the opportunity to attack the spikes if you are infected by the coronavirus in the future.

3. **The mRNA is the vaccine delivers the instructions to make the coronavirus spike protein.**
   - Your immune cells recognize that your cells shouldn’t be making spike proteins, so they produce antibodies to fight off the perceived invaders.

4. **Coronavirus spike proteins.**
   - Human cell
   - Immune cells

5. **Dispelling common myths about mRNA vaccines**

   - **The vaccine was developed quickly, is it safe?**
     - Scientists have been developing and using mRNA vaccine technology for decades. Approval processes were not changed for these vaccines. Because the groundwork had already been laid, scientists were able to remove mRNA information from a different virus and package it in coronavirus-specific mRNA for the spike protein. All new and medications require 3 phases of human trials.

   - **Will the mRNA vaccine change my DNA?**
     - No, mRNA vaccines cannot change your DNA! Why? Because mRNA is the protein in the vaccine cannot and will never enter the nucleus, where your DNA is stored! To The Central Dogma from above, mRNA leaves the nucleus to find the ribosomes in the cytoplasm. The vaccine delivers these mRNA to the cytoplasm to be translated. Once the spike protein is made, the mRNA degrades and cannot be saved for later.

   - **Does the vaccine affect fertility?**
     - No, there are no data to support this myth falsely claiming that administering mRNA vaccines might affect the placenta. There is no evidence that COVID-19 mRNA vaccines (whether mRNA or vaccine-produced) affect fertility. In fact, during the Pfizer vaccine trial, 23 women conceived 15 in the vaccine and 11 in the placebo group. Although protective antibodies might be passed to the baby, the mRNA cannot because it is destroyed too quickly.

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