Physical Activity and Wellness Corner #39

David Docherty (1 of 3)

COVID-19 AND HOW THE VACCINES WORK

COVID-19 has undoubtedly affected everyone in some way, and there has been so much about it in the media that it has been impossible to ignore. I was approached by the UVRA Forum group to do a short presentation about the difference between the two types of vaccines that have been developed to bring the virus under control. This article covers some of the main points that were discussed in the Forum. I found a useful source of information published in two articles in *The New York Times* which I have referenced at the end of the article.

It is useful to understand a little about the actual virus before describing the types of vaccines and how they work. Most of us now know it is a Corona Virus (SARS-CoV2). SARS is an acronym for Severe Respiratory Syndrome because the virus specifically targets the cells that line the respiratory tract. This can lead to Acute Respiratory Distress Syndrome (ARDS) due to inflammation in the lungs which causes extreme difficulty in breathing. The term "corona" refers to the fact that one characteristic of the virus is the spikes that protrude from the membrane which supposedly makes it look like a crown. The virus uses the spikes to attach to healthy cells, gaining entry which then allows it to reproduce and infect many other healthy cells. Without vaccination it replicates very quickly before the immune system can control it.

The two new vaccines that are proving effective in controlling the virus are using techniques that have not previously been used. Most vaccines take the actual virus and deactivate it reducing its ability to replicate and use that as the main way to stimulate the immune system and produce long term immunity. The two new vaccines use the genetic code just for the essential spike part of the virus and utilize this as the basis of the vaccine (see Figure 1).

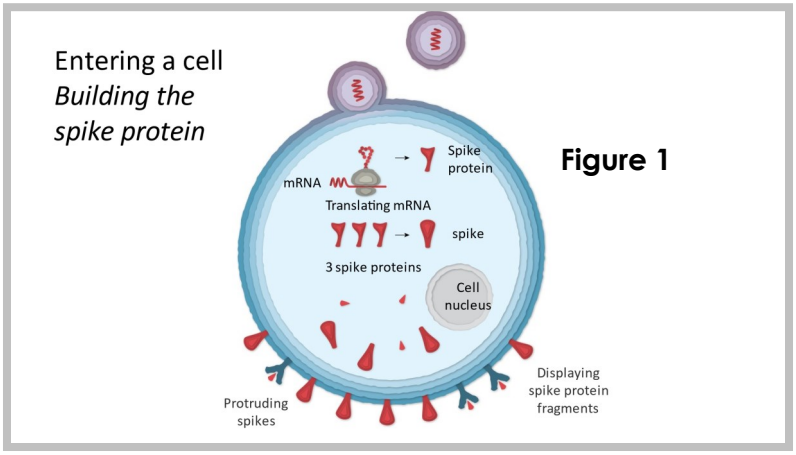

Figure 1

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In the case of the Pfizer and Moderna vaccines they use messenger RNA (mRNA) embedded in a lipid membrane which is engulfed by a respiratory tract cell that will then produce the spike proteins or parts of the spike protein and place them on its membrane. The AstraZeneca and Johnson and Johnson vaccines use a genetically engineered DNA that also contains all the instructions for a cell to produce the spike proteins, and then put them on its membrane.

However, cells are generally resistant to absorbing DNA, so the cell has to be tricked into engulfing it. This is done by inserting the DNA in an actual virus (called a vector) which has been modified so it will not replicate or cause disease. Hence the term vector vaccine. So, both types of vaccines cause a cell to make the spike protein which will then stimulate the immune system to start the process of developing immunity to the SARS-Co2 virus spike, should it ever invade the body.

So how does this stimulate the immune system and produce long term immunity? It is an extraordinarily complex, complicated and miraculous process so this will be a very simple and partial description of how it works. The infected cell will break down and release the spike proteins or fragments of the spike. A special cell called an antigen presenting cell (APC) will engulf the spike proteins or fragments, recognizing them as not belonging or foreign to the body; they then place them on their own cell membrane in a modified form (see Figure 2).

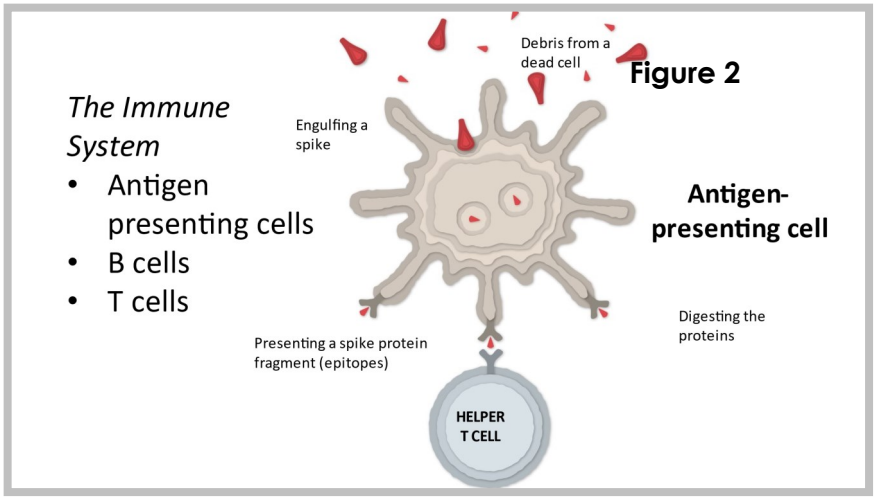

Figure 2

The main actors are then two white blood cells or lymphocytes called T cells and B cells that work together. Both have special receptors on their membranes that are specific to only one type of antigen or pathogen, in this case the spike protein. The T cell attaches to the antigen now displayed on the antigen presenting cell and becomes activated.

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Once the T cell has made contact it starts to replicate into one of several other types of T cells. One of these cells is called a helper T cell (Th) and will eventually work with the B cell to produce antibodies (see Figure 3). One of the other T cells (killer T cell) will search for any infected cells showing the spike protein and kill them (see Figure 4). At the same time, the B cell has also attached to an infected cell and becomes activated. However, the B cells do not really start producing huge amounts of antibodies until the T helper cell has attached to it (see Figure 3).

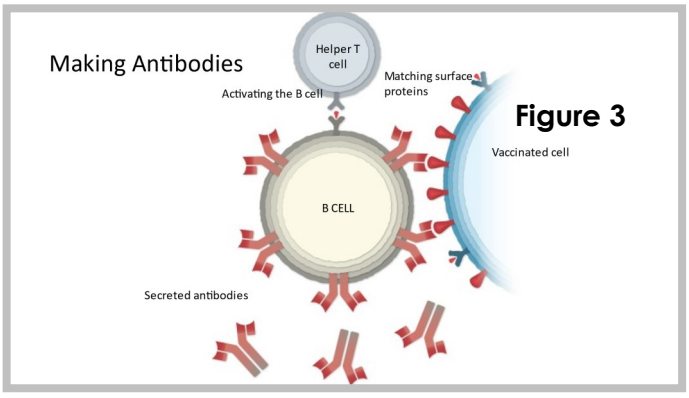

Figure 3

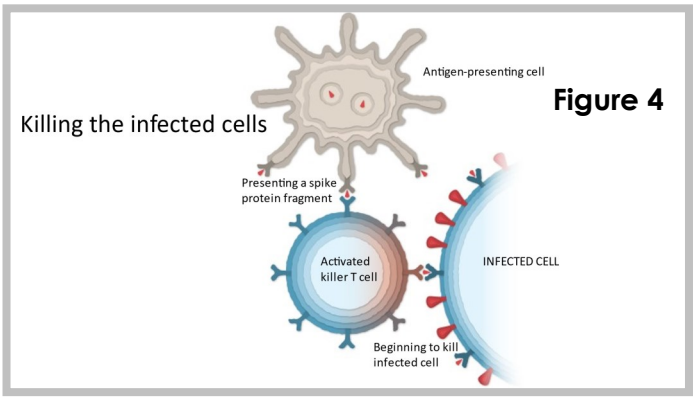

Figure 4

The antibodies block the spike protein and stop it entering any other cells as well as targeting infected cells and bringing other immune cells to help fight the pathogen. Another B cell is produced that will become part of the long-term immunity called a B memory cell. Some T cells are retained and become T memory cells. The memory cells will now recognize any pathogen in the future that contains the spike protein, in this case the SARS-Co2 virus, and immediately start to fight it before it can take hold. The good news, now, is that the memory cells can recognize slight variations in the spike protein, such as in the variants, and are equally effective in attacking them.

And of course, remember that physical activity boosts the immune system so be sure to stay active!

David Docherty

The New York Times References:

file:///Users/docherty/Desktop/How%20the%20Pfizer-BioNTech%20Covid-19%20Vaccine%20Works%20-%20The%20New%20York%20Times.html

file:///Users/docherty/Desktop/How%20the%20Oxford-AstraZeneca%20Covid-19%20Vaccine%20Works%20-%20The%20New%20York%20Times.html

Note: The 4 figures are reproduced from *The New York Times*, May 7, 2021