Vaccines, Vaccination and the four types of COVID-19 Vaccines

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The control of COVID-19 has seen vaccine development move at record speed with more than 170 different vaccines in trials. But how are these vaccines prepared and how will they protect us against the disease? Before we delve into that, let us understand what vaccines and their related procedures are.

Vaccines

Vaccines are products that help the immune system combat invading disease-causing microorganisms of the body (Coelho, 2020). They are scientifically prepared biological formulations that provide protection to the body from certain diseases (Tortora, Funke & Case, 2019).

Vaccines can be administered via;

- **Oral route** – administered through the mouth
- **Intranasal route** – administered through the nose
- **Subcutaneous route** – Injected into an area just beneath the skin
- **Intramuscular route** – injected into the muscles
- **Intradermal route** – injected into layers of the skin (CDC, 2021).

Vaccination

Vaccination is the act of receiving a vaccine as protection against contracting certain particular diseases (WHO, 2021).

The principle of vaccines and vaccination

Vaccines contain suspensions of weakened, killed, fragmented, toxins of microorganisms or antibodies to certain microorganisms (Brunson, 2020). Vaccines train the immune system to detect and fight diseases-causing microorganisms. Vaccines and vaccination teach the immune system to "destroy" and "remember" diseases-causing microorganisms (see Figure 1). This act begins the process of immunization/immunity to that particular disease or diseases (CDC, 2021).

Vaccination is the safest, simple and effective method of protecting people from certain harmful diseases before they come into contact with them. Unlike most medicines, which treat and/or cure diseases, vaccines prevent diseases.

Figure 1: How vaccines work

Source: Brunson, (2020).

The four major types of COVID-19 vaccines

There are more vaccine candidates simultaneously in the pipeline for COVID-19 than ever before for an infectious disease. All of them are trying to achieve the same thing; immunity to the virus. They do so by stimulating an immune response to an antigen, a molecule found on the virus. In the case of COVID-19, the antigen is typically the characteristic spike protein (S protein) found on the surface of the virus, which it normally uses to help it invade human cells (see Figure 2).

There are four categories of COVID-19 vaccines in clinical trials. They include; whole virus, protein subunit, nucleic acid (RNA and DNA) and viral vector (Gavi, 2021).

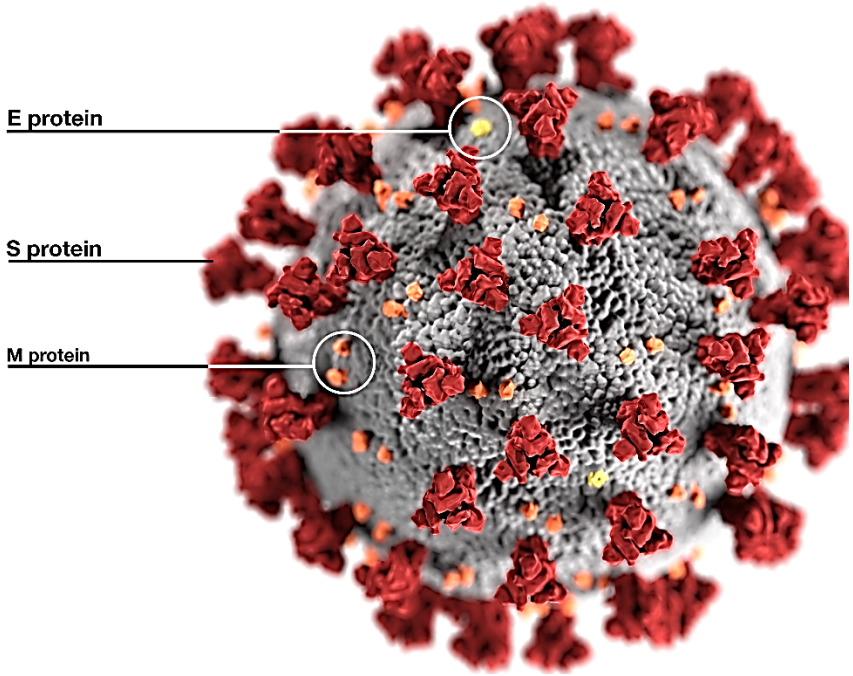

Figure 2: SARS CoV 2 (Causative agent of COVID-19)

Source: Coelho, 2020.

Whole virus

Whole virus vaccines use a weakened (attenuated) or deactivated form of the virus that causes a disease to trigger protective immunity to it. There are two types of whole virus vaccines. **Live attenuated vaccines** use a weakened form of the virus, which can still grow and replicate, but does not cause illness. **Inactivated vaccines** contain viruses whose genetic material has been destroyed by heat, chemicals or radiation so that they cannot infect cells and replicate, but can still trigger an immune response.

Protein subunits (fragments of microbes)

Rather than injecting a whole virus to trigger an immune response, subunit vaccines (sometimes called acellular vaccines) contain purified pieces of it, which have been specially selected for their ability to stimulate immune cells. Because these fragments are incapable of causing disease, subunit vaccines are considered very safe. There are several types: **protein subunit** vaccines contain specific isolated proteins from viral or bacterial pathogens; **polysaccharide vaccines** contain chains of sugar molecules (polysaccharides) found in the cell walls of some bacteria;

conjugate subunit vaccines bind a polysaccharide chain to a carrier protein to try and boost the immune response. However, the immune response might be weak.

Nucleic acids

Nucleic acid vaccines use genetic material from a disease-causing virus or bacterium to stimulate an immune response against it. Depending on the vaccine, the genetic material could be DNA or RNA; in both cases it provides the instructions for making a specific protein from the pathogen, which the immune system will recognise as foreign (an antigen). Once injected into host cells, this genetic material is read by the cell's own protein-making machinery and used to manufacture antigens, which then trigger an immune response. Since the antigens are produced using the body's own cells and in large quantities, the immune reaction is strong.

Viral vectors

Viral vector-based vaccines differ from most conventional vaccines in that they don't actually contain antigens, but rather use the body's own cells to produce them. They do this by using a modified virus (the vector) to deliver genetic code for antigen, in the case of COVID-19, spike proteins found on the surface of the virus, into human cells. By infecting cells and instructing them to make large amounts of antigen, which then trigger an immune response, the vaccine mimics what happens during natural infection with certain pathogens, especially viruses. This has the advantage of triggering a strong cellular immune response by T cells as well the production of antibodies by B cells.

Vaccines are the new tool in the fight against COVID-19 and it is hugely encouraging to see so many vaccines proving successful and going into development. Working as quickly as they can, scientists from across the world are collaborating and innovating to bring us treatments and vaccines that will collectively save lives and end this pandemic.

However, but for the foreseeable future we must continue wearing face protection, practicing hand hygiene, practicing respiratory hygiene and ensuring physical distancing and all the other specific COVID-19 safety protocols. Being vaccinated does not mean that we can throw caution to the wind and put ourselves and others at risk, we must continue to live safe.

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