The History of Vaccines and my Christian Response to Vaccination

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Overview

Talk will emphasize the history of the Smallpox, Polio and Coronavirus vaccines

Outline

I. Types of vaccines

II. Smallpox vaccine history
1. Time history of disease

2. Variolation

3. Edward Jenner

III. Louis Pasteur

IV. Edward Kock

V. Polio vaccine history
1. Time history of disease

2. Salk vaccine

3. Sabin vaccine

VI. Other vaccines
1. List of other vaccines with short comments

VII. Coronavirus vaccine
1. New type of vaccine mRNA - brief description
2. Possible issues - mutations or variants

VIII. Christian response to vaccination

Our direction here is to illustrate how our Religion, Faith, is involved in decisions

Purpose of Vaccines and how they work

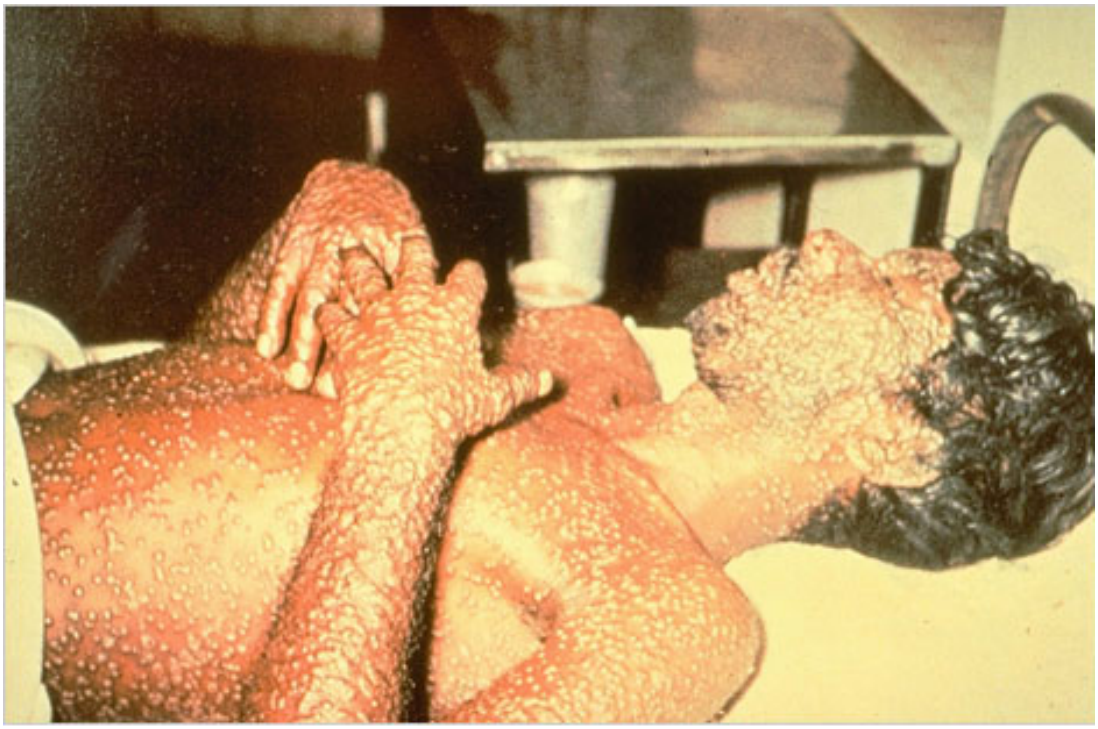
When a pathogen (a virus, bacterium or other microorganism that can cause disease) enters your body, your immune system generates antibodies and enlists other cells to try to fight it off. Depending on the strength of your immune response and how effectively the antibodies and cells fight off the pathogen, you may or may not get sick. When you get a vaccine it introduces some aspect of the pathogen that isn't strong enough to make you sick, but it is enough for your immune system to generate antibodies against it. As a result, you gain future immunity against the disease without having gotten sick.

Types of Vaccines

1. Live, attenuated - The live virus or bacteria's ability to produce disease in a human is attenuated to the point that it can not cause illness, but elicits an immune response.
2. Killed or inactivated - The virus or bacteria is killed or inactivated using heat or chemicals. This destroys the pathogen's ability to replicate, but keeps it intact so that the immune system can still recognize it.
3. Toxiods - Some bacterial diseases are not directly caused by a bacterium, but by a toxin produced by the bacterium. Vaccines for this type of pathogen can be made by inactivating the toxin that causes the disease
4. Subunit and conjugate - Subunit vaccines use only part of the target pathogen to provoke a response from the immune system. Conjugate vaccines are made using pieces of bacteria that are chemically linked to a carrier protein. This combination creates a strong immune system response without causing illness
5. RNA or DNA - This vaccine uses RNA or DNA molecules to teach the immune system to target key viral proteins. RNA or DNA is engineered from germ genome (i.e. Covid-19). Instructions for the body to make

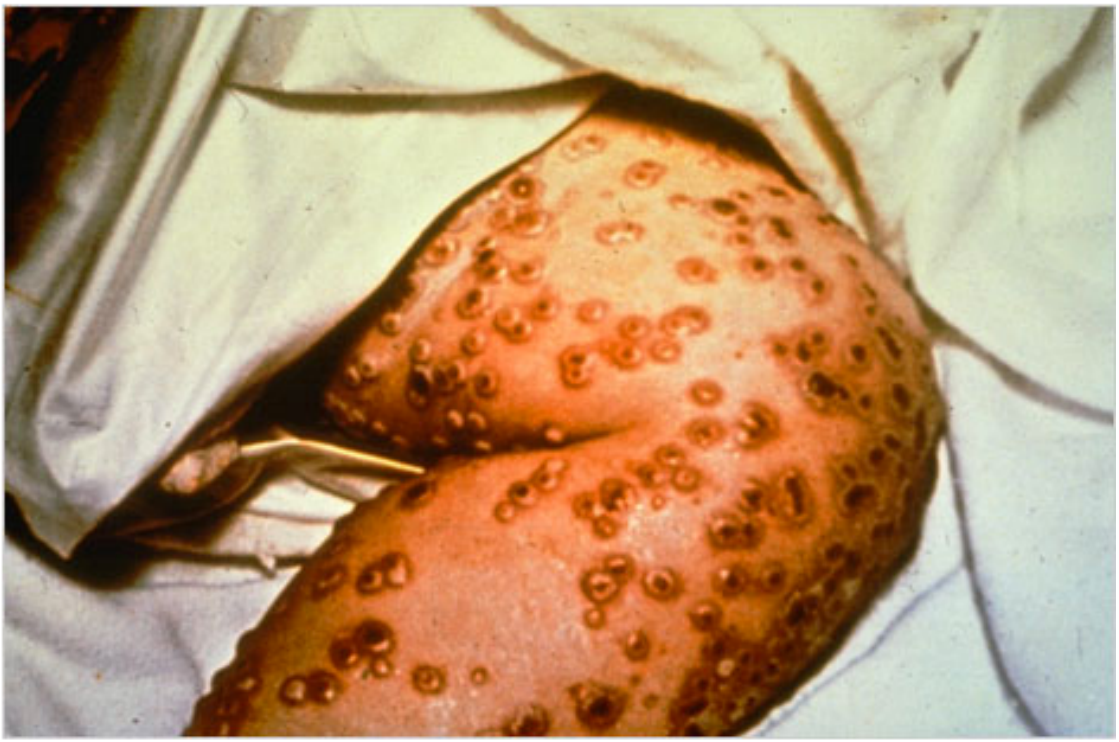
the antigen (virus) itself are used. This creates an immune response and protects the body from the virus. A more complete discussion is contained in the coronavirus section

Smallpox



Man has smallpox; body is covered with smallpox lesions

Smallpox killed over 300 million people in the 20th century



Close-up of smallpox lesions on a person's leg

Brief History

There is evidence that the smallpox disease occurred as early as 500 AD and that it may have been one of the diseases during the so called Black Death that was the bubonic plague pandemic occurring in Afro-Eurasia from 1346 to 1353. It continued to be a deadly disease, for example in Europe until the smallpox vaccine was widely used. Typically 30% of the people who got smallpox died.

Methods to combat the disease

Variolation was the intentional introduction into a healthy person of smallpox-infected matter to cause a very mild case of the disease and, hence, induce future immunity. At least two different techniques were used. One used pulverized smallpox scabs blown into the nostrils of an individual. Another would take smallpox pus from sores of an infected person and scratch the pus into skin of a heathy person. Unfortunately, 2 to 3% of those variolated died.

Edward Jenner (1749-1823) - It became pretty well known that milking maids who became infected from a cow disease called cowpox were immune to smallpox. The disease was mild. Jenner reasoned that using a cowpox sore from a milkmaid scratched into the skin of an individual might be an effective way protecting the person from getting smallpox. He tested his idea on an eight year old local boy who suffered a mild reaction. He than exposed the child to smallpox pus by scratching it into his skin. The child remained healthy, showing no signs of the disease. He than inoculated his own son and other children with similar results. He

published his results in 1798 to little fanfare. An associate in London, Henry Cline showed the effectiveness of the vaccine and its use quickly spread. Jenner than worked tirelessly to get as many people vaccinated as he could. In 1806 President Thomas Jefferson wrote to Jenner's family to thank them. He said

"You have erased from the calendar of human afflictions one of its greatest. Yours is the comfortable reflection that mankind can never forget that you have lived. Future nations will know by history only that the loathsome smallpox has existed and by you has been extirpated."

The last known case of wild smallpox occurred in Somalia, and in 1980 the disease was declared eradicated.

Louis Pasteur

With Koch considered the founder of microbiology

Pasteurization - His experiments demonstrated that fermentation and rotting could not take place when outside organisms were excluded from solutions by heating or by filtering.

Cholera - He discovered that a weakened or attenuated cholera bacteria could be used as a vaccine for the cholera disease

Anthrax - He showed that by attenuating anthrax bacteria with carbolic acid that the resulting bacteria could be used in a vaccine against anthrax.

Rabies - By exposing the rabies virus to oxygen he and colleagues were able to attenuate the virus to the point it could be used for a vaccine. However, before they had completed tests, they were asked to use their

idea on a 9 year old boy. Pasteur had tested the vaccine on only two other people, and neither had completed the necessary series of shots. One was a 60 year old who had one shot and the other was a 10 year girl who died.

Robert Koch

Anthrax - He was able to show that the anthrax bacteria produced spores that could survive in conditions that killed the bacteria. The spores could remain dormant for long periods, yet still cause anthrax when conditions changed.

Isolating bacteria - He and his team pioneered important techniques for growing pure cultures of bacteria.

Koch's Postulates - when trying to identify the cause of an infectious disease Koch developed postulates for doing so that are still being used today. They are:

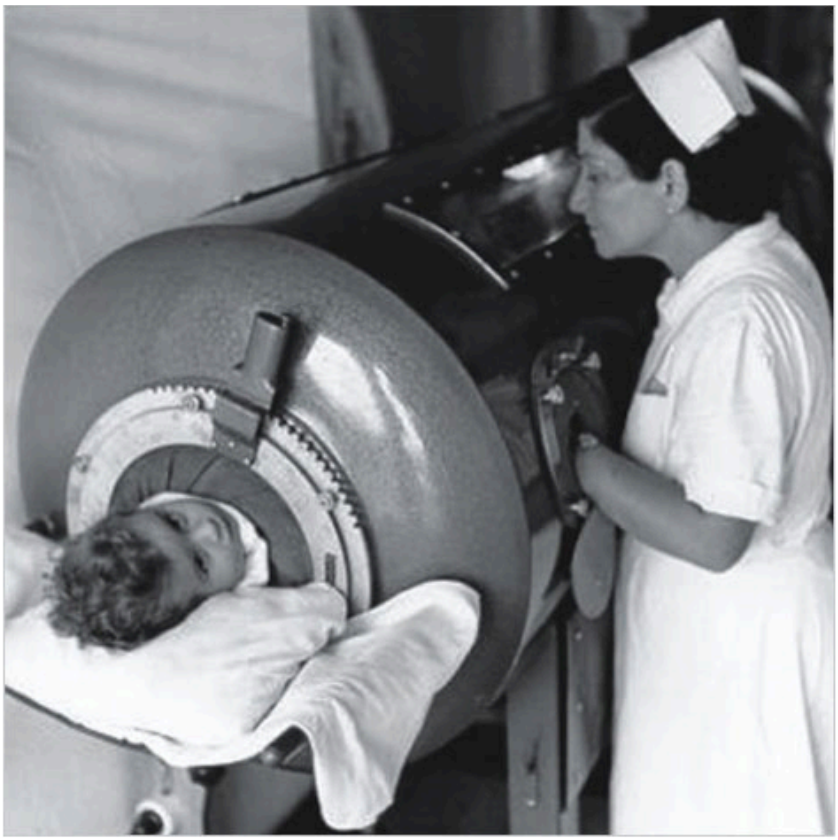
1 The microbe is present in each case of the disease

2 The microbe can be taken from the host and grown independently

3 Introducing a pure culture of the microbe into a healthy experimental host produces the disease in the host

4 The microbe can be isolated and identified from the host infected in step 3

Polio



Patients whose respiratory muscles were affected were placed in an "iron lung" machine to enable them to breathe

Cheshire Home for Handicapped Children, Freetown, Sierra Leone

First major outbreak of Polio in United States occurred in Vermont in 1894. In 1916 an epidemic centered in Brooklyn killed more than 2,000 people there and 4,000 more across the country. Thousands more were paralyzed. In 1921, Polio paralyzed the future president Franklin Delano Roosevelt, who at the time was assistant secretary of the Navy. For Polio sufferers who had paralysis of the muscles needed for breathing, researchers in 1929 developed the “iron lung” that forced air into and out of the lungs enabling the person to survive.

Variants - In 1908, Karl Landsteiner, MD(1868-1943), and Erwin Popper, MD(1879-1955), identified polio as a virus. Later it was found that Polio had variants. If the vaccine was made with only one of the variants, a person could get Polio from another. There were 3 variants and vaccines had to be made to protect you from all 3.

Methods for growing and isolating the virus - In 1954 John Enders, PHD(1897-1985), Frederick Robbins, MD(1916-2003) and Thomas Weller, MD(1915-2008) won the Nobel Prize in Medicine for their work on culturing Polioviruses

Jonas Salk, MD(1914-1995) - By cultivating poliovirus in monkey kidney tissue, large quantities of the virus were produced that could be used for vaccines. In 1952 Salk began the first tests in humans of a killed-virus vaccine. All three variants were tested in resident children in institutions for the disabled. The trials were a success. Salk and his team than developed the inactivated (killed) virus vaccine that became known as the Salk

vaccine. In 1954 a large trial involving 1.8 million children took place. It was found to be 80-90% effective against paralytic polio. This paved the way for general use, but one major hiccup occurred. Vaccine produced at the Cutter Laboratories had a problem and the vaccine killed 11 people and hundreds were paralyzed. It is believed that the production methods failed to kill the poliovirus. Much more strict production methods were implemented without further issues.

Albert Sabin, MD(1906-1993) - Sabin had also been working on a vaccine, an attenuated polio vaccine. With the help of the Soviet Union he was able to do a massive vaccination campaign, feeding (a sugar cube could be used) vaccine to 10 million children. Salk's vaccine retained one major advantage over the Sabin vaccine: rarely, the weakened viruses in the Sabin vaccine can revert to virulent form and cause polio. The Salk vaccine is now the only type of polio vaccine used in the United States.

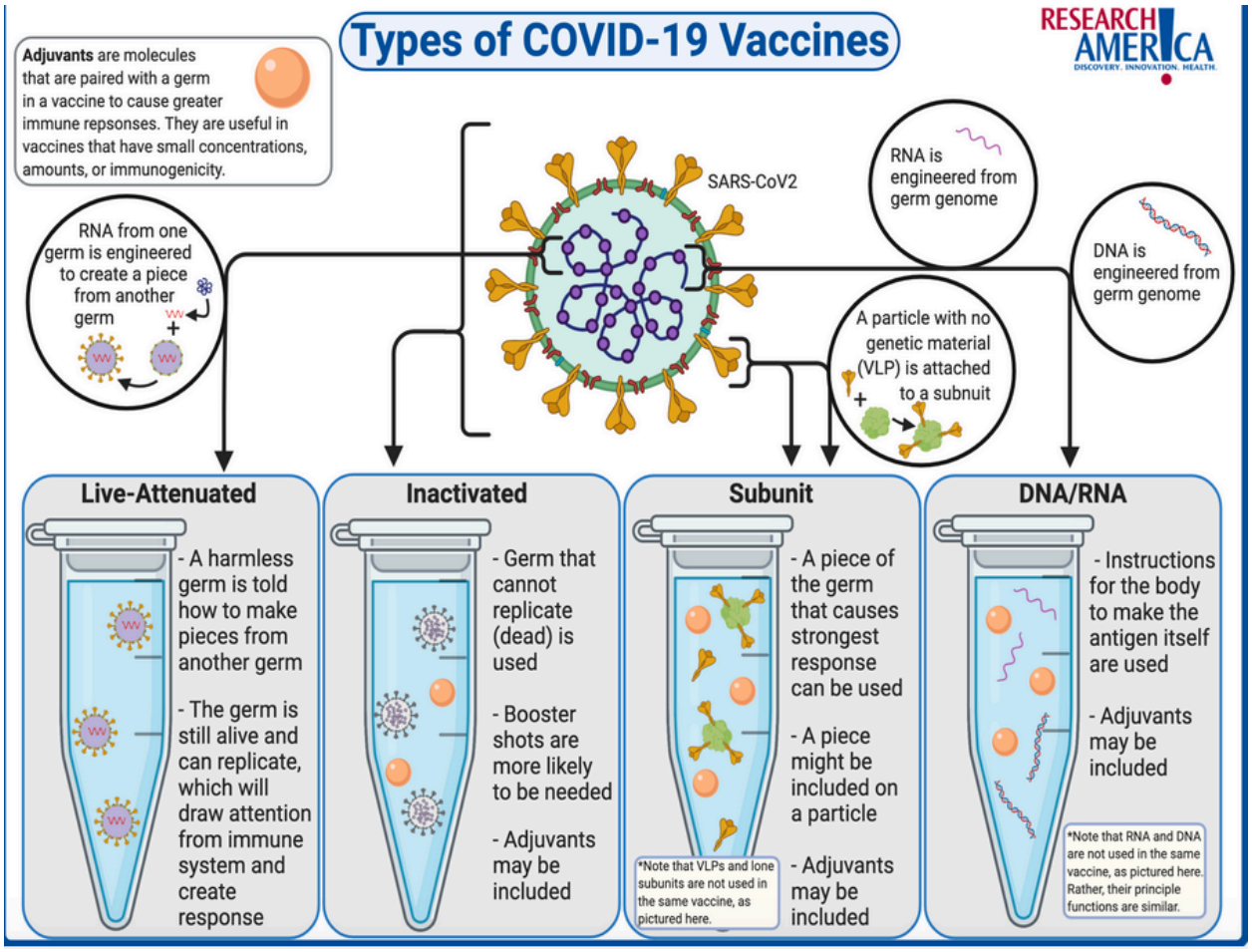
In 1994 the Pan American Health Organization reported that 3 years had passed since the last case of polio in the Americans. Still polio still exists in the world, polio remains in four countries: Afghanistan, India, Nigeria and Pakistan.

List of vaccines

Types of vaccines	DNA and RNA	Live attenuated	Inactivated	Subunit	Viral vector
					
How it works	This vaccine uses DNA or RNA molecules to teach the immune system to target key viral proteins.	This is a weakened version of the actual virus.	An inactivated vaccine uses the whole virus after it has been killed with heat or chemicals.	This vaccine uses a piece of a virus' surface to focus your immune system on a single target.	This approach takes a harmless virus and uses it to deliver viral genes to build immunity.
Advantages	Easy and quick to design.	Stimulates a robust immune response without causing serious disease.	Safe because the virus is already dead and is easy to make.	Focuses the immune response on the most important part of the virus for protection and cannot cause infection.	Live viruses tend to elicit stronger immune responses than dead viruses or subunit vaccines.
Disadvantages	Never been done before. There are no licensed DNA or RNA vaccines currently in use.	May not be safe for those with compromised immune systems.	Not as effective as a live virus. Some previous inactivated vaccines have made the disease worse; safety for the novel coronavirus needs to be shown in clinical trials.	May not stimulate a strong response, other chemicals may need to be added to boost long-term immunity.	Important to pick a viral vector that is truly safe. An immune response to the viral vector could make the vaccine less effective.
Existing	• None	• Measles, Mumps	• Polio	• Pertussis	• Ebola

Coronavirus (Covid-19)

600,000+ Americans and 3,740,000 people world wide have died from this virus


Types of COVID-19 Vaccines
RESEARCH AMERICA
DISCOVERY. INNOVATION. HEALTH.
Adjuvants are molecules that are paired with a germ in a vaccine to cause greater immune repsonses. They are useful in vaccines that have small concentrations, amounts, or immunogenicity.
SARS-CoV2
RNA from one germ is engineered to create a piece from another germ
RNA is engineered from germ genome
DNA is engineered from germ genome
A particle with no genetic material (VLP) is attached to a subnuit
Live-Attenuated
- A harmless germ is told how to make pieces from another germ
- The germ is still alive and can replicate, which will draw attention from immune system and create response
Inactivated
- Germ that cannot replicate (dead) is used
- Booster shots are more likely to be needed
- Adjuvants may be included
Subunit
- A piece of the germ that causes strongest response can be used
- A piece might be included on a particle
- Adjuvants may be included
*Note that VLPs and lone subunits are not used in the same vaccine, as pictured here.
DNA/RNA
- Instructions for the body to make the antigen itself are used
- Adjuvants may be included
*Note that RNA and DNA are not used in the same vaccine, as pictured here. Rather, their principle functions are similar.

Description of the Pfizer and Moderna Vaccine

mRNA vaccines work differently from your typical vaccine. They do not contain antigens. Instead, they contain a blueprint for the antigen in the form of genetic material, mRNA. In the case of Pfizer's and Moderna's vaccines, the mRNA provides the genetic information to synthesize the spike protein that the Covid-19 virus uses to attach to and infect human cells. Each type of vaccine is packaged in proprietary lipid nanoparticles (lipid is an organic compound insoluble in water; a nanoparticle is a particle 1 to 100 nanometers in size) to protect the mRNA from rapid degradation, and the nanoparticles serve as an adjuvant to attract immune cells to the site of injection. When injected into the muscle, the lipid nanoparticles containing the mRNA inside are taken into the muscle cells, where the cytoplasmic ribosomes detect and decode the mRNA resulting in the production of the spike protein antigen. The antigen is exported to the muscle cell surface where the immune system's antigen presenting cells detect the protein, ingest it, and take it to regional lymph nodes where interactions with T cells and B cells results in antibodies, T cell-mediated immunity, and generation of immune memory T cells and B cells.

Johnson and Johnson adenovirus vaccine

An adenovirus vaccine uses a virus that has been altered so that it can't make you sick, it can't replicate, it cannot integrate into your DNA, so they take out some really important parts of that virus genome.

What's done to the virus is that actually a little genetic snippet is exchanged and placed into the adenovirus that is actually from the COVID virus. It's the section of genetic code that codes for the spike protein. The adenovirus is like a Trojan horse, except that what it's delivering is a good thing, instead of delivering something that you don't want in your body. You get the vaccine, the adenovirus goes into your cell, it's got this Trojan horse code on it that makes the spike protein. That spike protein then goes to the surface of your cell and then your immune system recognizes it and starts to make antibodies to it.

In the end, what you get is your body makes the spike protein and you develop the immune response to that spike protein, exactly like you do with the Pfizer vaccine and the Moderna vaccine

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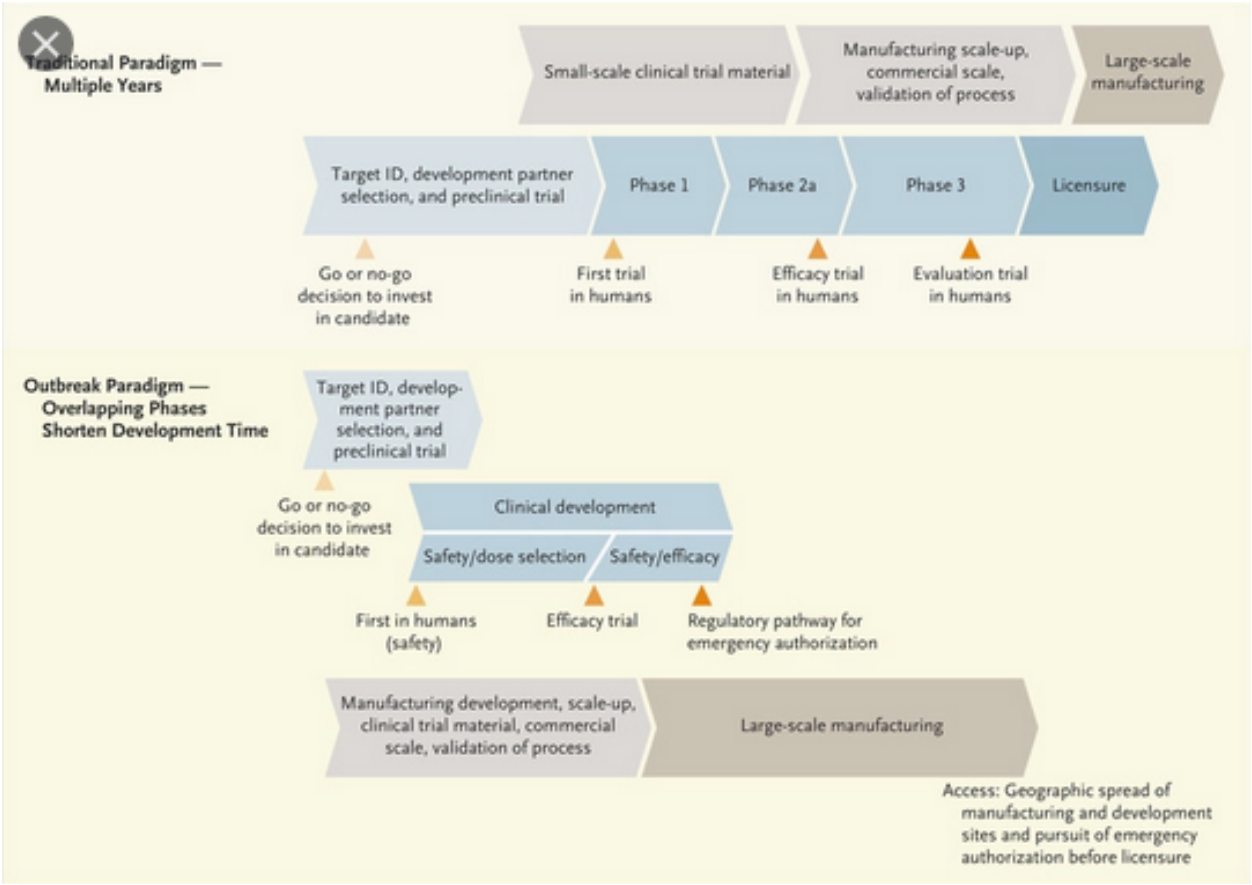
Process for developing Covid-19 vaccine

So far the Pfizer, Moderna and Johnson vaccines have been hugely successful in controlling the virus, but the learning process continues (booster shots?, variants?)


Traditional Paradigm — Multiple Years
Small-scale clinical trial material
Manufacturing scale-up, commercial scale, validation of process
Large-scale manufacturing
Target ID, development partner selection, and preclinical trial
Phase 1
Phase 2a
Phase 3
Licensure
Go or no-go decision to invest in candidate
First trial in humans
Efficacy trial in humans
Evaluation trial in humans
Outbreak Paradigm — Overlapping Phases Shorten Development Time
Target ID, development partner selection, and preclinical trial
Go or no-go decision to invest in candidate
Clinical development
Safety/dose selection
Safety/efficacy
First in humans (safety)
Efficacy trial
Regulatory pathway for emergency authorization
Manufacturing development, scale-up, clinical trial material, commercial scale, validation of process
Large-scale manufacturing
Access: Geographic spread of manufacturing and development sites and pursuit of emergency authorization before licensure

Personnel comments on the Christian response to vaccination

I started studying religion and theology shortly after I graduated from high school and have continued most of my life. Like many of you I have incorporated much of what I've learned into my life direction and in my decision making. Here is an example:

About 13 years ago I was diagnosed as a diabetic. I had a heart attack about 10 years earlier. In reading the Bible I was reminded that my body was a special gift from God and that He expected me the that care of it. I realized that I had ignored His calling. I weighed about 200 pounds and am 5 feet 9 and half inched tall. I was obese. I realized I needed to greatly change my life style. By eating better and exercising I dropped my weight after about a year to 150 pounds and have maintained that weight.

When I have a decision to make I ask for God's help and for help from the Christian community. Religion is a part of who I am. With this in mind this is my response to vaccination.

Do your homework

What is the history of your bodies response to vaccines

What kind of vaccine is it and how effective is it

Do you have allergies

Understand the risks

How many people are getting sick

Is the illness severe - long term illness, death

Understand the risk to others

How contagious is the virus

Can I make others sick

How important is a quick response

By responding quickly, do I slow down the viruses ability to propagate

Does a quick response slower the rate of virus variants

Are there methods to protect yourself

Wearing of masks

Social distancing

Avoidance of large group gatherings

Indoors verus outdoors

Are we over the pandemic and how will it effect our lives

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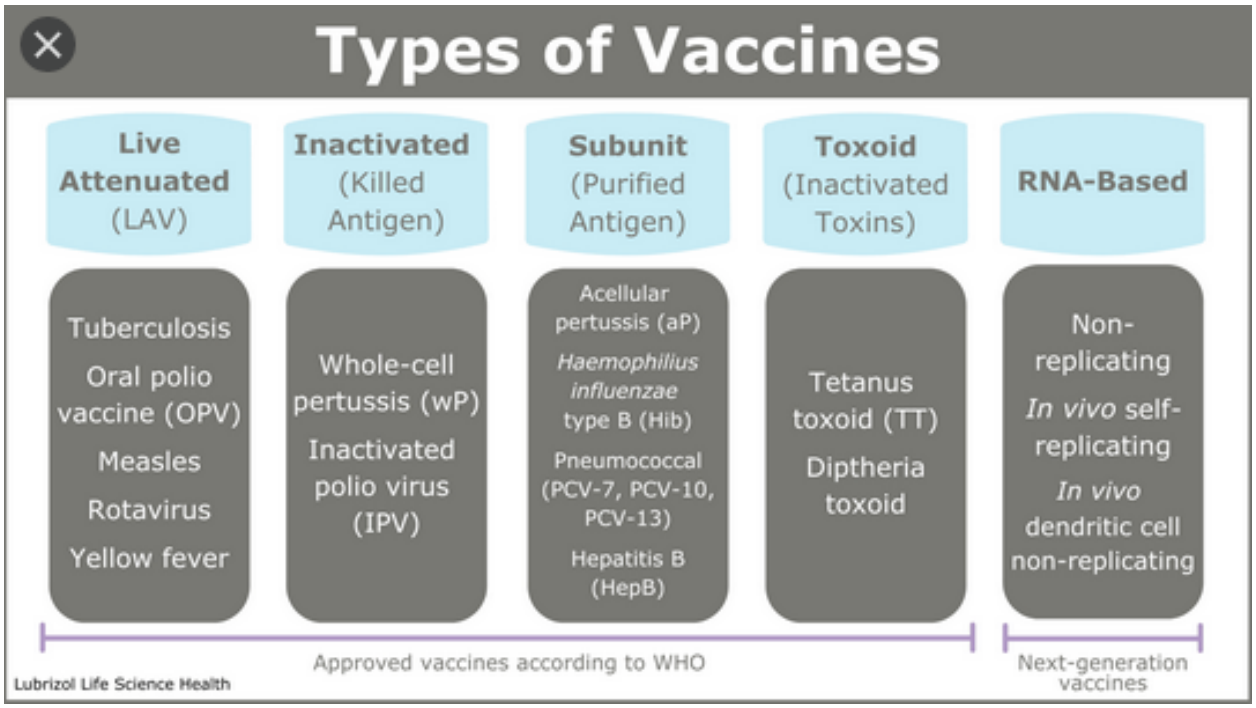
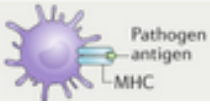
Additional Information



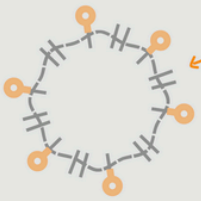
Type	Description	Advantages	Disadvantages	Disease	Reference
Live attenuated	Less pathogenic strain of microbe	Induction of long lived responses	Adverse effects in immune-compromised	MMR, Smallpox	World Health Organization, 2017
Inactivated	Pathogens killed through chemical treatment or heat	Cannot replicate	Often induces weaker immune responses than other methods	Cholera	Bi et al., 2017
Subunit	A vaccine designed to induce immune responses to the most dominant epitopes of a pathogen	High level of safety	Multiple doses are usually required	Hepatitis B	Van Den Ende et al., 2017
Toxoid	Induces an immune response to the pathogens toxin	Strong antibody response and long-lasting antigen specific memory	Booster doses are often required	Diphtheria	World Health Organization, 2017
Conjugate	A strong antigen (often a protein) covalently attached to a weak antigen (often a bacterial polysaccharide)	Safe for use in infants. Long lasting immune responses	Expensive to produce	Bacterial Meningitis	Wasserman et al., 2018
DNA	Fragments of DNA encoding antigens for specific pathogens are injected for endogenous production	Non-infectious, no cold chain required	Limited to protein antigen production	Experimental	Vetter et al., 2018
Recombinant	Recombinant DNA delivered through bacterial or viral vaccine vectors	Strong immune responses	Anti-vector immunity can lead to adverse effects	HPV	Sipp et al., 2018

Type of vaccine		Licensed vaccines using this technology	First introduced
Live attenuated (weakened or inactivated)		Measles, mumps, rubella, yellow fever, influenza, oral polio, typhoid, Japanese encephalitis, rotavirus, BCG, varicella zoster	1798 (smallpox)
Killed whole organism		Whole-cell pertussis, polio, influenza, Japanese encephalitis, hepatitis A, rabies	1896 (typhoid)
Toxoid		Diphtheria, tetanus	1923 (diphtheria)
Subunit (purified protein, recombinant protein, polysaccharide, peptide)		Pertussis, influenza, hepatitis B, meningococcal, pneumococcal, typhoid, hepatitis A	1970 (anthrax)
Virus-like particle		Human papillomavirus	1986 (hepatitis B)
Outer membrane vesicle		Group B meningococcal	1987 (group B meningococcal)
Protein–polysaccharide conjugate		*Haemophilus influenzae* type B, pneumococcal, meningococcal, typhoid	1987 (*H. influenzae* type b)
Viral vectored		Ebola	2019 (Ebola)
Nucleic acid vaccine		SARS-CoV-2	2020 (SARS-CoV-2)
Bacterial vectored		Experimental	–
Antigen-presenting cell		Experimental	–

Types of SARS-CoV-2 vaccines for COVID-19

Attenuated vaccines

British Society for immunology
www.immunology.org



Contain **weakened SARS-CoV-2 virus**.

The weakened virus is recognised by the immune system to trigger a response without causing illness.

This response builds immune memory, so your body can fight off SARS-CoV-2 in future.

Considerations

A well-known approach which requires time and extensive testing.

The immune response resembles the natural infection.

Examples in human use

Oral Polio vaccine

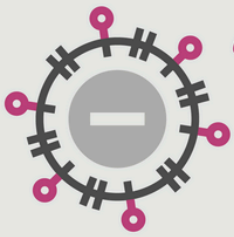
In clinical trials for COVID-19

Codagenix

Types of SARS-CoV-2 vaccines for COVID-19

Inactivated vaccines

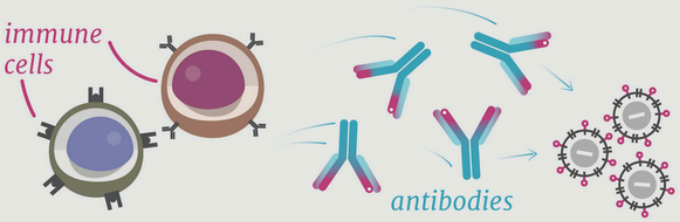
British Society for immunology
www.immunology.org



Contain **killed SARS-CoV-2 virus**.

The killed virus is recognised by the immune system to trigger a response without causing illness.

This response builds immune memory, so your body can fight off SARS-CoV-2 in future.



Considerations

May need to be administered with an adjuvant to boost immune response.

Examples in human use

Influenza vaccine

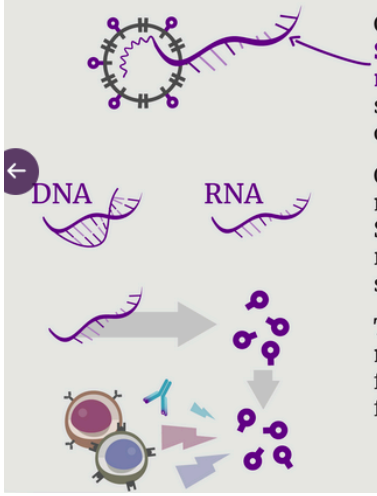
In clinical trials for COVID-19

Sinovac, Sinopharm

Types of SARS-CoV-2 vaccines for COVID-19

Genetic vaccines
(nucleic acid vaccines)

British Society for immunology
www.immunology.org



Contain a segment of **SARS-CoV-2 virus genetic material** that codes for a specific protein. Can be DNA or RNA.

Our cells use the genetic material to make the SARS-CoV-2 protein, which is recognised by the immune system to trigger a response.

This response builds immune memory, so your body can fight off SARS-CoV-2 in future.

Considerations

Low cost and fast to develop.

May need to be stored at specific low temperatures.

Examples in human use

None

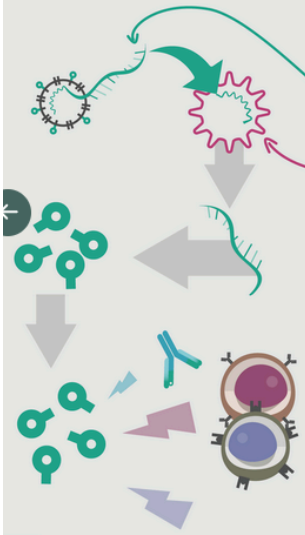
In clinical trials for COVID-19

Pfizer/BioNTech, Moderna, Imperial College London

Types of SARS-CoV-2 vaccines for COVID-19

Viral vector vaccines

British Society for immunology
www.immunology.org



Use an unrelated harmless virus, modified to deliver **SARS-CoV-2 genetic material**. The delivery virus is known as a **viral vector**.

Our cells use the genetic material to make a specific SARS-CoV-2 protein, which is recognised by the immune system to trigger a response.

This response builds immune memory, so your body can fight off SARS-CoV-2 in future.

Considerations

Generate strong immune responses.

May need to be stored at specific low temperatures.

Examples in human use

Ebola vaccine

In clinical trials for COVID-19

University of Oxford/AstraZeneca, Jannsen, Cansino, Gamaleya