Third and Final Portion of a Presentation Looking at How Humans Acquire Immunity and at Examples of Stimulating Immunity Via Vaccination

The first presentation dealt with how humans acquire immunity.

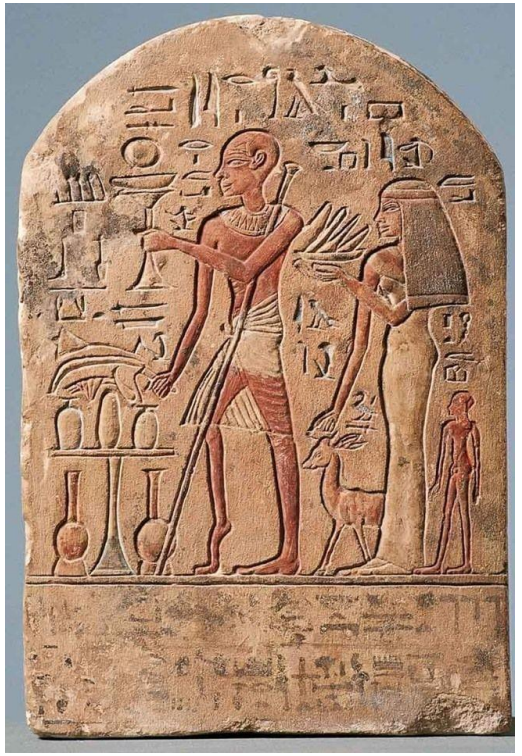
1. **If you will recall, we can have natural active acquired immunity by recovering from a natural infection. A child picks up immunity naturally and passively from its mother while in the uterus and from breast milk while nursing. We can acquire immunity by being given a vaccine (artificially active) or by being given antibodies made by another animal (artificial passive).**
2. **We then looked at types of vaccines which included living organisms (smallpox, killed organisms (flu), inactivated toxins, or by injecting parts of bacteria or viruses.**

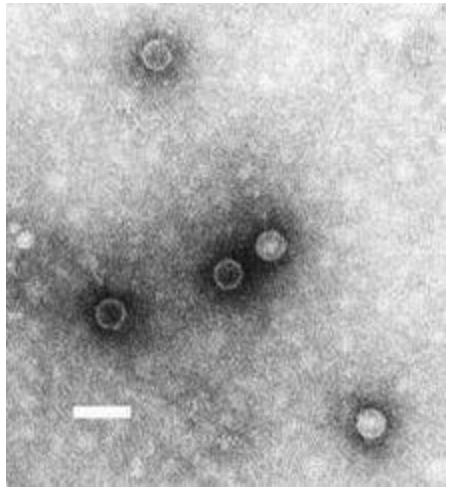
In the second presentation we looked at specific diseases and how we acquire immunity to smallpox, tetanus, diphtheria, and whooping cough.

In this third and final presentation, we will examine how we are typically immunized against polio, the flu, measles, mumps, and rubella. And finally, we will get a peek at what a vaccine against Covid-19 might look like.

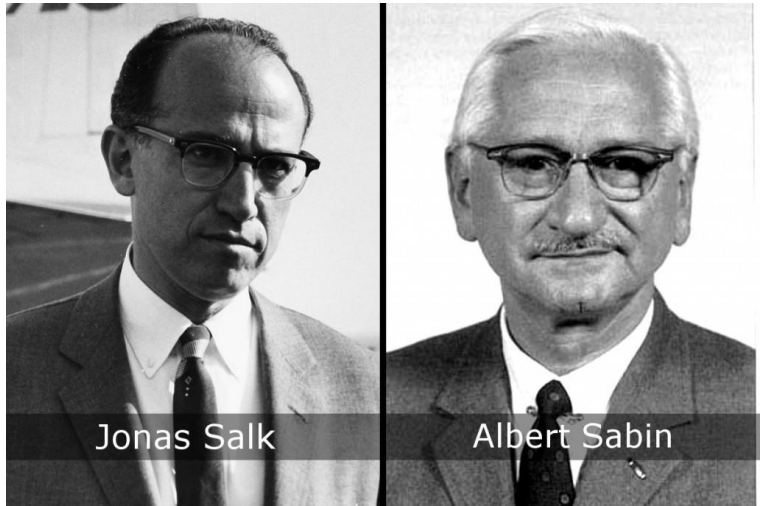
Immunization Against Polio

The polio virus has been present in the human population for thousands of Years. An Egyptian stele in a tomb dating back to the 18th dynasty (1570-1342 b.c.e.) exhibits a priest whose right leg shows signs of his having had polio.





The poliovirus shown on the left enters the environment through fecal contamination from infected individuals and enters a new host via the oral route. Most people will experience mild symptoms, but a small percentage of individuals will develop an invasion of the central nervous system resulting in a paralytic form of the disease. Dr. Jonas Salk (lower left) was able to grow the virus in cells raised in tissue culture flasks. The Viruses were inactivated and used to develop a vaccine in 1955. The Salk vaccine was 75% effective for a period of around 15 years. Later, Albert Sabin developed live, weakened strain of the polio virus, that could be administered orally which made this form of the vaccine easier to administer.



Unfortunately the virus in the oral vaccine can mutate back to a form that could cause polio. Today, the U.S. has switched to the inactivated vaccine while Europe still uses Sabin's oral, active vaccine. Currently, there is a push to do away with the "live" vaccine completely because its serious side effects.

Vaccination Against The Influenza Virus

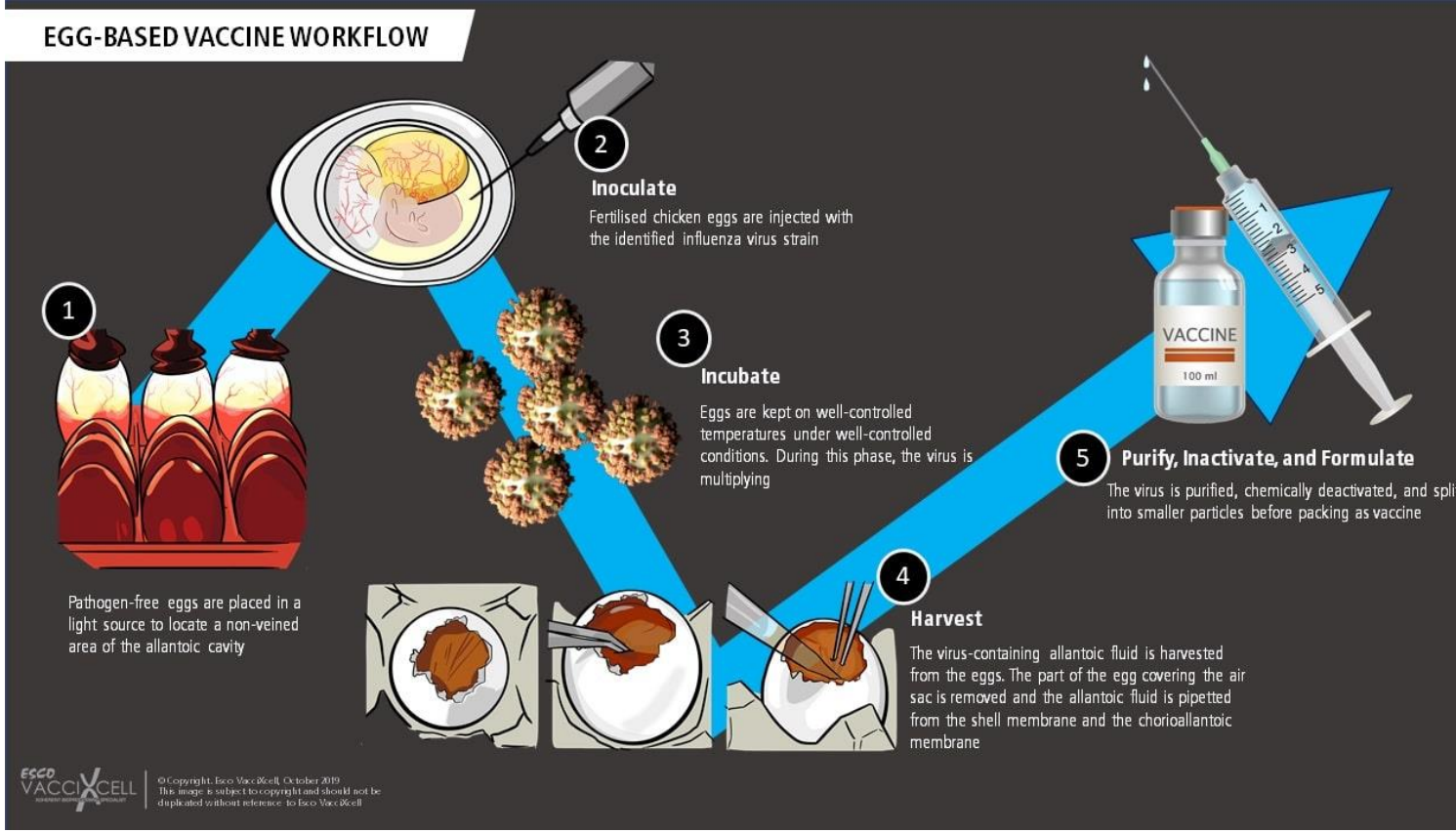
We are currently dealing with the Covid 19 pandemic, a worldwide disease that most likely jumped from animals to humans because of contact with the former. The impact of this pandemic has changed our lives significantly and we may continue to feel the effects of this disease for years to come.

If we go back to the fall of 1917 and the spring of 1918, we will see a very similar situation that we are currently experiencing. World War I was still raging in Europe and the United States was starting to mobilize troops to be sent to join this conflict of immense proportion. An illness appeared in a troop training facility in Kansas which would follow the solders as they boarded transport ships destined for the trenches in Europe. When 1918 gave way to 1919, America would experience a disease outbreak that had started in Kansas and spread to the rest of the country to a level like we had never seen before. When this epidemic, which consisted of flu-like symptoms, finally burned itself out, 600, 000 citizens in the U.S. were dead as were millions more in other countries throughout the world.

Each year the "flu" comes back to our communities but not to the same degree that we saw in 1918-19 due in part to a better understanding of how to treat and prevent the disease. Vaccination against the flu viruses has become a yearly ritual that is performed in order to prevent the serious side effects associated with flu.

Flu Vaccine Production

Most of the current flu vaccines contain in-activated viruses grown in embryonated eggs. As shown on the right, eggs are injected with live virus which replicates. The virus population is then harvested, chemically inactivated, and prepared for use. Each year, vaccine makers must choose which virus to use in making their vaccine because the virus mutates or undergoes gene recombination, producing new viral strains.



New Wrinkles in Flu Vaccine Production

- **Multiple virus strains in one vaccine: This does away with some of the guess work as to which virus to use to make the yearly vaccine**
- **Component vaccines (Parts of virus used): Pieces of the virus in a vaccine can speed up vaccine production.**
- **Universal vaccines (Jan., 2020 NY Times): Finding molecules that all flu viruses share, thus one vaccine for all flu viruses.**

Measles, Mumps, and Rubella Vaccine

These three diseases a lumped together because they are viral in origin, typically childhood in nature and have serious side effects that can lead to death, organ damage, or birth defects when fetuses are infected in utero. The current MMR vaccine contains <u>attenuated, living viruses.</u>

It is critical that immunity to these viruses exists in the human population because of complications associated with natural infections such as encephalitis and pneumonia. Cases of measles and rubella are on the rise despite the availability of effective vaccines because of the unsubstantiated link of childhood vaccination with the development of autism. Over seven hundred cases of measles occurred in New York City in 2019-20 because of reduced immunization using the MMR vaccine.

Development of Covid-19 Vaccines

One such vaccine is Moderna Inc's mRNA vaccine or mRNA-1273 vaccine. Moderna Inc. has received almost $500 million to develop their version of a Covid-19 vaccine. It involves focusing on the surface spike protein that allow the virus to attach to the host cell which then allow the virus to enter the cell and start replicating. Moderna's novel approach to vaccination involves constructing a messenger RNA that carries the information for making the viral, surface spike. That RNA is then replicated in the lab and inserted into the person who is to be immunized. This mRNA will find its way into host immune cells where it will be converted to viral protein. It is this viral protein that will be presented to cells of the host's immune system which, in turn, will be stimulated to produce antibodies that will recognize the surface protein on an invading Covid-19 virus. (View the process in lower right diagram.)

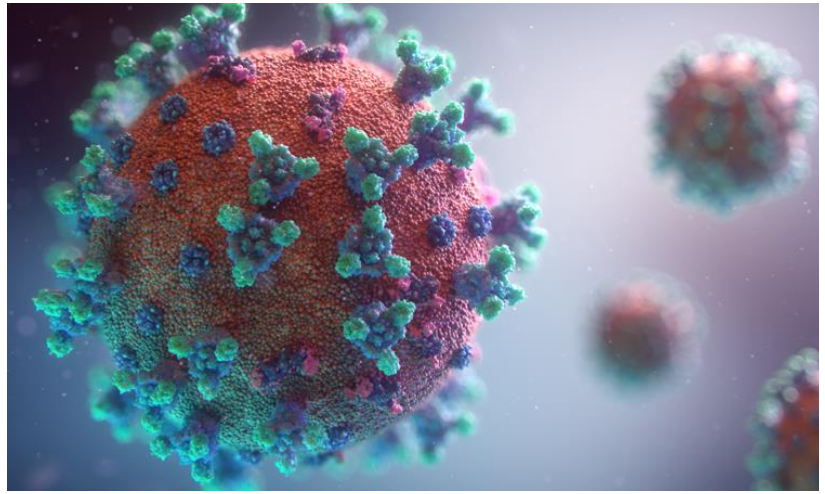
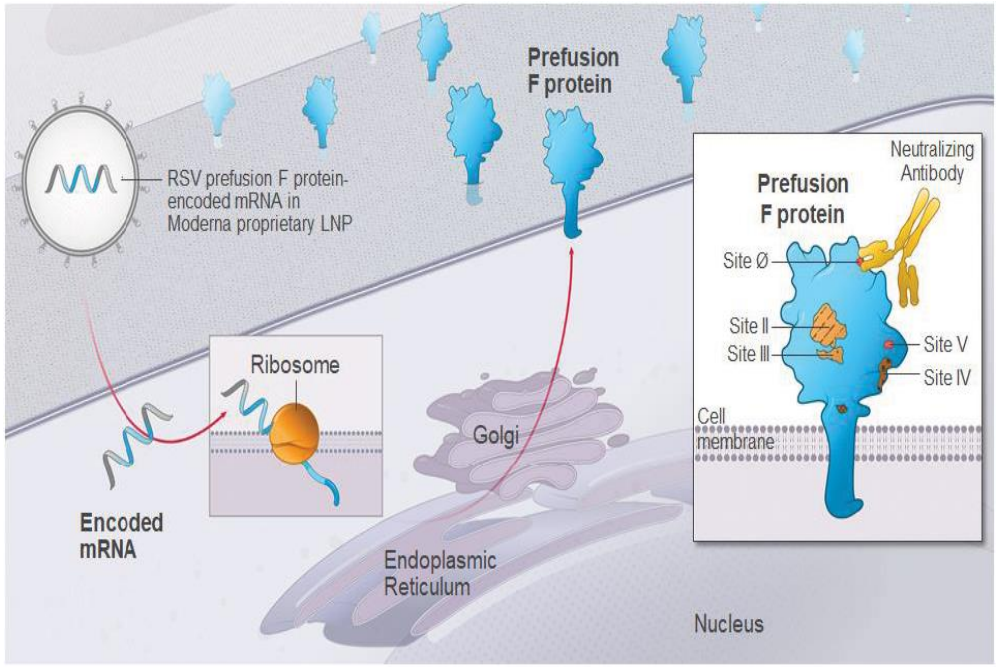


Image showing a Covid-19 virus with spike proteins

mRNA for viral spike is prepared (upper left) and then transferred into a non-immune host. Once inside immune cells (lower center), the mRNA is converted to viral protein. The viral spike protein is then trans-ported to the surface (upper right) where it will stimulate other immune cells which will then attack invading Covid-19 viruses



Summary Of Information On Vaccines

We have seen that the immune system of the human body can be stimulated to produce immunity toward invading microorganisms. This immunity can take the form of circulating antibodies or it may consist of immune cells that may attack infected body cells. This attack will be relatively specific in nature, meaning that the immunity produced is directed toward the substance, virus, or bacterium that stimulated the immune response. Vaccination is the term used to describe the process by which substances or organisms or "vaccines" are introduced into the body to elicit a "specific" immune response.

A vaccine may contain living organisms as seen in the development of immunity to smallpox in 1796 or, more recently, when immunizing against measles, mumps, and rubella viruses. Living organisms typically produce strong immunities, but they have the disadvantage of sometimes producing mild or serious forms of the original disease. To circumvent this problem, killed or inactivated vaccines have been used instead of organisms that can reproduce. Unfortunately, nonliving vaccines often produce levels of immunity in the host that will fade with time.

Today, as we see with the Moderna vaccine that recently started clinical trials, the vaccines may consist of pieces of genetic material from the target organism that will stimulate the formation of antibodies. Thus, we have come a long way from inhaling dried pus from skin lesions to induce immunity to smallpox.

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