An Introduction To Current Epidemics In the United States

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The Development of Acquired Immunity

At this point of our lives, where we are trying to adjust to the presence of Covid-19, the one question that is foremost in our minds is, when are we going to get a vaccine that will return our lives to relative normality. This is not the first time that humans have asked "how are going to get rid of a disease that is causing our world to "go upside down?" Thousands of years ago the Chinese asked this question about smallpox; a disease that we learned to cope with in the 1700's and eradicated in the 1900's. The same question was asked about bubonic plague, polio, measles, mumps, rubella, influenza, HIV-AIDS, and now Covid-19.

Having immunity to an infectious disease takes many different pathways, and this journey is what I want to look at in this presentation. Resistance to disease can be built into who we are in the form of what immunologists describe as our *innate immunity.* Humans have resistance to a number of diseases that plague other animals; examples of this would include canine distemper, bird cholera, blackleg in cattle, and equine sleeping sickness. We are just now looking at how innate immunity to these and other diseases works and a discussion of innate immunity is beyond the scope of our current inquiry. The important idea that we should take from this is that innate immunity does not require any kind of stimulus, it is built into the chemistry and cellular structure of our bodies which is determined by our DNA.

What I do want us to look at in more detail is our *acquired immunity* to disease. This is immunity that requires some kind of stimulus from outside our bodies. If that stimulus doesn't occur, we never acquire immunity to a particular infection. I usually tell my microbiology students that acquired immunity comes to us in four forms: natural active, natural passive, artificial active, and artificial passive. You will understand these terms when I give you examples of each. Examples of natural active would include *recovering* from a measles or mumps infection, or from a case of influenza, or from a Covid-19 infection. The important point here that you must remember is that you have to, obviously, recover from the disease. Natural passive, acquired immunity is a little more subtle, but important none the less. A newborn human child receives maternal immunity in the form of antibodies that crossed the placenta, in utero, from the mother to the fetus. The neonate will also receive immunity in the form of antibodies found in breastmilk of nursing mothers. Both of these forms of passive immunity are temporary; it only lasts as long as the antibodies circulate in the newborn's body; the child's developing immune system did not make these antibodies.

Artificial forms of acquired immunity are what we pick up in the doctor's office or from someone trained to give and injection. Artificial active immunity involves receiving some kind of vaccine or toxoid, both of which will be covered later. Vaccines may consist of "live", weakened viruses and bacteria or they may contain inactivated, killed organisms, or they may contain pieces of an organism that will stimulate the type of immunity that will protect a person when exposed to a natural infection by the targeted organism. Artificial passive immunization is relatively rare. One example would be receiving an anti-venom when bitten by a poisonous snake. The anti-venom consists of antibodies produced by some host, usually a horse, who has been exposed to the venom. Other examples would include anti-toxins against tetanus toxin, diphtheria toxin, botulism toxin, etc. These are usually produced in the same manner as the anti-venom. This type of transfer of immunity is not without associated hazards, and is therefore, used only when absolutely necessary to save the life of a person.

Some General Aspects of Vaccine Development

Criteria to be Followed During Vaccine Development

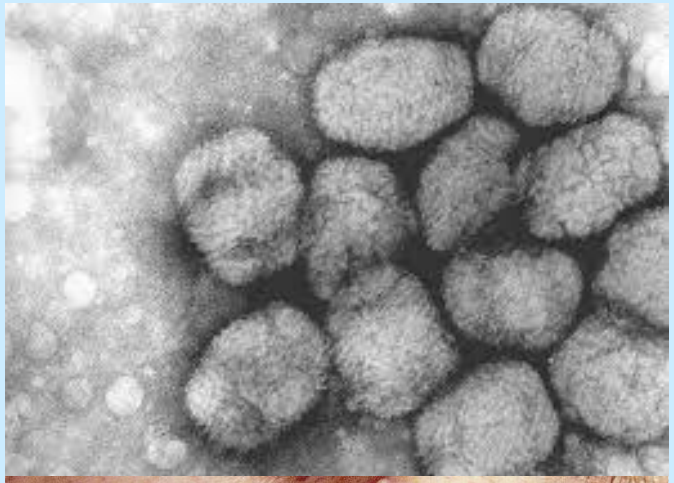
1. The vaccine must be safe to use
2. The response by the host must result in a protective level of immunity
3. The level of immunity should last for a “reasonably” long period of time.

General Types of Vaccines

1. Vaccine may consist of living or weakened organisms. Some organisms have, through natural processes or by laboratory manipulation, have lost their ability to produce disease in humans. In some cases, these “weakened” viruses or bacteria can produce excellent immune responses in nonimmune hosts against natural infections.
2. If weakened organisms for immunization are not available, disease producing viruses and bacteria can be killed or inactivated and used to produce immune responses that are protective against natural infections.
3. New technologies have allowed makers of vaccines to by-pass the use of whole viruses and bacteria to prepare immunogenic vaccines. They are now able to select a particular molecule from a virus or bacterium that will produce strong immune reactions without the side effects often associated with whole organisms. With the advent of new genetic manipulations, we see vaccines made from viral RNA or DNA that will produce the desired target immunogenic molecule in the host. Some of the Covid-19 vaccines being developed are in this category.

Smallpox-Our First Example Of Vaccine Development

The Virus



Skin Pustules

The smallpox virus is a highly infectious organism that has been with us for thousands of years. It is picked up via the respiratory tract or by direct contact with infected individuals. The virus is spread throughout the body by the circulatory system, but we typically see pustules developing on the skin. The typical form of the disease had a mortality rate of 30% which was due to damage done to multiple organs of the body. Hemorrhagic smallpox, a more lethal form of the disease had a much higher mortality rate. Those who survived the infection had significant scarring after the pustules, opened, drained, and crusted over.

It is estimated that millions of people died because of small-pox epidemics. Entire civilizations in the Americas were decimated after the poxvirus was introduced by the Spanish Conquistadores, starting in the 1500's. It is not surprising that there were attempts early on to reduce the destructive powers of this disease agent