Dear Editor,

Please find enclosed a modified version of my high school textbook “Vaccines: How it works with our Immune System.” To address the concerns of 2 of my reviewers, I changed a few of my sentences to make it flow better, fixed grammar, and expanded on some more information. It is my hope that these changes make the manuscript acceptable for publication in Micro reviews in Cell and Molecular Biology.

Sincerely,

Sydney Henricks

**Reviewer 1:**

1. Reviewer 1 did not leave very much criticism to improve my paper. They did leave a few comments that were helpful that I didn’t notice, but for the most part, it wasn’t super helpful.
2. Review 1 pointed out that my font switched halfway through my chapter which was very helpful because I did not notice.

**Reviewer 2:**

1. This reviewer left helpful comments such as my microbe definition was incorrect. They did suggest that I should expand on herd immunity but I didn’t feel it was necessary.
2. Reviewer 2 helped me realize that I was too vague in a few of my sentences by saying “something” and “somehow.” I made those changes and believe that it helped improve my chapter.

**Reviewer 3:**

1. Reviewer 3 left the most helpful reviews I have received. They edited my chapter in order to see where I could improve. I do disagree with a few of their comments, such as stating that my chapter sounded like Wikipedia, which is something that I was aiming for. High school chapters are supposed to be factual, like Wikipedia.
2. I made many changes to my chapter that this reviewer pointed out, such as grammar and misinformation.

**Vaccines: How it works with our Immune System**

**Introduction**

Vaccines and their effects on people have been a controversial topic for many years now. People have been refusing to vaccinate their children due to the worries and suspicions that they will cause major issues to their child. A **Vaccine** is a substance created from a causative agent of a specific disease or illness, such as a virus, that is introduced to a patient’s body to help their immune system recognize a specific infectious disease and hopefully prevent it from infecting if it ever comes in contact with that virus again by having immunity. Vaccines are made from **microbes**. A microbe is a single cellular organism. The microbes used for vaccinations are dead and inactive so they are unable to prevent disease, but allows the immune system to register it as dangerous and remember it for the future. Some vaccines may need booster shots years later. This means that the immune system may not remember the dangers of a disease that it’s been previously introduced, so it needs a “boost” to fight it better when it starts to wear off. If the majority of the people are vaccinated, it could eliminate a disease all together. While vaccines do protect individuals, it also gives ‘herd immunity.’ **Herd Immunity** is a collective community protection. This means that if enough people in a community are protected, it will help prevent the people who haven’t been vaccinated from getting the disease.

**Microbes and Diseases**

Believe it or not, only 1% of bacteria has the capability to invade our human bodies and cause us to get sick. There has been some talk about how they could cause heart disease or even some cancers. A **Pathogen** is a micro-organism that could cause disease. An **infection** occurs when a pathogen invades a body and begins to multiply and release toxins that will cause a reaction in the host. A **disease** is when an infection causes damage to someone’s body and/or systems. Just because an individual gets an infection, it does not always have to result in disease. In order to get a disease, you have to start with a pathogen getting into an individual’s body through many different pathways. Microbes and pathogens work their way into our bodies in several ways: Respiratory tract, gastrointestinal tract, urogenital tract, and skin. Microbes that enter through our respiratory tract have the capability get into our nose and mouth and cause several illnesses like the flu and a respiratory infection. The gastrointestinal tract is through the oral cavity. Urogenital tract is through a person’s urethra; common illnesses can be cystitis or urinary tract infections. It is not enough just for the microbe or pathogen to enter the body through those different pathways, but it has to go through steps to become an illness. One way it can become an illness is by reaching a target site in the body. For example, *Gardnerella Vaginalis* must work its way to the vagina to cause the disease. Another way for the microbe to cause disease is by multiplying quickly. This is how cancer turns into what it is. Other ways to cause disease is if the microbe begins to take nutrients from their host while hurting the host, this is a **parasite.** The main way it turns into disease is by avoiding and surviving through an attack of the immune system. It can not get to the target site or multiply if it has been killed by the immune system.

**Immune system**

The human’s immune system is one’s own personal military. It fights off unwanted and threatening microbes. The human immune system is very complex with so many moving parts. There are several stages of defense in the immune system that a pathogen must get through before it can cause illness or disease. The first line of defense is specifically trying to stop pathogens from entering the body. The skin and mucous membrane is the main defender in this step. The skin acts as a barrier to most, when there is a cut, the skin produces a scab or seal in order to prevent pathogens from entering. The skin, lining of the nose and even a humans intestinal and digestion tract have flora that is natural to the body. This gives the pathogens a place to attach themselves, but they have to compete with the flora for nutrients and normally lose. The respiratory system contains a mucous passageway from the nose leading to the lungs. This helps trap pathogens and other particles that do not need to be in the lungs. When particles get into the mucus pathways, it is worked back up the nose or throat to be coughed or sneezed out. It gets moved up the pathway by hair-like features called **cilia.** There areother defenses, such as our saliva has enzymes that break down bacteria, our stomach acid kills some bacteria, and our urine kills the pathogen in our urinary tract.

The second line of dense is activated if the first line fails and lets the harmful bacteria into the body. **Phagocytes** surround the pathogens and eat them. When the eat them, they release an enzyme to break down the pathogens before they are released and able to cause infection. This process is called **phagocytosis.**

The third line of defense is the immunity phase. Now the pathogen is called an **antigen**. This means that it is now a real threat to the body and has potential to cause infection or disease. **Antigens** is a type of protein that is found on a pathogen. When an antigen enters the body, an **antibody** will be produced and will bind to the antigen on the pathogen to prevent it from binding to other proteins in the body. The antibody produced will have a binding site specific to the antigen it is trying to fight off. Antibodies are always a ‘Y’ shape. A certain type of white blood called **lymphocyte** will recognize the antigen and send the antibody to it. The antibodies kill the antigen by being engulfed and eaten. While the antibody is doing its job, the immune system is developing a memory of that antigen in order to fight it quicker the next time it gets introduced to the body, these are called “memory B cells.”

**How Vaccines Are Made**

There are several strategies for vaccines for different types of diseases. There are weakened vaccines. These are not very strong when they are put into the body, but its just enough for the immune system to go through its stages and remember it. This technique is used for measles, mumps, chickenpox, polio, influenza, etc. These work by only reproducing themselves in the body about 20 times, when it is a real infection, it can reproduce thousands of times. This gives the immune system just enough for the memory b cells to act on it but not enough to cause a real threat. One good thing about the weakened vaccines is that they last a long time. They may need a booster once or twice but it lasts several years. A downside to these, is that they can not be given to someone with a damaged immune system like a cancer patient or someone who has been diagnosed with AIDS.

Inactive viruses are another form of vaccine. This is when a virus is dead or inactive. They do this using a specific chemical to deactivate the pathogen that will be injected into the person’s immune system. When they are inactive, it is impossible for them to replicate. This technique is used for polio vaccines, rabies, and hepatitis A. The vaccine is still registered by the immune system so the defense is still practiced in case you run into a real threat to those illnesses. There are positive reasons to use this vaccine, such as, it cannot cause that person to get sick and it can be given to someone with a weaker immune system. Although, it may have to be administered multiple times to build a complete immunity.

Using part of the virus is also an option for vaccinations. They do this by just using the protein that is on the virus itself. This can be used when protection is only used from a part of the bacteria. It can be used on people with weaker immune systems and have been shown to achieve immunity with just two doses.

The last option is to use part of the bacteria instead of the virus. Some bacteria form a **toxin**, which is a protein that can cause damage to the persons body tissue. The use this method by inactivating the toxin and injecting it into the immune system. It has a similar process as the inactive virus. The inactive toxin can not form disease but gives the immune system an idea of how to fight it off. The tetanus vaccine is made this way.

**Vaccines with babies**

Every year, 10 million vaccinations are given on babies a year or younger. There has been debates over whether or not vaccines cause babies to have congenital conditions. These congenital conditions will start to show their signs and symptoms around the first year of life, which is when they get their vaccinations. This puts the two situations in close relation to each other time wise, although this does not mean that the vaccinations are causing these conditions. It has not been proven one way or another. The Food and Drug Administration (FDA) and the Disease Control (CDC) have been monitoring and analyzing the connection between the two.

The main argument is that too many vaccines at once cases the baby to be in distress. Studies have shown that it is just as stressful for the baby to get one shot as it is to get several shots. Experts say that receiving one shot every month could be more stressful than receiving several at one time. At birth, babies should receive the hepatitis B shot to prevent any illnesses when they are defenseless, it is a safety net in case anyone around the baby may be a hepatitis B carrier. Breastfeeding also helps build the babies immune system because the mother is sharing some of her defense.

While breast milk helps, vaccines are one of the most important measures to prevent infection and the spread of the disease. These fears of vaccinating our children go back to the 18th century. A more recent example, in the 1970’s the British decided they did not want to vaccinate against pertussis, this caused the almost extinct disease to skyrocket years later. The country published what had happened and even offered a financial incentive to doctors if they hit a target number of vaccinations. In result, the disease declined drastically.

**Conclusion**

Vaccines have been a vital part of our immune system and wellbeing for years and years. They have adapted and improved to make them as safe as possible. The vaccines are made in several ways in order to be able to give them to everyone regardless of their health. Our immune system is a tricky thing to learn about since it has so many moving parts and stages to protect our health and fight off unwarranted bacteria and pathogens. In 2020, a pandemic broke out with COVID-19, which is a novel virus. That means that it was brand new and science knew hardly anything about this virus. Our immunity helped researchers learn about the virus and how to vaccinate for it. Vaccines have been known to help so many illnesses be fought.

Refernces

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