**Chapter 1: Immunization, antiseptics & antibiotics**

Though you would not expect it, most microbes and microorganisms are not harmful. However, some of them are pathogens, or organisms that cause disease in humans. The study of microbes and the study of the immune system are very closely related. Three major purposes of microbiology are to treat, diagnose and find cures for illnesses. To find and understand illnesses you must first understand the basics of microbiology, starting with the difference between the treatments and preventions of illnesses like immunization, antiseptics and antibiotics.

“Almost all aspects of life are engineered at the molecular level, and without understanding molecules we can only have a sketchy understanding of life itself”

–Francis Harry Compton Crick (1916-2004)

**1.1 Immunizations & the immune system**

We all have a general understanding of what an immunization is, but most of us do not know why we get them or how they work. **Immunization** is known as the process by which a person or animal becomes protected against a disease. It can also be referred to as a vaccination or inoculation. When the body is infected with a virus it uses its natural responses to try to fight off the illness. But in many cases, the cells and defenses that our bodies can supplies cannot always combat the virus. For example, when our bodies are introduced to the influenza virus, the contact can come from the airways or due to salivary contact. The virus attaches to epithelial cells in the respiratory tract. **Epithelial cells** form epithelia that line the body’s cavities. Epithelial cells are different from blood cells because they do not have capillaries. **Capillaries** are the smallest of blood vessels. The virus tricks the cell into letting it enter into the cell and it makes its way into the nucleus. Just hours after the virus has entered the body, the influenza virus begins to start replicating. Once in the nucleus the virus will encode the nuclear material of the virus and make a brand new construction set, kind of like a copy machine. A single cell can make millions of copies of the virus and release it into the body. The viral replication will begin to infect the cell causing epithelial cells to be destroyed. While the virus multiplies fast, your immune system can work faster.

Our bodies are constantly under attack. Because of this, our bodies have created an immune system made up of our own little soldiers to combat illness. The immune system has several functions and each cell can have many different jobs. The main job of the majority of these cells is to kill viruses. Every cell is lined with antigens; the antigens on the cells that belong to your body will not trigger an alert to your immune system. However, a foreign cell will be coated with antigens that cause a stimulus in the receptors on your cells. When an antigen receptor on a bacterium attaches to one of your cells, that is when one of your B cells will divide and flag the unknown cells for your immune system. This will cause the immune system to be alerted. At first, your guard cells known as macrophage intervene. They are huge cells that can often stop an attack by engulfing the flagged cell and breaking it down. When the virus is too large, these cells send out messenger proteins that communicate location and urgency. Neutrophils, the next response effort are one of the most common white blood cells in most mammals. They make their way to the infection and they work so hard that they often kill healthy cells as well. They also generate boundaries to hold the infection back. If this is not enough, the dendritic cellbecomes active and collects sample of the infection, and also determines who to call next for help. A dendritic cell’s main function is to process antigen material and present it on the cell surface to the cells in the immune system. The dendritic cells makes it way through the body until it eventually finds a helper T cell. The T cell is another type of white blood cell that plays a central role in cell-mediated immunity. The T cell multiplies, and some of these cells, memory T cells, can often stay in the body after the infection or virus is gone to make the body somewhat immune to the virus. T cells activate B cells, a type of white blood cell, that release antibodies. **Antibodies** protect the body from disease by binding to these organisms and destroying them. There are three essential functions of antibodies: they effectively layer the surrounding of an invading cell, they bind precisely to unwanted antigens, and they also trigger other parts of the immune system. Though the immune system can be complex, every part of its effort is imperative.

**1.2 Vaccinations**

If there were something that could prevent the body from having to go through this tremendous process, wouldn’t we all take advantage of it? Vaccines give your body a practice run in defending against germs. There are five ways a vaccine can be made; a weakened form, an inactive form, part of a form, deactivated toxins from a disease, or a mimic of the disease. All vaccines initiate the production of protective antibodies, like from the B cell. They are constantly on the lookout, and if the germ arises it sends signals to the whole body so it is ready to go. Vaccines help develop immunity by imitating an infection. **Immunity** is a natural defense system of the human body. Millions of immune cells, like the B cell, are on the lookout of specific germs. If they spot something dangerous they prepare to fight, the immune cells arm themselves and replicate creating an army. After the release of antibodies and the removal of these germs, these cell leave behind memory cells, always looking out for the germ. A vaccine prepares the immune system, just enough to recognize the viral infection. This creates the memory cells to be on the lookout. Sometimes, after getting a vaccine, the imitation infection can cause minor symptoms; such as fever, but vaccination do not normally cause someone to acquire the illness. Receiving a vaccine is a primary way for your body to develop immunity.

There are two types of immunization, active and passive**. Passive immunity** is when you have gained resistance to the disease without having to actively do anything to gain resistance. You have received the antibodies to fight off an illness without having to create the antibodies. On the other hand, **active immunity** is when your immune system has to be exposed to the disease in order to actually create the antibodies that are needed to fight the disease. Passive immunity is the goal; it would be great to be immune to all diseases without having to experience the illness at all, but passive immunity does not last for very long because your body does not know how to make the antibodies. **Natural passive immunity** can occur; such as when a baby acquires the antibodies from the mother’s body before it is born. Breast fed babies often receive milk packed with antibodies in the first few feeding after birth as well. When you receive a vaccination it is like acquiring a short-term passive immunity. That is why you have to get a flu shot every year.

These vaccinations are made from microbes that are inactive or dead so that they cannot cause disease. Vaccinations are designed to prevent disease not cause it. **Microbes** are tiny organisms (including viruses and bacteria) that can only be seen with a microscope. An **antigen** is the foreign substance in the body surrounding a foreign cell that the capable of causing disease. Likewise, a **pathogen** is a microorganism that has the potential to cause a disease. Not all infection result in disease. To make us ill, microbes have to attach to the targeted spot that it is their function to infect, obtain nutrients from the host or target, and survive the attack from the immune system. Vaccines contain special antigens that can be the same as the antigen at the surface of the disease. This is how the vaccine stimulates the body to produce antibodies. Vaccines can be given in different forms, by injection or in a mist through your nose. The person treated with the vaccine will now have immunity to the pathogen.

Microorganisms that are studied in microbiology affect every aspect of human life, some can cause disease and other can be harmless. These life forms are essential to our bodies’ nutrients and ecosystems. They are the key role in maintaining life, whether they are friend or foe. The development of immunization is crucial in preventing foes like viruses. Though vaccinations do a great deal in preventing disease, the scientific community has developed several alternatives to fight pathogens after it has already infected something.

**1.3 Disinfectants or Antiseptics**

On a broader scale, antisepsis, disinfectants, and sterilization are often clumped together. Whether you are performing brain surgery or just cleaning your house, these three things are essential needs to clean items and maintain cleanliness. Disinfection is very common and is a task many of us perform daily. **Disinfection** is the process of destroying and eliminating almost all of the microorganisms on inanimate objects and surfaces. A simple house cleaner is a disinfectant, but the important thing to remember is that disinfectants do not eliminate all microorganisms and are used on inanimate, or non-living, objects. Even the best disinfectants cannot eliminate all microorganisms and require special conditions, like a specific temperature or definitive concentration, to perform at its best. Some disinfectants kill microorganisms and other just inhibit their growth and reproduction. This is in relation to sterilization. **Sterilization** is the destruction of all microorganisms on an inanimate surface or object. Sterilization is not necessary in a household, but it is indispensible in areas of a hospital, like a surgical area. Different from Disinfectants and Sterilization, **Antiseptics** are substances that kill or prevent the growth of microorganisms on a living surface. Antiseptics are **Antimicrobial**, An agent that destroys microbes, inhibits their growth, or counteracts their function. Antiseptics are toxic to both the microorganism and host, which is why they are not used casually. Antiseptics clean things that are crucial; they are often found in mouthwash, and cold sore or yeast infection treatment creams. Antiseptics can also be used on the skin in areas with a cut or an area that is about to be cut, to prevent infection. They are also commonly used before a surgery on the area where an incision is going to be made. This works because the antiseptic kills all of the bacteria on the skin to prevent infection once the cut is made. A familiar antiseptic would be Iodine; Iodine is a yellowish color, and this is often what you may see on surgical television shows before surgery. Antiseptics function by changing the environment of the bacteria and altering the pH. Microorganisms flourish when they are within their desired pH level, but when they are not in their demanded pH level they deteriorate or all of their function is inhibited. Though Antiseptics do a great job of killing bacteria on the body, they are not ideal or safe to be used within the body because they prevent the growth and development of all microorganisms, not just the bad ones. Disinfectants, sterilization, and antiseptics are all a very valuable tool in today’s society, but they all have great room for improvement.

**1.3 Antibiotics and Resistance**

When treating a bacterial disease inside the body, the use of an antibiotic is often necessary. **Antibiotics** are substances that stop the growth of bacteria or kill them. For a simple illness, like the common cold, your white blood cells can destroy these microorganisms and release antibodies to help. Although, when an infection is severe enough you may need more antibodies to inhibit the germs or to treat the illness more abruptly. Pathogenic germs may enter the body causing infections, which can be treated by antibiotics. The most commonly known antibiotics are penicillin and tetracycline. Antibiotics can function in many different ways. Their main function is to stop the bacterial cell from multiplying by using the difference between a cell body and the bacteria to its advantage and interfering with the processes that the bacterial cells need to multiply: including DNA replication, metabolism, & protein production. Antibiotics will simply allow the host to kill the infection by inhibiting the bacteria for a certain amount of time. Some antibiotics drugs may cause the cell wall to deteriorate or even cause the bacteria to become unresponsive. Most antibiotics have no effect on your immune system because they are simply adding their own antibodies.

The reason antibiotics are so different from vaccinations is vaccinations often preclude viruses. On the other hand, antibiotics have no effect on viruses because they are such a different structure compared to bacteria. Viruses incorporate themselves into a host cell in the body; antibiotics have no effect on your body’s cells. It is difficult to develop drugs that kill viruses without also damaging the body’s tissues. Therefore, they cannot stop the replication of the viruses. The use of antibiotics to treat viruses has become a huge issue. Bacteria acquiring drug resistance could be caused by the use of antibiotic when not necessary, or the use of antibiotics to kill bacteria that are no harm. The incorrect use of antibiotics by patients and doctors is the most common source of antibiotic resistance. When taking an antibiotic, they should be taken for the entire time they are prescribed for. Even if you no longer see symptoms, it is still essential to continue the antibiotic because the pathogen could still be flourishing in your system, do to how rapidly bacteria can multiply. In addition to taking the antibiotics in full length, they should only be taken when truly necessary. Antibiotics are frequently prescribed to treat illnesses that are not bacterial. They should not be given for viral infections, like influenza. The bacteria that survive an antibiotic are the ones have offspring that can have evolved to be drug resistant. Society is up against a very serious issue; drug-resistant bacterial infections are becoming more prominent. The only way to control the spread and creation of drug-resistant bacteria are to use antibiotics responsibly. It can be hard to find the precise amount of antibiotics needed; if too little is given then it can be easier to turn to broad-spectrum antibiotics. Also, the use of more than one antibiotic at the same time can also misattribute the functions of the antibiotic. To fix the prolonged growth of antibiotic resistance, it will take effort form both physicians and patients. The use of antibiotics is so critical to today’s medicine that the only option is to work our way around the issue of antibiotic resistant bacteria. Antibiotic are an amazing tool when used correctly.

**Overview**

As complex as the immune system is, after broad explanation of vaccinations, antiseptics, and antibiotics you should now be able to tell the similarities and the differences between the three components. Antibiotics and vaccines are both used to protect the body from germs but they perform in very different ways. Vaccines are dead or inactive organisms that are used to help provide immunity to disease or infections. While vaccinations prevent disease, antibiotics *treat* the illness. Differing from vaccines, antibiotics cannot be used to treat a virus, opposed to vaccines, which prevent viruses. Both of these mechanisms are in favor of keeping your body happy and healthy. Antiseptics kill all microorganisms, this differs from vaccines and antibiotics because it can be hostile to use inside of the body. The investigation of the immune system, viruses, and microbes continue to bring new discoveries to light. Maybe some day in the future, Immunologist and Microbiologists could have one treatment for all of the potential bacterial and viral illnesses.

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