**The Immune System: Your Body’s Superhero**

**Chapter Overview:**

In this chapter we will be discussing the immune system and the complexity of the system on defending host cells from antigens, viruses, and anything else that poses a threat to the health of the cell. There are different immunities that carry vasts amounts of different cells with specific functions to help fight off an infection. You will understand why your body functions and reacts the way it does to protect itself from getting worse. There is a reason for every sneeze, swelling, cough, and more.

**What Is a Pathogen? Where Does It Come From?:**

It is very common for humans to experience some form of an infection at one point in their lives. An infection is spread through contact with what we call a **pathogen**, which is the cause of an infectious disease. Pathogens can be either a bacterium or virus that is spread through some form of contact, which is then replicated and spread, posing a threat to the healthy cells in the body. Pathogens are usually found and spread from different sources. They can be found in humans, animals, and other natural surroundings. Humans usually contract a disease through some form of physical contact, ingestion, or through respiration.

(McGraw-Hill Biology 2017)

**Symptoms and Their Purpose:**

Your body generates many different physical responses to an infection, and this is usually the first indicator of being sick. The most common symptoms are fever, aching, fatigue, and pain. When a pathogenic cell enters the body and attacks the healthy cells it exits through a mechanism called exocytosis, which causes the cell to burst, damaging the tissues. There are also harmful chemical toxins that are released during this spreading process. These toxins, when spread via the bloodstream, can induce different responses like the examples discussed. These responses are the first attempt at trying to get rid of the infection and is a good notification to the host that something is wrong.

(McGraw-Hill Biology 2017)

**Innate Immunity- Nonspecific Immunity:**

Innate immunity is also known as **nonspecific immunity**, this is the defenses that we are born with. The name itself implies that this immunity isn’t specific towards any specific pathogen. It works on a more broad spectrum and protects the body from any pathogenic threat. The innate immunity is the first line of defense while the adaptive immunity develops an attack plan. There different barriers a pathogen must face before fully entering the cells. These barriers are physical and chemical barriers.

**Physical-**

The very first line of defense is the skin. The skin is made to protect what’s on the inside from harm from the outside. The skin contains symbiotic bacteria that release a toxin when feeding on the oils. This toxic acid produced can inhibit pathogens.

**Chemical-**

Bodily secretions such as tears, saliva, and mucus contain **lysozyme**, which is an enzyme that breaks down the cell walls of bacteria to kill pathogens. Mucus works as a protection to capture pathogens and prevents it from sticking to epithelial cells. The mucus exits the body through physical mechanisms like coughing and sneezing. Another chemical response comes from the stomach. The stomach produces hydrochloric acids that kills pathogens from food during digestion.

**Innate Cellular Defenses:**

One method of trying to get rid of a foreign invader of the body is a cellular process called **phagocytosis**, which is the full engulfment of a cell by a phagocytic cell. Neutrophils and macrophages are primary examples of phagocytic cells. Phagocytic cells engulf the invading microorganism, releasing an enzyme to destroy it.

**Complement-**

The complement system contains a series of 20 proteins that are found in the plasma of blood. These proteins are called complement proteins which play a part in phagocytosis. These proteins help phagocytic cells bind more efficiently to the pathogens. They can also form a complex in the plasma membrane of the pathogen, forming a pore, and killing the pathogenic cells.

**Inflammation-**

Inflammation is another nonspecific response. Inflammation is a combination of chemicals and immune cells that help in the immune response to infections. When tissues get damaged by a pathogen, chemicals are released to call for phagocytic cells. In response, increased blood flow occurs to the site making the blood vessels permeable to allow white blood cells to enter the infection site. Inflammation has different components like pain, redness, swelling, and heat.

**Adaptive Immunity- Specific Immunity:**

When the first line of defense (nonspecific defense mechanisms) fails, the adaptive (specific) immunity steps up as a second line of defense. Specific immunity is a lot more effective than the nonspecific immunity. However, it takes time to develop the adaptive immunity. A major system that has a part of the adaptive immunity is the lymphatic system.

**Lymphatic System-**

Lymph nodes are found throughout the body. Lymph nodes produce a fluid called lymph which is leaked out of capillaries and bathes body cells. Lymphatic organs are the organs of the lymphatic system that contain lymphatic tissue or **lymphocytes**. Lymphocytes are produced in bone marrow and are a type of white blood cell. The lymphatic organs other than lymph nodes are tonsils, spleen, and thymus. Other organs hold lymphatic tissue, such as intestines, lungs, bladder, and genitals.

**B Cells**

B cells are also called B lymphocytes, which produce **antibodies**. Antibodies are proteins that specifically attack a foreign antigen introduced into the body. Antigens stimulate an immune response and bind to an antibody or a T cell. The B cells are located in lymphatic tissues and produce antibodies when a macrophage presents an antigen.

**Steps of Antibody Response**

B cells use DNA that codes for production of heavy and light protein chains to make combinations of antibodies. All heavy chains can combine with all light chains.

1. Macrophage engulfs antigen
2. Antigen is presented to helper **T cell**, a type of lymphocyte that activates antibody secretion in B cells and another T cell
3. Processed antigen presented to B cells and they then divide
4. Daughter B cells continue to divide and produces antibodies
5. Antibodies initiate inflammation to promote nonspecific responses

**Cytotoxic T cell Response**

Similar to antibody response but after being presented to T cell, cytokines are secreted.The cytotoxic T cells are then divided and then releases cytokines killing the antigen. These T cells have a specific name, **cytotoxic T cells**. Cytokines are important because when secreted, they stimulate the cells in the immune system to divide and concentrate at the site of the infection. The cytotoxic T cells are very powerful in that multiple target cells are destroyed by one single cytotoxic T cell.

**Other Immunities (Passive and Active):**

The specific immune response produces memory B and T cells. Memory cells provide protection to the body by reducing the chances of the disease if exposed again to the same pathogen. These memory cells are exposed to the certain types of antigens during the primary immune response.

**Passive Immunity-**

Passive immunity is best described as a temporary form of protection against a disease. Passive immunity is the temporary protection provided when antibodies are ingested or injected into the body. For example taking an antibiotic is a form of passive immunity. Mothers also can transfer antibodies into the fetus when necessary or through the breast milk. The antibodies formed from an individual who’s already built up an immunity to a disease can be used to treat others.

**Active Immunity-**

Active immunity is the process where exposure of a certain pathogen to the immune system will help develop the memory cells needed for future immunity. This is how immunizations, or vaccines, work. The whole concept of a vaccine is to expose the immune system to the pathogens of different diseases so that the body can create memory cells to learn how to fight of a certain disease in the future. The vaccines contain weakened pathogens so it will still form memory cells without actually causing an infection in doing so.

**Chapter Summary**

The immune system plays a very important role in helping us live and not die from a common cold or small infections. There are different immunities such as the specific, nonspecific, passive, and active immunity. They all play a part in the overall immune system generating different cells that have a specific task to fight off infections. If it wasn’t for a well developed immune system, we would all be dead.