**Immunology: An Introduction**

Immunology – What is it?

Throughout history, there have been many inventions and discoveries. In the late 1700s, a man named Edward Jenner created the first vaccination. During that time, smallpox was taking the lives of many people and Jenner came up with a vaccine. He collected a sample of cells from the wound of a cow infected with cowpox. He made a cut onto a boy’s arm and then rubbed the wound cells into the cut. The boy never contracted smallpox after that point in time. Today, we recognize Edward Jenner as the Father of Immunology.

When we get a cold, cut, burn or simply suffer from allergies, it involves your immune system. Your immune system is part of the study of immunology.

**Immunology** is the study of the body’s defense against infection. Immunology encompasses the immune system, immune response, infection, inflammation, vaccines, and various cells.

Let’s begin with discussing what microorganisms cause disease.

There are four microorganisms that cause disease: parasites, fungi, bacteria, and viruses.

* **Parasites** are microorganisms that live either in or on another organism and feeds off the organism. The parasite does not provide any benefit to the organism that it is feeding off of.
* The second microorganism is **fungi**. Fungi can be unicellular or multicellular. The most common example of fungi is mold.
* The third microorganism is **bacteria**. Bacteria lack a nucleus and are unicellular. They can survive in a wide variety of environments.
* The fourth and final disease-causing microorganism is a **virus**. A virus is made up of either DNA or RNA. The virus is protected by a capsid that is made up of protein.

Adaptive vs. Innate Immunity

When the disease-causing organisms enter the body, they face the immune response. There are two immune systems that are responsible for protecting against pathogens. The initial immune system is the innate immune system.

The **innate immune system** is the more rapid response. It is the response that contains resistance mechanisms that recognize and respond to the presence of a pathogen. The innate immune system is fast-acting and each person is born with this response. This response is able to combat a wide range of pathogens.

Main Purposes of the Innate Immune System

1. Recognizing the presence of a pathogen
2. Recruit immune cells
3. Kill and remove foreign material
4. Regulation/activation of adaptive immune system

Following the innate immune system, the adaptive immune system is activated. The **adaptive immune system** is the response of specific lymphocytes to antigens and the development of immunological memory. This system takes time to respond and it is antigen specific. Once the infection of a pathogen has evaded the innate immune system, the response of the adaptive immune system comes into play. The activation of the adaptive immune system leads to the development of immunological memory. This means that once the body encounters a pathogen, the body can store information on the pathogen to better defend the body if it is attacked by that pathogen again.

Cellular Components of the Innate and Adaptive Immune Systems

Now that we are more familiar with what the two immune systems are and what they do, let’s explore what cellular components make up both responses.

To begin we must know that all components of the blood originate from the bone marrow. The cells that we will be focusing on will either have come from lymphoid progenitors or myeloid progenitors. Lymphoid tissue is the tissue that produces lymphocytes and antibodies. Common areas in the body where one can find lymphoid tissue are in the lymph nodes, thymus, tonsils and spleen. The central lymphoid organs are the thymus and bone marrow. The secondary lymphoid tissues are the lymph nodes, adenoid, tonsil, spleen and Peyer’s patch in the small intestine. Myeloid tissue comes from the bone marrow. The bone marrow contains white blood cells like granulocytes.

Granulocytes are composed of five different cells that fight infection in the immune response:

* **Neutrophil**

Activated Function: Phagocytosis and the activation of bactericidal mechanisms

* **Eosinophil**

Activated Function: Killing of antibody-coated parasites

* **Basophil**

Activated Function: Promotion of allergic responses and augmentation of anti-parasitic immunity

* **Monocyte**

Largest type of white blood cell that is the precursor to macrophages

* **Unknown Precursor of Mast Cell**

This cell’s purpose is to function as the precursor to the mast cell

The two main products from these granulocytes are the mast cell and the macrophage. The mast cell is responsible for the release of granules containing histamines and active agents. **Macrophages** function in antigen presentation, phagocytosis, and activation of bactericidal mechanisms.

There are four major cells that originate from lymphoid tissue:

* **B cell**

Differentiate into plasma cells and contain a unique antigen receptor

* **T cell**

Encompass cytotoxic T cells and helper T cells

* **NK cell**

Natural killer cells that look for abnormal cells

* **Dendritic cell**

Responsible for antigen uptake in peripheral sites and antigen presentation

From the four lymphoid progenitor cells, B and T cells have something in common. Both are lymphocytes that can develop into memory cells. Recall that this is essential for the adaptive immune system and both cells are referred to as the true acquired immunity.

The Defense in the Body

There are four areas on or in the body that contain epithelial cells that help defend the body.

These areas are:

* Skin
* Gut
* Lungs
* Eyes/nose.

All four areas possess all or some of the three barriers: mechanical, chemical, and microbiological.

The skin possesses all three barriers. The skins mechanical barrier is the longitudinal flow of air or fluid. Its chemical barriers are fatty acids and antibacterial peptides. Its microbiological barrier is normal flora.

The gut also possesses all three barriers. The gut has a longitudinal flow of air or fluid for its mechanical barrier. The gut’s chemical barriers are low pH, enzymes, and antimicrobial peptides. The gut’s microbiological barrier is normal flora.

The lungs possess only mechanical and chemical barriers. Movement of mucus by cilia is the lung’s mechanical barrier and its chemical barrier is antimicrobial peptides.

The eyes and nose possess epithelial cells along with the rest of the areas as a mechanical barrier. The eyes and nose’s chemical barrier is the salivary enzymes called lysozymes.

When is each immune system going to respond after infection?

As we already know, the innate immune response will be activated first, then the adaptive immune response and ending with immunological memory.

The following are the steps involved in the phases of the immune response containing what system it is, the description of the event, the time after infection until the start of the response, and the duration of the response.

Innate Immune Response Step 1:

Inflammation occurs, along with complement activation, phagocytosis, and the destruction of the pathogen. This step takes minutes after infection to take place and can last for days.

Adaptive Immune Response Step 2:

Interaction between antigen-presenting dendritic cells and antigen-specific T cells. The recognition of the antigen occurs along with adhesion, co-stimulation, T cell proliferation and differentiation. This step can take hours after infection to take place and can last for days.

Adaptive Immune Response Step 3:

Activation of antigen-specific B cells. This step can take hours to take place after infection and can last for days.

Adaptive Immune Response Step 4:

Formation of effector and memory T cells occurs. This step can take days to take place after infection and can last for weeks.

Adaptive Immune Response Step 5:

Production of antibodies occurs days after infection and can last for weeks.

Adaptive Immune Response Step 6:

Emigration of effector lymphocytes from peripheral lymphoid organs can occur after a few days and last for weeks.

Adaptive Immune Response Step 7:

Elimination of pathogen by effector cells and antibody can occur within a few days and can last for weeks.

Immunological Memory Step 8:

Maintenance of memory B and T cells and protection against reinfection can take days to weeks and can be lifelong.

References:

<http://www.mta.ca/pshl/docs/janewayimmunobiology8.pdf>

Notes from Dr. Shaw’s Immunology class MICR 3253