Immune system basics

Author: A. Craddock, SUNY-Cortland 2005. Primary source: Brain, Marshall " How the immune system works"
http://ibs.howstuffworks.com

"Inside your body there is an amazing protection mechanism called the immune system. It is designed to defend you against millions of bacteria, microbes, viruses, toxins and parasites that would love to invade your body. To understand the power of the immune system, all that you have to do is look at what happens to anything once it dies…. In a matter of hours the body is invaded by all sorts of bacteria, microbes, and parasites. None of these things are able to get in when your immune system is working, but the moment your immune system stops the door is wide open. Once you die it only takes a few weeks for these organisms to completely dismantle your body and carry it away, until all that's left is a skeleton. Obviously your immune system is doing something amazing to keep all of that dismantling from happening when you are alive" (Brain 2004).

Any foreign material that can get inside your body and make you sick is called a *pathogen*. Bacteria and viruses, fungi and parasitic organisms are common examples.
Your body protects you from pathogens in three different ways:

Surface barriers: They prevent pathogens from entering your body. Examples include skin, mucous, tears, harmless bacteria, pH of urine. These all create an inhospitable environment for the establishment of pathogens inside or on the body.
Non-specific responses: If a bacteria or virus does get into the body, the immune system tries to detect and eliminate it before it can make itself at home and reproduce. Examples: fast acting lymphocytes, macrophages, mast cells, the symptoms collectively known as "inflammation".
Specific responses: If the virus or bacteria is able to establish a population—that is, you become *infected*—your immune system is in charge of eliminating that population. Examples: T cells and B cells, memory T and B cells.

When surface barriers are breached, the immune system responds:

Step 1. Damage or death of cells spurs on the **non-specific responses** of the body. The major players are fast-acting lymphocytes (mature ones are concentrated in the lymph nodes and thymus) and mast cells (located in connective tissues). The first responders are the *mast cells*. They release *histamine*, a chemical that causes dilation (widening) of vessels and makes the walls of vessels more permeable. Plasma leaks out of capillaries and swelling and redness occurs. The increased blood flow brings *fast acting lymphocytes* and *macrophages*. *Macrophages* (a type of white blood cell) begin to indiscriminately engulf any material that is identified as foreign.

How do macrophages recognize something as "foreign?" All of your own cells have unique *MHC protein markers* on the outside—this is how your immune system recognizes "self" and thus avoids attacking portions of your own body. On the other hand, foreign materials have unrecognized molecules on the surface—any unrecognized molecules are called *antigens* and they signal that a cell or other material is an invader. While this first response is occurring, all the fighting cells are releasing various chemicals that—with histamine—cause the symptoms we recognize as *inflammation*: swelling,

redness, soreness, fever. Fever may create an inhospitable environment for pathogens such as bacteria and the expanded, leaking vessels allow quick movement of white blood cells to areas of infection.

Macrophages do not merely disassemble the invaders; they also take the antigens off the invader and stick them on their own cell surface with their own MHC proteins! It sounds weird, but this is a red flag to the immune system, and sets the stage for the next level of defense: the specific responses.

Step 2. The specific responses are divided into 2 halves, and the first is called the **primary response.** At this point in the process, the pathogen may be establishing populations within the body in spite of the body's defenses. The display of antigens on the outside of macrophages mobilizes a suite of special white blood cells called *T cells* and *B cells.* The display of antigens alerts them to the specific identity of the invader, and initiates the rapid division of T and B cells that are *specifically* engineered to recognize that antigen and destroy that antigen.

T cells are made in bone marrow but mature in the thymus. When T cells encounter the antigen they recognize, they "touch and destroy" the carrier of that antigen. T cells specialize in destroying body cells that have already been invaded by a pathogen such as a virus. This is why they are often called "killer T cells." *B cells* are made and matured in bone marrow. When B cells encounter the antigen they recognize, they secrete an *antibody*. This is a chemical that binds to the antigen and thus prevents the pathogen from being active. B cells specialize in disabling pathogens that are circulating freely in blood or tissues.

Step 3. Hopefully the combined effort of T and B cells will eradicate the disease from the body. (This is called the *primary response*: a body's response to a first encounter with a particular antigen). But what happens if your body encounters the same disease a second time? Your immune system has already primed itself to deal with a secondary infection—and this half of the specific defenses is called the **secondary response**. During the initial infection-- when T and B cells were dividing rapidly-- most of them went on the offensive immediately. However, some special T and B cells wait behind and do not attack; these are called *memory T cells* and *memory B cells*. These cells (along with some of the original antibodies) will remain in the body long after the first infection has been cured. If you encounter the disease again, your body is ready to go on the offensive much faster than before because the memory cells immediately recognize the antigen and start dividing to make new T and B cells. This is called the *secondary response,* and it is bigger and faster than the primary response.