The Immune System

What is the Immune system?
The Immune system is an integration of organs, tissues, cells and cell products that identifies, non-self and neutralizes potentially pathogenic organisms and substances.

What does the Immune system do?
Do you ever think about the thousands of foreign particles your body comes into contact daily? They range from the "germs" or bacteria that live everywhere, including your own skin and large intestine, to the viruses flying around the room, and even the very life-sustaining food you place in your body. All of these substances are foreign. Unless you are an identical twin, even a cell from another person's body is considered foreign to your body (yes, that includes sperm and eggs). So how does your body decipher what's you and what's not you? Then what does it do when it encounters something not self? And if all this wasn't enough to think about, there's autoimmune diseases and allergies, what's the big idea of the body attacking itself? All of these questions can be answered by studying the Immune System.

The body must continually maintain homeostasis by defending against pathological invaders that threaten the health of the organism and repair damage they might cause. To do all this, the Immune System must first **identify** and **define** the boundaries of the organism…what is self? And what is not self? Furthermore, the Immune System needs to determine what is part of the organism and needs to be repaired and restored versus what is part of a tumor or foreign invader and needs to be killed.

One of the amazing things about the Immune System is the cells are *mobile*. Unlike the nervous system, these cells can travel through the blood and lymph and even in-between the cells in the extracellular fluid.

The Immune System protects the body in two ways. It has a nonspecific branch, which is resistant to a broad range of invaders. **Innate resistance** is much like the design of a castle against invaders. There's a moat, high, non-scaleable walls and the castle is usually situated atop a bluff, knoll, or mountain, so anyone thinking about invading will have a difficult time even getting in. The design is not personal, just an overall defense against anyone getting in. We will examine the Innate resistance branch of the Immune System and find many of these "not-so-personal" lines of defense already in place within and atop your body.

Having an external defense against invaders is great, but worthless if they get in and there's no further defense, like soldiers or armed guards on the inside. Our body's come fully equipped to deal with invaders should they make it to the jackpot, the blood. The branch of the immune system dealing with specific invaders is called **Adaptive resistance** to disease or **Immunity**. Here the body has very specific cells to fight the invaders. You may have heard of some of these cells, leukocytes or antibodies B-cells and T-cells.

Before we begin, a definition is in order. **Antigens** are foreign cells able to initiate an Immune response. They can be whole cells or even pieces of cells. Sometimes they are called foreign invaders, viruses, microbes, bacteria or germs. They are called pathogens when their presence results in pathology or disease.

Let's talk first about the general defense of the body, Innate Resistance to disease.

First line of defense…what the invader comes into contact with first: Coevolutionary Bacteria.
These "friendly" bacteria take up all the space of the "soil" of your skin and mucous membranes so pathological bacteria cannot colonize.

The next layer. Skin and mucus membranes. The ways they defend us are….

a. **Mechanical/physical protection:**
   - The skin is made up of tightly packed, keratinized epidermal cells. So the invaders can't get in between them but must go through the cells to get in.
   - The epidermal cells continually shed and when they shed, the invader goes with them.
   - Mucus membranes secrete mucus, which lubricates, moistens, and traps microbes and foreign substances.
   - Hair and cilia protect against microbes getting inside.
   - The lacrimal apparatus (tears) continually washes the surface of the eye.
   - Saliva contains enzymes to digest certain bacteria and an acidic pH, which kills some.
   - Urine flow washes the invaders back outside (think tidal wave).
   - Defecation moves invaders back outside.
   - Vomiting expels toxic invaders out.

b. **Chemical protection:**
   - Sebum on skin inhibits certain bacteria from growing.
   - Perspiration contains enzymes, which kill bacteria.
   - Gastric juice is very acidic (pH 2.0), and kills some foreign cells.
   - Vaginal secretions are acidic and also kill some foreign cells. At different times throughout the menstrual cycle, the secretions are more or less viscous, affecting the movement of any cells, including sperm.

Once they get through the first line, they enter the **Second line of defense:** which is in the blood…it's still not personal.

a. **Antimicrobial agents…**specific chemicals that work against bacteria.
   - Transferrins make iron unavailable to bacteria, and some need it to grow.
   - Interferons: Proteins that are released by virally infected cells. The proteins spread to uninfected cells and cause the uninfected cells to produce antiviral substances. They also increase the effectiveness of Natural Killer (NKC) cells and Phagocytic cells.

b. **Complement**
   - A system of 20 proteins which enhance the Immune response, allergic and inflammation reactions and increase phagocytosis.

c. Natural Killer Cells (NKC)

- A type of leukocye programmed to destroy any cell without the "self" marker. (all your cells have a little "flag" on them that says "hey, it's me")

d. Phagocytosis

- Specialized leukocytes that actually engulf or "eat" foreign cells or broken down self-cells. Once inside, the phagocytes break down the ingested material and recycle it.

Third Line of Defense: now the invaders are in and thriving**.**

a. Inflammation

Inflammation is a response to the stress of tissue damage caused by microbes, chemical agents or mechanical injury. It is a **healthy** response of the body.

Symptoms of inflammation are:

Redness, pain, heat, swelling, and sometimes loss of function.

Function of Inflammation…why do we have it?

- ✧ Aids in the disposal of microbes, toxins or foreign materials at the injury site.
- ✧ Prevents the spread of the above to other organs.
- ✧ Prepares the site for tissue repair.
- ✧ Brings in more blood with phagocytes, clotting factors, fibroblasts (cells used to repair all wounds) and nutrients.

Physiology of Inflammation…what is really going on here?

Immediately after injury, damaged cells release **Histamine** *and various other chemicals*, which causes an attraction of phagocytes, and the stimulation of nociceptors (pain receptors). The chemicals also stimulate surrounding blood vessels to vasodilate and increase their permeability (more substances can leak in and out of the blood vessel). This causes:

- ✧ The symptoms redness, more blood to move into the area.
- ✧ Increased numbers of antibodies, phagocytes and thrombocytes to the area.
- ✧ The removal of toxic products produced by invaders and dying cells.
- ✧ heat and edema.

Pain is caused by increased pressure on the nerve from the edema, physical damage to the nerve or irritation of the nerve by toxic chemicals from the invader.

Within one hour the **neutrophils** begin to invade the area and phagocytize any invaders, but they die quickly. **Macrophages** take longer to reach the scene, but are more powerful and can engulf damaged tissue, the dead neutrophils and the invading microbes (neutrophils and macrophages are types of leukocytes).

Eventually the macrophages die also and a pocket of dead phagocytes and damaged tissue forms. This accumulation we all know as **pus**. Pus continues to form until the infection subsides. Pus can either push itself to the surface of the body, or an internal cavity, or it can remain where it will eventually be destroyed.

b. "you give me"…Fever

Fever is an abnormal increase in body temperature during infection or inflammation. Within limits, it is *very* beneficial. The benefits include:

- intensifying the effects of interferons
- decreasing the activity of certain microbes
- increasing heart rate, which brings more blood to damaged areas
- increasing repair reactions of the body
- increasing immune reactions in the body

Once the invaders are in and Innate resistance is not working…we go to Adaptive Immunity.

Innate resistance to disease offers resistance to a variety of pathogens, but nothing specific. Once an invader is in the blood and proliferating, a more intense and specific approach must be activated, enter Adaptive Immunity. **Adaptive Immunity** is the ability of the body to defend against specific invaders. It has the characteristics of **specificity** and **memory.** Specificity allows the body to recognize particular foreign invaders, and the Immune System also retains a memory of past encounters with them. Basically the Immune System will remember what they look like the next time they encounter them. There are two types of immunity:

Cell-mediated Immunity

Cell-mediated immunity is carried out by a variety of different lymphocytes (types of leukocytes) called T-cells. T-cells are able to leave lymphatic tissue and enter the blood or tissue fluid, unlike their counter part the B-cells who must stay in the Lymphatic System. T cells mature in the thymus, thus the name T-cell. T-cells must be presented with an antigen by an antigen-presenting cell (APC). The APCs are either macrophages or B-cells. An APC ingests the antigen, processes it, marks it, and returns it to the surface of itself for the T-cell to interact with. The interaction with the antigen "activates" the T-cell, which causes it to produce thousands of clones of itself, which can interact with the same type of antigen and kill it. Types of T-cells to explore are Helper, cytotoxic, supressor, natural killer and memory T's.

Antibody-mediated (Humoral) Immunity

Antibody-mediated immunity is carried out by B-cells. B-cells are able to interact with antigens directly, but their rate of reaction is much faster if they are "costimulated" by a special kind of T-cell called a Helper T-cell. Once the B-cells interact with the antigen, they proliferate. Some of the "offspring" B-cells will become **plasma cells**, and some will become **memory cells**. Plasma cells can produce up to two thousand **antibodies** per second for 4-5 days. Antibodies are specific proteins called **globulins,** which are able to "lock on" specific antigens. One antibody will only combine with one type of antigen. For example, the antibody for *Streptococcus* bacteria will only bind to *Streptococcus* and nothing else. These protein structures are able to leave the lymph and enter the bloodstream, unlike their progenitors the B-cells, which are restricted to the Lymphatic System. So if there's a lot of a certain antigen in the blood, millions of antibodies will flood the blood to inactivate them and defend the body. Memory cells will circulate throughout the Lymphatic System waiting to interact with the same type of antigen again days, months or even years later.

Primary and secondary response

The first time an individual is exposed to an antigen, the individual initiates a **primary response**. The Immune System produces antibodies and memory cells. The process takes awhile, and this is why people often exhibit symptoms of an infection. The body now has a set of memory B and T cells circulating through the lymph, surveying the situation. The next time the same type of antigen invades the system the body is ready. The large number of memory cells quickly produce plasma cells and antibodies to deactivate the antigen. This quicker response usually happens so fast that the individual does not show symptoms of infection. This is the **secondary response**.

Now for some interesting factoids

- **Immunization** uses the body's ability to generate a secondary response. Individuals who are "immunized" are given small doses of the virus or bacteria so the body will initiate a primary response and therefore be "ready" when the individual is exposed to the "live" antigen. Some things to research are, is the vaccine a live virus, partially live (which, is live), or dead? Questions to think about, When does the body's Immune System kick in? At what age does an individual have the ability to generate a primary response? Memory cells? When do we immunize individuals? How long does the mom's antibodies circulate in the newborn? What percentage of individuals receiving immunization develop the infection the vaccine is supposed to prevent? What are the side effects of the vaccine? What else is in the vaccination? Are individuals given this information upon receiving immunizations?

- **Antibiotics** do not give the individual antibodies like they naturally produce. Antibiotics are a general medication that inhibits the growth of **bacteria** in some way (for example, penicillin pokes holes in the walls of the bacteria*)*. **Viruses are not effected by antibiotics.** How often are individuals given antibiotics for the common cold or the flu (influenza **virus**)?

- **Environmental pollutants** enter the cell membranes and alter the shape of the receptors for peptides. The receptors are loose and don't bind the peptides as well. The mitochondria are no longer as efficient at making energy and could be the cause of the increases in chronic fatigue syndrome, allergies and chemical sensitivities. The pollutants can also mimic Estrogen and Progesterone, bind their receptors and possibly be related to the increases in prostate and breast cancers. (What about the earlier menarche in girls?…..hmmm). Basically the Immune System is more fatigued by dealing with the toxins all day.

- **Monocytes (macrophages)** as we already know clean up the blood after invaders are killed, repair the body fabric, manufacture tissue if needed, basically orchestrate healing. They are a type of leukocyte and are an Antigen Presenting Cell for the T-cells. They have binding sites for Helper T-cells and most neurotransmitters made by the brain.
  - They make **interleukin-1** a peptide responsible for mediating inflammation, fever, activating T-cells, inducing sleep, and putting the body into a healing state. The brain also makes this peptide and when it binds sites in the brain, it initiates mild anxiety, cautious avoidance and induces sleepiness and lethargy. Overall this peptide initiates the healing state the body needs to be in, and the interesting thing is the brain **or** the Immune System (via macrophages) can initiate this state.
  - Macrophages have receptors for over 50 peptides and have the ability to manufacture peptides that are known to regulate mood, emotion, and other body activities.

What does this really have to do with Herbalism?
A basic understanding of how the Immune System works is required when dealing with people who have compromised immunity. Understanding how the body works to defend itself is important and also how *Western Medicine* affects the body's own ability to respond to antigens. This chapter is meant to be a starting point into what will hopefully be a long research relationship with the body's immunity and how we can *support* it. ☺

When working with individual plants it is good to understand who the **deep nourishers** are. The ones who will work at the level of the bone marrow in increasing the number of circulating and effective cells. Mostly these are the medicinal mushrooms. The next layer to think about is which plants help strengthening the Immune System in a more acute situation. What herbs are anti-viral? Since the most common pathology we will treat is the cold and flu viruses. What herbs help locally? In the digestive tract or urinary tract? What herbs are symtom relievers, who help us feel a little better when we're infected. What herbs are synergists? The ones who help the other herbs work better? And finally, which herbs will help move the lymph towards the end of the infection?