

THE IMMUNE SYSTEM

First line of defense

The first line of body's defense against pathogens starts with its **passive barriers**: **skin**, **stomach acid**, **mucous membranes** and **endothelial tissues** that are physical obstruction to pathogens' advance and/or inhospitable for their survival due to their acidity, alkalinity or temperature. These barriers are passive because they do not detect pathogens, nor react to their presence.

However, once pathogen clears this first defense line, the body needs to detect and destroy the intruder as soon as possible. The time factor is critical: pathogens tend to multiply exponentially, so if they are given twice the time they need to double in numbers, there will be four times as many, and if they are given only another half of that time, there will be eight times as many, and so on... The larger number of pathogens, the greater damage they can do, and the harder for the body to mount successful defense.

Second defense line: Innate immune system

Part of the immune system in charge of delivering that first punch to pathogens which have penetrated the first defense line is so called innate immunity. It forms body's second defense line. Immune cells and chemical communications of the innate system are created from the inherent, parent's genetic code. Their primary mode of action is through:

(1) so called **complement response**, consisting of a cascade of reactions of some 25 proteins produced in the spleen and liver, which detect and finally destroy invaders either by rupturing their outer membrane, or having it coated with complement fractions, marking them to be eaten by immune cells called phagocytes (in old Greek, *phago* is "eat", and *cyto* is "cell")

(2) **phagocytes**, white blood cells which either react to the complement mark, or detect pathogens with some other receptor type, engulf it and digest with their enzymes (phagocytes include **neutrophils**, **monocytes**, and **macrophages** - which are

monocytes settled in specific tissues, like liver, spleen and lymph nodes)

(3) **granulocytes**, white blood cells like **eosinophils** and **basophils**, which pack granules of toxic chemicals, like histamine, that burst and spray onto perceived pathogens; special form of basophils, called **mast cells**, are distributed primarily along blood vessels and, together with other granulocytes, have as their main function breaking down antibody-antigen complexes (that is, destroying antigens marked by antibodies), part of which is initiating allergic responses (neutrophils are both, phagocytes and granulocytes, since they use granules of toxic chemicals to decompose pathogens they engulf)

(4) **cytokine action**, where cytokines are signaling protein molecules produced by immune system cells, but also by damaged regular body cells (the latter being called **chemokines**); they trigger a multitude of effects, among the major ones being inflammatory response (characterized by locally increased blood flow and permeability, enabling better access for the immune response), increase in body temperature, which reduces pathogen activity while stimulating that of the immune system, and signaling to the liver to produce *acute phase proteins*, a type of complement marking bacteria to be eaten by macrophages (cytokines, like **lymphokines**, are also secreted by the adaptive immune system cells; cytokine called **interleukin 2**, secreted by both macrophages and T-cells, stimulates T-cell production)

The final defense: adaptive immune system

All this may not be enough to stop pathogen invasion. In such case, the body mobilizes its third line of defense, so called adaptive immune system. Unlike innate immune cells, those adaptive do specialize for specific pathogens, by

selective mutation controlled by the immune system.

The price to pay for such specialized response is time - it can take days, or even weeks for it to fully develop. However, after the pathogen is eliminated, certain number of these specialized cells continues patrolling the body, keeping the "memory" of it, ready to launch much faster massive response if that particular - or similar - pathogen

invades again.

White blood cells (leucocytes) mainly carrying out adaptive immune system response are **lymphocytes**. Similarly to innate immune cells, their action is based on chemical reactions between immune cell receptor molecules and a peptide or molecular fragment on the surface of pathogen, called *epitope*.

The receptor-epitope connection is based on the lock-and-key principle of matching three-dimensional molecular structures, also involving electrical charge. The degree of receptor-epitope match determines strength of *affinity*, which has to exceed threshold minimum in order for the cell to activate.

Lymphocytes include:

- **B-cells** (with "B" for these cells going through their selective multiplication process in the bone marrow), specialized in pathogen detection and secretion of pathogen-specific antibodies, which mark the pathogen (also *antigen*, or "non-self") for elimination by attaching to it to form *antibody-antigen complex*, and
- **T-cells** (with the "T" label from their selective production taking place in the thymus), which come in several forms - helper Th-cells, suppressor Ts-cell, cytotoxic, or "killer" Tk-cell (also called *natural killer cells*), which detect and destroy internally infected and abnormal (including cancerous) cells; T-cells are much less versatile as pathogen detectors than B-cells, but have the key role in ensuring their proper function, as well as in initiating inflammatory response (by activating macrophages), balancing the immune reaction by suppressing leukocyte activity, destroying body cells infected by intra-cellular pathogens (such as viruses, or malaria parasite), as well as abnormal body cells, and so on.

These two lymphocyte forms represent the back bone of the adaptive immune system.

The inner workings of the immune function can be illustrated on the process of creation and mutual dependence of B- and T-cells. B-cells are created in the bone marrow, where they are selectively cloned to tolerate "self" (body entity in all its constituent parts). After that, they move to lymph nodes, where they are introduced to

pathogens. Those that succeed in binding to pathogens leave lymph nodes and become plasma, or memory B-cells, specialized to detect particular type of a pathogen and mark it with antibody. B-cells that don't bind to pathogens are programmed to die.

The imperative of producing astronomically high number of efficient B-cell varieties, capable of detecting trillions of different pathogens, dictates astoundingly high rate of their cellular division/mutation inside lymph nodes. This, on the other hand, compromises their "self" tolerance. In order to protect the body from possible harm inflicted by autoreactive (attacking "self") B-cells, the immune system uses helper T-cells to verify - using molecules of the Major Histocompatibility Complex (MHC) - that what was detected by B-cell is not "self". If that is the case, B-cell receives signal from T-helper cell, which activates B-cell's production of antibodies. In the absence of this signal, B-cell dies.

For their part, T_k-cells which are cloned to self-tolerance in the thymus, are themselves controlled by a signal given from innate immune system cells, that has to follow T_k-cell detection of infected, or abnormal cell. In the presence of tissue damage, such signal could be given by damaged cells even to autoreactive T_k-cells, enabling them to survive and multiply. This could be one of the mechanisms of developing **auto-immune disorders**.

The importance of the adaptive part of the immune system is in providing needed volume and flexibility in pathogen detection and elimination. Those that can be detected and destroyed by the innate immune system are many millions, but still only a fraction of all existing pathogens. Also, there is no clear dividing line between the two immune system "departments": they vitally assist each other, to the extent that neither could possibly remain functional and effective without the other.

Immune system antagonists

Among the factors that inhibit activity of the immune system are negative outlook, acute and chronic stress, smoking, alcohol, overweight, insufficient rest (sleep) time, high sugar intake, high blood lipids, and nutritional deficiencies⁷.

In his book "Your Body Doesn't Lie", Dr. John Diamond describes how even simple negative thoughts - about tragic events, bad experiences or expectations, hateful feelings, fear - can directly affect thymus gland, lower your life energy and suppress all body functions, including the immune system. According to his experiments,

thymus is the first organ to be affected -

positively or negatively - not only by stress and emotional states, but also by food, posture, or physical and social environment.

Obviously, this implies a great number of factors possibly negatively affecting your immune system. Many of them may not have significant effect alone, but the combined effect of a multitude of such factors can have significant impact. And most of us are widely exposed to these immuno-suppressing factors: from our own [negative emotions](#), to negative people and events around us, stressful daily routines, that also often drive us to unhealthy lifestyle (smoking, alcohol, insomnia, sedatives, painkillers, lack of rest, lack of [exercise](#), fast foods, overeating and other addictions), synthetic materials, [foreign chemicals](#), fluorescent light, noise, [food additives](#), denatured, over-processed foods, electromagnetic field, loud, aggressive music, and so on...

Immune system support

Positive attitude, healthy lifestyle and healthful diet - with accent on green leafy vegetables - are all critically important for proper, efficient functioning of the immune system. Particularly beneficial [nutrients](#) include vitamins [A](#), [C](#), [E](#), B-complex, [iron](#), [zinc](#) and [selenium](#)⁷.

[Enhancing thymus function](#) with thymus extract strengthens the immune system, particularly antiviral and cancer-protective responses (Tk-cells). According to Dr. Diamond, there are simple natural ways of directly stimulating thymus function. One is by making sure that the tip of your tongue is resting against the roof of your mouth, centered at about 1/4 inch from your teeth. The other is by lightly tapping top of your breast bone with a finger, several times; this has been shown in experiments to have an immediate stimulating effect on the thymus (which is located beneath the

breastbone, at the 2nd rib height).

Enhancing spleen function by taking spleen extract also stimulates immune system, especially resistance to bacterial infections.

Among the herbs stimulating immune system - particularly the lymphatic system - are Echinacea, Cleavers, Golden Seal and Astragalus.
