



CENTER FOR IMMUNE RESEARCH

Backgrounder: Understanding the Body's Immune System

The human body is constantly under attack from millions of microorganisms with which we share the planet, such as bacteria and viruses. The immune system is the human body's defense against these "foreign invaders" and operates a silent army that wards off infection and keeps us healthy. Consisting of a complex network of cells, tissues, and organs, the immune system involves a sensitive process of checks and balances within the body that produce an immune response that is prompt, accurate, effective and self-limiting. As a result, scientists believe that a healthy immune system rivals in scope and complexity the workings of the brain and nervous system -- and is every bit as important for survival.

How does the body's immune system function and what are the factors that influence its ability to fight infection and disease? The following provides a layman's explanation of the body's highly effective defense system.

The Anatomy of the Immune System

The ability of the immune system to protect the body is based on an incredibly elaborate and dynamic regulatory-communications network. A complex network of cells, tissues and organs stationed throughout the body pass information back and forth like clouds of bees swarming around a hive. This includes the organs collectively called the lymphoid organs because they are concerned with the growth, development, and deployment of lymphocytes -- the white cells in the blood that are the key operatives of the immune system. Besides the blood and the lymphatic vessels that carry lymphocytes to and from the other structures in the body, lymphoid organs include the bone marrow, thalamus, lymph nodes, spleen, tonsils and adenoids, and the appendix.

Cells destined to become immune cells, like all other blood cells, are produced in the bone marrow, the soft tissue in the hollow shafts of long bones. Here, they develop into two major types of lymphocytes called B cells and T cells. While B cells complete their maturation in the bone marrow, T cells migrate to the thymus, an organ that lies high behind the breastbone, where they multiply and mature into cells capable of producing an immune response. Once they have matured, some lymphocytes congregate in immune organs or lymph nodes while others use the blood circulation as well as a body-wide network of lymphatic vessels to travel widely and continuously throughout the body. Another type of white blood cell called macrophages reinforce the work of the lymphocytes because they engulf and digest microorganisms and antigens

Along with white blood cells, the immune system employs a complex system of small, bean-shaped lymph nodes in the neck, armpits, abdomen, and groin to create lymphatic routes for the body. Each lymph node contains specialized compartments that house platoons of B cells, T cells, and other cells capable of sparking an immune response. Clusters on lymphoid tissue can also be found in many parts of the body, such as around the mucous membranes lining the respiratory and digestive tracts that serve as gateways into the body. They include the tonsils and adenoids and the appendix. Further, the immune system deploys the spleen, a fist-sized organ at the upper left of the abdomen, as a filter for the blood. In the spleen, B cells become activated and produce large amounts of antibody. Also, old red blood cells are destroyed in the spleen.

Activating the Immune System

The immune system has many different types of cells acting together to take care of unwanted infections and altered cells. Cytokines are the chemicals produced by these cells in order to communicate and orchestrate the attack. Binding to specific receptors on target cells, cytokines recruit many other cells and substances to the field of action. Cytokines also encourage cell growth, promote cell activation, direct cellular traffic, and destroy target cells.

Cytokines include interleukins and growth factors, but another cytokine -- interferon -- is considered especially important because it can boost the immune system's ability to recognize foreign invaders. In humans, there are three major classes of interferon: alpha, beta and gamma. Because interferon is considered an effective anti-viral agent, and is important both for orchestrating and stimulating the immune system response, it is used to treat Hepatitis C and other diseases. Moreover, researchers have shown that pharmaceutical interferon, given in daily doses, can prevent infection and illness. However, pharmaceutical forms of interferon can cause side effects such as nosebleeds and is not considered useful in treating established colds.

How the Body Mounts an Immune Response

The immune system is considered one of the most sophisticated systems in the human body because it displays several remarkable characteristics, including the ability to distinguish between healthy cells that are part of the body -- called "self" -- and invading cells called "nonself." But when the immune system encounters an antigen -- the substance that announces the cell or organism is "foreign"-- the immune troops move quickly to eliminate the intruders. What happens is the presence of the antigen signals interferon or another cytokine to trigger an immune response by either the B or T cells. When the foreign microbe presents an antigen on the surface of one of these cells, the B or T cells multiply and produce antibodies that specifically bind to that antigen. This response then leads to other parts of the immune system engulfing and killing the invading cells or to what is known as the "complement destruction cascade," where serum proteins called complement bind to the immobilized antibodies and destroy the bacteria by creating holes in them.

Whenever T cells and B cells are activated, some become "memory" cells that enable the immune system to remember previous experiences and react accordingly. Thus, if a person were to contract chicken pox, the immune system would produce memory cells for this disease, resulting in future immunity. Long-term or "specific" immunity can be naturally acquired by previous infection or artificially acquired by vaccines made from infectious agents.

Despite these remarkable abilities, the immune system can also malfunction with results ranging from minor nuisances to disabling conditions. The most common immune system malfunction is an allergic reaction produced when an apparently harmless substance such as ragweed pollen or cat hair triggers an immune system response. In more serious situations, the immune system can wrongly identify "self" as "nonself" and execute a misdirected immune attack against healthy cells in the body. This can produce an autoimmune disease, such as rheumatoid arthritis or lupus.

Factors the Affect the Immune System

Although the immune system is very resilient and flexible, a number of factors have been shown to weaken the body's ability to fight infection. For example, there is a growing scientific consensus that the immune system doesn't function as efficiently in older adults. According to new research, while the elderly produce the same number of lymphocytes as their younger counterparts, their configuration is different leading to infection-fighting cells that are less vigorous and less effective than in younger adults. At the same time, research points to psychological stress, lack of adequate sleep, poor diet and lack of exercise as factors that weaken the immune system. Because stress produces many different effects on the endocrine systems, including the well-known fight or flight response, scientists hypothesize that the abilities of the immune system are diminished after frequent activation of the autonomic nervous system in the case of chronic stresses. For example, a large study comparing parents of children with cancer with parents whose children were relatively healthy showed that chronic psychological stress might reduce the immune system's reactions to hormonal secretions that were normally used to fight the inflammatory response.

Regarding the link between sleep and the immune system, research summarized by the National Sleep Foundation finds that sleep deprivation weakens the immune system, increasing susceptibility to colds and the flu. It is also not uncommon for people who suffer from sleep deprivation to suffer from other problems including diabetes, asthma or a second sleep disorder.

The role of nutrition in determining the strength of the immune system has also been widely studied. According to a number of studies, both undernourished people and those who are overweight or obese are at greater risk from infections. At the same time, research suggests that reducing the amount of fat in the diet may increase immune activity. For these reasons, nutritionists recommend a well-balanced diet that includes plenty of fruit, vegetables, low-fat dairy products and whole grains. In one placebo-

controlled study of healthy elderly adults, daily consumption of a multivitamin-multimineral supplement resulted in fewer days of infection-related illnesses.

Summing It Up

Because the immune system is the human body's defense against viruses, bacteria, allergens and other "foreign invaders," public health authorities agree on the importance of building a healthy immune system. This means avoiding the factors that weaken immunity by learning how to cope with stress, getting enough sleep, exercising more, and getting the right balance of immune supporting nutrients.

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