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THE ROLE OF THE IMMUNE SYSTEM

The overall function of the immune system is to prevent or limit infection it protects against disease or other potentially damaging foreign bodies. The immune system can distinguish between normal, healthy cells and unhealthy cells by recognizing a variety of "danger" cues called danger-associated molecular patterns (DAMPs). Cells may be unhealthy because of infection or because of cellular damage caused by non-infectious agents like sunburn or cancer. Infectious microbes such as viruses and bacteria release another set of signals recognized by the immune system called pathogen-associated molecular patterns (PAMPs). When the immune system first recognizes these signals, it responds to address the problem. If an immune response cannot be activated when there is sufficient need, problems arise, like infection. On the other hand, when an immune response is activated without a real threat or is not turned off once the danger passes, different problems arise, such as allergic reactions and autoimmune disease. The immune system is complex and pervasive. There are numerous cell types that either circulate throughout the body or reside in a particular tissue. Each cell type plays a unique role, with different ways of recognizing problems, communicating with other cells, and performing their functions.

TYPES OF IMMUNITY

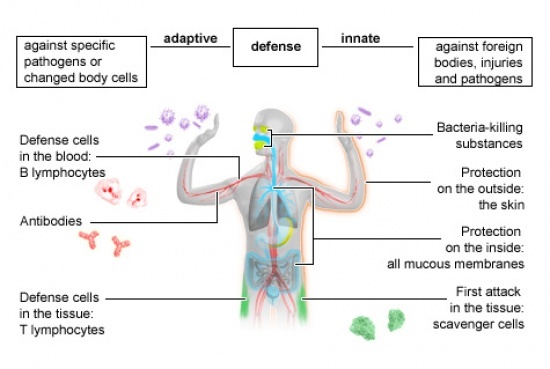
1)Innate immunity

Innate immunity is the first line of defense against foreign substances and pathogenic microorganisms. It is an immediate, nonspecific defense that does not involve immunologic memory of pathogens. Because of the lack of specificity, the actions of the innate immune system can result in damage to the body’s tissues. A lack of immunologic memory means that the same response is mounted regardless of how often a specific antigen is encountered.

The innate immune system is comprised of various anatomical barriers to infection, including physical barriers (e.g., the skin), chemical barriers (e.g., acidity of stomach secretions), and biological barriers (e.g., normal microflora of the gastrointestinal tract). In addition to anatomical barriers, the innate immune system is comprised of soluble factors and phagocytic cells that form the first line of defense against pathogens. Soluble factors include the complement system acute-phase proteins and messenger proteins called cytokines. The complement system, a biochemical network of more than 30 proteins in plasma and on cellular surfaces, is a key component of innate immunity. The complement system elicits responses that kill invading pathogens by direct lysis (cell rupture) or by promoting phagocytosis. Complement proteins also regulate inflammatory responses, which are part of innate immunity. Acute-phase proteins are a class of plasma proteins that are important in inflammation. Cytokines secreted by immune cells in the early stages of inflammation stimulate the synthesis of acute-phase proteins in the liver. Cytokines are chemical messengers that have key roles in regulating the immune response; some cytokines directly fight pathogens. For example, some interferons have antiviral activity. These soluble factors are important in recruiting phagocytic cells to local areas of infection. Monocytes, macrophages, and neutrophils are key immune cells that engulf and digest invading microorganisms in the process called phagocytosis. These cells express surface receptors that identify pattern recognition receptors that are unique to pathogenic microorganisms but conserved across several families of pathogens

2)Adaptive Immunity

Adaptive immunity (also called acquired immunity), a second line of defense against pathogens, takes several days or weeks to fully develop. However, adaptive immunity is much more complex than innate immunity because it involves antigen -specific responses and immunologic "memory." Exposure to a specific antigen on an invading pathogen stimulates production of immune cells that target the pathogen for destruction. Immunologic “memory” means that immune responses upon a second exposure to the same pathogen are faster and stronger because antigens are "remembered." Primary mediators of the adaptive immune response are B lymphocytes (B cells) and T lymphocytes (T cells). B cells produce antibodies, which are specialized proteins that recognize and bind to foreign proteins or pathogens in order to neutralize them or mark them for destruction by macrophages. The response mediated by antibodies is called humoral immunity. In contrast, cell-mediated immunity is carried out by T cells — lymphocytes that develop in the thymus. Different subgroups of T cells have different roles in adaptive immunity. For instance, cytotoxic T cells (killer T cells) directly attack and kill infected cells, while helper T cells enhance the responses and thus aid in the function of other lymphocytes. Regulatory T cells, sometimes called suppressor T cells, suppress immune responses. In addition to its vital role in innate immunity, the complement system modulates adaptive immune responses and is one example of the interplay between the innate and adaptive immune systems. Components of both innate and adaptive immunity interact and work together to protect the body from infection and disease.



Types of Antibodies

1)-**Immunoglobulin A(IgA)**

Properties:

-IgA is found in the mucous membranes of the gastrointestinal and respiratory tracts. It is located in mucus secretions, saliva, tears, and the colostrum.

-It constitutes 13% of total antibody content found in the serum. There are two subclasses of the IgA antibody – IgA1 and IgA2.

-The IgA1 antibody is the most prevalent and is also called secretory immunoglobulin or sIgA, and is most commonly found in secretions in high quantities.

Structure

-The heavy chains of the IgA antibody are of the Alpha subclass, and it has four antigen binding sites.

-The molecular weight of IgA is around 385,000 Da. IgA exists in both monomeric and dimeric forms.

Functions

-IgA is found in the secretions and provides the first line of defense against the uptake of microbes and antigens into the body.

-It limits inflammation.

-Participates in the immune response through the activation of the complement pathway.

-Provides immunity to the fetus and the newborn infant.

2)-**Immunoglobulin M(IgM)**

Properties:

-IgM is the largest antibody found in the body and is the first to be produced after an antigen enters the body.

-It is found in the blood and the lymph fluid. It constitutes 6% of the total antibody content of the serum.

Structure:

-The heavy chains of the IgM antibody are of the Mu subclass, and it has ten antigen binding sites.

-The molecular weight of IgM and is around 900,000 Da. IgM exists in the pentameric form and is the largest of all the antibodies.

Functions:

-IgM is the antibody that is found on the surface of the B-cell that helps in antigenic recognition.

-Activation of the complement pathway of the immune response.

-It is involved in opsonization and agglutination.

-Facilitates efficient activation of the immune system due to the more significant number of antigenic sites on its surface.

-The ABO system of blood grouping consists of IgM antibodies that are specific to the ABO antigens expressed on the surface of the RBCs.

3)-**Immunoglobulin E(IgE)**

Properties:

-IgE antibody is also known as the reaginic antibody and is involved in hypersensitivity reactions or allergic responses.

-It is found in the linings of the respiratory and intestinal tracts.

-It is the least abundant antibody which constitutes about 0. 002% of the antibody content in serum.

-The antigenic site binds to mast cells or basophils that are known to be involved in hypersensitivity reactions.

Structure:

-The heavy chains of the IgE antibody are of the subclass Epsilon with two antigenic binding sites.

-It exists in the monomeric form and has a molecular weight of about 200,000 Da.

Function:

-Immune protection against pathogens is invading through the gastrointestinal or respiratory barriers.

-It has a vital role in Type 1 hypersensitivity reactions or allergic response.

4)- **Immunoglobulin D(IgD)**

Properties:

-IgD antibody makes up less than 1% of the total antibody content of serum.

-It is usually co-expressed on the surface of B cells with IgM.

-Its specific function is still unknown. However, it is thought to be involved in the process of B cell activation.

Structure:

-The heavy chains of the IgD antibody are comprised of the subclass Delta, with two antigen binding sites.

-It is found in the body as a monomer and has a molecular weight of around 180,000 Da.

-It is present on the surface of the B cell and acts as a receptor.

Function:

-The known function of the IgD antibody is to act as a receptor on the surface of the B cell and participate in B cell activation and differentiation.

5) **Immunoglobulin G(IgG)**

Properties

-IgG is the most predominant antibody found in the body and constitutes for 80% of the total antibody content in the serum.

-It is the only antibody with the ability to cross the placental membrane and provide immunity to the fetus. There are four sub-classes of the IgG molecule: IgG1, IgG2, IgG3, and IgG4.

-Among these, IgG 3 and IgG 4 possess the ability to cross the placenta. IgG1 is the most common antibody subclass among the four.

Structure:

-The heavy chains of the IgG antibody are of the subclass Gamma, and it has two antigen binding sites. It is a monomer with a molecular weight of approximately 150,000 Da.

Functions:

-It provides immunity to the developing fetus.

-Activates the complement pathway of immune response.

-Mediates a process known as opsonization which refers to antibodies coating a pathogenic cell to lure the phagocyte towards the antigenic surface of the pathogen.

-Facilitates the process of phagocytosis.

-Neutralization of toxins and pathogens.

-Since it is widely found circulating in the blood, it offers protection against pathogens in the blood and tissues.