INJ INTERNATIONAL NEUROUROLOGY JOURNAL

Concept on Immunology: A Review

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Abstract

The role of the immune system is important and complex yet challenging to remove or eliminate pathogenic agents. The immune system has specific and nonspecific components. Some constituents of immune system act without specific recognition of the target, others have without specificity. The regulation of the immune response and maintenance of immunity to self are critical to the health of the human beings and animals. The knowledge of the various basic components of the normal immune system is essentially required for evaluation or control immune function. This review covers the knowledge of various basic individual components of the immune system and how they will interact to protect the host from infectious agents.

Key Words: Immunity, spleen, bone marrow, antigen, antibody, Innate.

Introduction

Immunology the branch of biomedical science concerned with the response of the organism to antigenic challenge and all the biological, serological, and physical chemical effects of immune phenomena [1]. The study the immunology consists three basic critical factors like specificity refers to host's response to an individual and memory. It implies once body has responded to an agent, it will react vigorously during a subsequent exposure. Recognition of non-self: Means that the host will develop resistant to agent that is foreign to itself [2]. The term **"**immune**"** is derived from the Latin word "immunis" (literally means, safe or free from taxes or free from burden) meaning "exempt," or the state of protection from infectious disease.[3] In other words, immunity is the ability of the body to specifically counteract with foreign organisms or substances [3]. A person may develop or acquire immunity after the birth. The acquired immunity is not inherited but it is specific resistance to infection developed during the life of the individual. However, it results from the production of antibodies and sensitized lymphocytes [4].

Immunity can be broadly classified into two types [5]
Innate or nonspecific Immunity
Acquired or Adaptive (specific) Immunity
Natural Acquired Immunity
Naturally acquired active immunity
Naturally acquired passive immunity
Artificially Acquired Immunity
Artificially acquired active immunity
Artificially acquired passive immunity

Innate Immunity

The term innate immunity refers to the basic resistance to disease that a species possesses as the first line of defense against infection. Innate immunity system is that part of immune system with which we are born; that means it does not change nor adapt to specific pathogens [5].

Acquired Immunity

In comparison to innate immunity, acquired (adaptive) immunity develops when the body is exposed to various antigens and builds a defense that is specific to that antigen.
Acquired immunity is of two types-
Naturally acquired immunity
Artificially acquired immunity
(a) Naturally Acquired Immunity:
Naturally acquired immunity (NAI) is of two types-
Naturally acquired active immunity

ISSN:2093-4777 | E-ISSN:2093-6931
DOI: 10.5123/inj.2023.4.in94
Vol. 27 Iss. 4 (2023)

Naturally acquired passive immunity.

(i) Naturally acquired active immunity:

Naturally acquired active immunity is obtained when a person is exposed to antigens in the course of daily life and the immune system responds by producing antibodies and specialized lymphocytes. For some diseases, immunity is lifelong, for example, measles, chicken pox and yellow fever [6,7].

(ii) Naturally acquired passive immunity:

Naturally acquired passive immunity involves the normal transfer of antibodies from a mother to her infants. An expectant mother is able to pass some of her antibodies to her fetus across the placenta. This mechanism is called placental transfer. If the mother is immune to such diseases as diphtheria, rubella or polio, the newly born infant will be immune to these diseases [8].

(b) Artificially Acquired Immunity

Artificially acquired immunity is of two types, artificially acquired active immunity and artificially acquired passive immunity.

(i) Artificially acquired active immunity

Previously prepared antigens are injected into the susceptible individual who produces antibodies and specialized lymphocytes. This process is known as vaccinationor immunization [9].

(ii) Artificially acquired passive immunity

It involves injection of immune serum in the susceptible individuals. A person bitten by snake might be injected with antibodies from a horse that is immune to snake venom.[4,6]

Types Adaptive Immune Response

There are two types of immune systems, such as
Humoral immune system
Cell mediated immune system.

Humoral Immune System:

The humoral immune system involves the antibodies that get dissolved in extracellular fluid such as blood plasma, lymph and mucus secretion. These were formally known as humors [10]. The humoral immunity is conferred through B-cells, also called B lymphocytes that develop from stem cells of bone marrow in adults and the liver in embryos. However, RBCs, neutrophils, monocytes, macrophages and other types of WBCs are produced from the same stem cells. The specialized lymphocytes i.e. B-cells of the system responds when exposed to antigens [11]. B-cells have the capacity that they can recognize the antigens themselves with the help of receptors on their surface and secrete antibodies in correspondence to the specific antigens and these antibodies clump with those antigens to inactivate them or to neutralize their effects. This system responds mostly against bacteria (and their toxins) and viruses. So, humoral immune system can also called antibody-mediated immune system [7,12].

Cell-Mediated Immune System:

The cell-mediated immune system directly involves the specialized lymphocytes called T-cells [13]. They do not secret antibodies rather; they kill or destroy the antigens directly by releasing a protein perforin which makes a pore in the target cell. This system of immunity is most effective against bacteria or viruses, protozoan, fungi, helminthes, transplanted tissues and. cancer cells [14].

CELLS OF IMMUNE SYSTEM:

Lymphocytes

These are the primary cells involved in adaptive immune responses and divided into two main groups: B cells and T cells. B cells are the precursors of plasma cells that secrete antibodies [15]. T cells are themselves divided further into two main groups: CD4 T cells that function principally as regulator and coordinator cells in adaptive immune responses[16], and CD8 T cells that can develop into cytotoxic cells with the capacity to kill cells infected with viruses or other microbes [12].

Macrophages

These are divided into two main types:

- Resident macrophages are present in steady-state tissues (i.e. before infection occurs) and can detect the presence of microbes. In turn they can help to trigger inflammation [17].
- Recruited (or elicited) macrophages are not tissue-resident cells, but they can be recruited into sites of infection. After development into macrophages they can act as effector cells to help eliminate the infection [18].

ISSN:2093-4777 | E-ISSN:2093-6931
DOI: 10.5123/inj.2023.4.in94
Vol. 27 Iss. 4 (2023)

- Macrophages are one of the two main types of specialized phagocyte that can engulf and internalize (phagocytose), and subsequently kill microbes such as bacteria [19].

Mast cells

These cells also reside in steady-state tissues and can detect the presence of microbes[19]. Mast cells contain granules that are discharged when they are stimulated, and the granule contents can contribute to triggering of local inflammation [20].

Granulocytes

These are containing cytoplasmic granules that are visible under the light microscope [21]. Granulocytes are divided into three groups derived from a common precursor: neutrophils, which are abundant in blood and are a very important type of phagocyte; the rarer eosinophils, and the basophils that are somewhat related to mast cells in function [13].

Natural killercells

Natural killer cells are present in tissues as resident cells and can also be recruited to sites of inflammation. They can kill other cells, such as virally infected cells and they also regulate immune responses [22].

Phagocytes:

Phagocytes are specialized cells that are able to internalize particles such as bacteria and small protozoa, and are able to kill microbes intracellularly. The two main classes of phagocytes are macrophages and neutrophils. Other cells such as eosinophils are also weakly phagocytic [12,23].

Organs of the immune system:

A number of morphologically and functionally diverse organs and tissues have various functions in the development of immune responses.

- Thymus
- Bone Marrow
- Spleen
- Lymph nodes

Thymus

The thymus is the site of T-cell development and maturation. It is a flat, bilobed organ situated above the heart. Each lobe is surrounded by a capsule and is divided into lobules, which are separated from each other by strands of connective tissue called trabeculae. Each lobule is organized into two compartments: the outer compartment, or cortex,is densely packed with immature T cells, called thymocytes, whereas the inner compartment, or medulla, is sparsely populated with thymocytes. The function of the thymus is to generate and select a repertoire of T cells that will protect the body from infection [24,25].

Bone Marrow

In humans and mice, bone marrow is the site of B-cell origin and development. The immature B cells proliferate and differentiate within the bone marrow, and stromal cells within the bone marrow interact directly with the B cells and secrete various cytokines that are required for development [25]. Like thymic selection during Tcell maturation, a selection process within the bone marrow eliminates B cells with self-reactive antibody receptors [26].

Lymph Nodes

They are encapsulated bean shaped structures containing a reticular network packed with
lymphocytes, macrophages, and dendritic cells. Clustered at junctions of the lymphatic vessels, lymph nodes are the first organized lymphoid structure to encounter antigens that enter the tissue spaces [27]. As lymph percolates through a node, any particulate antigen that is brought in with the lymph will be trapped by the cellular network of phagocytic cells and dendritic cells. The overall architecture of a lymph node supports an ideal microenvironment for lymphocytes to effectively encounter and respond to trapped antigens [6].

Spleen

The spleen plays a major role in mounting immune responses to antigens in the blood stream. It is a large, ovoid secondary lymphoid organ situated high in the left abdominal cavity [8]. While lymph nodes are specialized for trapping antigen from local tissues, the spleen specializes in filtering blood and trapping blood-borne antigens; thus, it can respond to systemic infections. Unlike the lymph nodes, the spleen is not supplied by lymphatic vessels. Instead, blood borne antigens and lymphocytes are carried into the spleen through the splenic artery [15].

DOI: 10.5123/inj.2023.4.in94
ISSN:2093-4777 | E-ISSN:2093-6931
Vol. 27 Iss. 4 (2023)

ANTIGENS

An antigen is a substance/molecule that, when introduced into the body, triggers the production of an antibody by the immune system, which will then kill or neutralize the antigen that is recognized as a foreign and potentially harmful invader. These invaders can be molecules such as pollen or cells such as bacteria. The term originally came from antibody generator [5].

A substance that reacts with the products of a specific immune response is called antigen. In other words, substances that can be recognized by the immunoglobulin receptor of B cells, or by the T cell receptor are called antigens.Although a substance that induces a specific or adaptive immune response is usually called an antigen, it is more appropriately called an immunogen. An immunogen is a specific type of antigen that is able to provoke an adaptive immune response if injected on its own [10].

ANTIBODIES

An antibody, or immunoglobulin (Ig), is a serum glycoprotein produced by plasma cells that mature from lymphocytes, called B lymphocytes (B cells), in response to an antigen [28]. The B cells develop in the bone marrow of humans. The term immunoglobulin (Ig)is generally used for all antibodies, whereas the term antibodyis mostly used to denote one particular set of immunoglobulins known to have specificity for a particular antigen. There are five classes of immunoglobulins (IgG, IgA, IgM, IgE, and IgD), which are characterized by differences in structure and function [29].

Types Of Antibodies

There are 5 types of antibodies, IgM, IgG, IgD, IgE and IgA.

Immunoglobulin M (IgM)

Release during primary response, the first antibody produced. It has found 5-10 % in serum. They predominate and are involved in ABO blood group antigens on the surface of RBCs.

Immunoglobulin G (IgG)

Produced during late primary and secondary immune response and most abundant (50-80 % of total) antibody present in the serum. These can pass the placenta from mother's womb to foetus. These can also pass the walls of blood vessels and enter into tissue fluid [30].

Immunoglobulin A (IgA)

Found in body secretions or body fluids such as saliva, sweat, secretions from GIT and blood serum it is about 15% of total antibodies. IgA gets attached to a protein called secretary components, which protects IgA from enzymatic degradation, and facilitates its entry into secretary tissue [31].

Immunoglobulin D (IgD)

Accounts for only 0.2% of total antibodies of serum. It resembles with IgM. These are bound to surface of plasma membrane of B cell.

Immunoglobulin E (IgE)

Concentration is 0.002% of total antibodies, bound very tightly to the receptors of mast cell and basophils and causes release of histamine [12,17].

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DOI: 10.5123/inj.2023.4.in94
ISSN:2093-4777 | E-ISSN:2093-6931
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ISSN:2093-4777 | E-ISSN:2093-6931
DOI: 10.5123/inj.2023.4.in94
Vol. 27 Iss. 4 (2023)