Jurnal Kedokteran Methodist, Vol. 17 No.1 Tahun 2024
https://doi.org/10.46880/jkm.v17i1

REVIEW ARTICLE

ANTIBODY MEDIATED IMMUNITY

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ABSTRACT

Maintaining individual integrity and balance requires an adequate immune system. Therefore, immune mechanisms against harmful antigens include physical and chemical defenses, symbiosis with normal bacterial flora, innate immunity, and acquired specific immunity, consisting of humoral immunity and cell-mediated immunity. Antibodies are components of acquired immunity that protect the body against infection by microorganisms and their toxic products. Therefore, the interaction between antigens and antibodies is crucial and widely used in vitro for diagnostic purposes. The use of in vitro antigen-antibody reactions is called serology.

Keywords: ***Innate immunity, Adaptive immunity, Antibodies***

INTRODUCTION

The immune system is a highly complex system with multiple roles in maintaining the body's balance. The immune system is necessary for the body to maintain its integrity and protect against hazards posed by various substances in the environment. 1,2

Immune defense consists of the natural or nonspecific (natural/innate/native) and the acquired or specific (adaptive/acquired) immune systems. The above division is intended for ease of understanding. In reality, these two systems work closely together; one cannot be separated from the other. 1,2

Unlike the nonspecific immune system, the specific immune system has the ability to recognize objects it deems foreign. The first foreign object in the body is immediately recognized by the specific immune system, resulting in sensitization of the immune system's cells. The same foreign object, upon re-exposure, is recognized more quickly and then destroyed. Because this system can only eliminate foreign objects that it has previously recognized, it is called specific. To destroy foreign objects that are harmful to the body, the specific immune system can work without the assistance of the nonspecific immune system. In general, there is a good collaboration between antibodies, complement, phagocytes, and between T cells and macrophages.1,2

The specific immune system can be divided as follows:

a. Humoral specific immune system

The main players in the humoral specific immune system are B lymphocytes or B cells.

b. Cellular specific immune system

T lymphocytes or T cells play a role in the cellular specific immune system.1,2

B Cells

B lymphocytes or B cells play a role in the humoral specific immune system. B cells constitute 5-25% of the lymphocytes in the blood, numbering

approximately 1000-2000 cells/mm3. The majority of these lymphocytes originate from the bone marrow (almost 50%), with the remaining approximately 1/3 originating from lymph nodes, lymph, and less than 1% from the thymus.1

B cells and T cells originate from the same precursor cells, produced in the bone marrow, including receptor formation. B cell maturation occurs in the bone marrow, while T cell progenitors migrate to and mature in the thymus. Each cell proliferates primarily under the influence of the cytokine IL-12, which increases the number of immature cells. 1,3,4

During development, immature B cells express membrane IgM in the bone marrow. These cells enter the bloodstream and develop into mature naive B cells that express both mIgM and mIgD. Only about 10% of potential B cells mature and exit the bone marrow. Naive B cells in the periphery die unless exposed to a soluble antigen protein and activated by T cells. Activated B cells proliferate in secondary lymphoid organs. Cells carrying high-affinity mIg differentiate into plasma cells and memory B cells, which can express various isotopes through class switching. 1,3,5,6,7

ANTIBODY

Antibodies are soluble substances classified as proteins called globulins and are now known as immunoglobulins. Two important characteristics are specificity and biological activity. Their primary function is to bind antigens and deliver them to the effector system for destruction.1

Immunoglobulins (Ig) are produced by plasma cells derived from the proliferation of B cells following contact with antigens. The antibodies produced specifically bind to other new antigens of the same type.1,8

ANTIBODY STRUCTURE

All immunoglobulin molecules have four basic polypeptide chains: two identical heavy chains and two light chains, linked by disulfide bonds.

Light chains (L = light) come in two types: α (kappa) and β (lambda), each consisting of 230 amino acids. This classification is based on differences in amino acids in the constant region. Both types are present in all immunoglobulin classes (IgG, IgM, IgA, IgD, and IgE), but each immunoglobulin molecule contains only one type of light chain. The amino end of each light chain contains the antigen-binding site.

Heavy chains (H = heavy) differ significantly for each immunoglobulin class and include IgG, IgM, IgA, IgD, and IgE. Heavy chains consist of 450-600 amino acids, making them twice the weight and length of light chains. Immunoglobulin molecules have a heterogeneous structural formula, although they consist of only four basic polypeptide units. 1,3,4,7,8

CLASSES AND PROPERTIES OF IMMUNOGLOBULINS

1. Immunoglobulin G

IgG is the main component of serum immunoglobulins, with a molecular weight of 160,000 daltons. Its serum concentration is approximately 13 mg/ml, accounting for 75% of all immunoglobulins. IgG is found in various fluids such as blood, CSF, and urine. 1,4,7

IgG can cross the placenta and enter the fetus and play a role in infant immunity until 6-9 months of age.

2. Immunoglobulin A

IgA, with a molecular weight of 165,000 daltons, is found in serum in small amounts. Its highest concentrations are found in respiratory, digestive, and urinary tract secretions, tears, sweat, saliva, and breast milk, where it is predominantly secretory IgA (sIgA).

3. Immunoglobulin M

The name IgM comes from macroglobulin, which has a molecular weight of 900,000 daltons. IgM has a pentameric structure and is the largest immunoglobulin. IgM is the most efficient Ig in complement activation (the classical pathway). Most B cells express IgM on their surface as an antigen receptor. IgM is formed first in the primary immune response but does not persist for long; therefore, high IgM levels are a sign of early infection. Newborns only contain 10% of the adult IgM level because maternal IgM cannot cross the placenta.

4. Immunoglobulin D

IgD is found in serum at very low levels. This is likely because IgD is not released by plasma cells and is highly susceptible to proteolytic degradation. IgD is the main surface component of B cells and a marker of more mature B cell differentiation. IgD constitutes 1% of total immunoglobulins and is found abundantly on B cell membranes, along with IgM, which can function as antigen receptors in B cell activation.

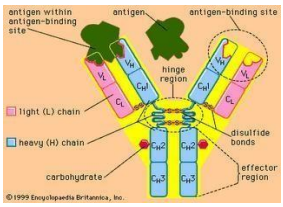
5. Immunoglobulin E

IgE is found in serum in very small amounts. IgE readily binds to mast cells, basophils, and eosinophils, which have receptors for the Fc fraction of IgE (Fcγ-R). IgE is produced locally by plasma cells in the mucous membranes of the respiratory and gastrointestinal tracts. High serum IgE levels are found in allergies, helminth infections, schistosomiasis, hydatid disease, and trichinosis. In addition to allergies, IgE is also thought to play a role in parasite immunity. 1,7,8

ANTIBODY-MEDIATED IMMUNITY (HUMORAL IMMUNITY)

- **Primary Response**

When an individual is first exposed to an antigen, antibodies against that antigen are detected in the serum within days or weeks,



depending on the origin and dose of the antigen, and the route of administration (e.g., oral or parenteral). Serum antibody concentrations continue to rise for several weeks and then decline; they may drop to very low levels. The first antibodies to be formed are IgM, followed by IgG, IgA, or both. IgM levels tend to decline more rapidly than IgG levels.1,3,5,6,7

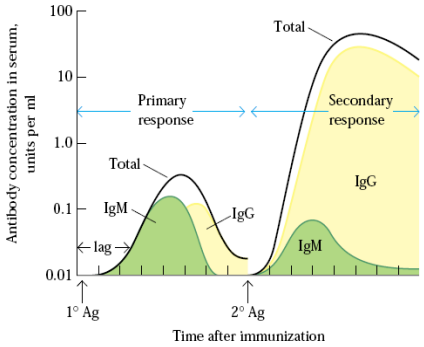


FIGURE 11-14 Concentration and isotype of serum antibody following primary (1°) and secondary (2°) immunization with antigen. The antibody concentrations are plotted on a logarithmic scale. The time units are not specified because the kinetics differ somewhat with type of antigen, administration route, presence or absence of adjuvant, and the species or strain of animal.

- Secondary Response

Upon a second exposure to the same antigen (or a cross-reactive antigen) months or years after the primary response, the antibody response is more rapid and increases to a level that allows memory cells sensitive to the antigen to persist after the first immune response.

In the secondary response, the amount of IgM produced is qualitatively similar to that produced after the first exposure to the antigen; however, more IgG is produced, and IgG levels tend to persist longer than in the primary response. 1,3,5,6,7

Antigen-Antibody Interactions

An antigen is a substance that can bind specifically to an antibody molecule or a receptor molecule on a T cell. Antibodies are

components of acquired immunity that protect the body against infection by microorganisms and their toxic products. Therefore, the interaction between antigen and antibody is very important and is widely used in vitro for diagnostic purposes. The use of in vitro reactions between antigens and antibodies is called serology. 1, 3, 6, 7

The interaction between antigens and antibodies can result in various effects, including precipitation (if the antigen is soluble in physiological saline), agglutination (if the antigen is insoluble/small particles), neutralization (toxins), and complement activation. Most of these reactions occur through the interaction between multivalent antigens and antibodies, which have at least two binding sites per molecule. 1, 3, 6, 7

CONCLUSION

o The specific immune response distinguishes between self and foreign specificities, possesses memory and adaptive capacity. Humoral immunity (B cells) produces antibodies that neutralize pathogens and toxins.

o B cells develop in the bone marrow. Their activation and differentiation are induced by antigens in the periphery. Activated B cells can develop into plasma cells that produce and secrete antibodies or memory B cells.

o The nature of primary and secondary antibody responses is not the same. The primary response requires a longer time to form antibodies. IgM is the first antibody produced, followed by a gradual shift to other classes. The secondary response takes less time and lasts longer. IgG is the primary product released

in the secondary response compared to IgM, and the average affinity of the antibodies produced is higher.

REFERENCES

1. Baratawidjaja, karnen G. Imunologi Dasar. Balai Penerbit FKUI. Jakarta: 8th; 95-111; 158-176

2. Kresno, Siti Boedina. Imunologi: Diagnosis dan Prosedur Laboratorium. Balai Penerbit FKUI, Jakarta, 2001; 4-12; 112-123

3. Abbas, Abul K, Et all. Celular and Molekular Immunology. Saunders Elsevier Inc, 2007; 6th; 75-96; 49-55; 215-217

4. Shetty, Nandini. Immunoglobulins I. In: Immunology Introductory Textbook, New Age International Publisher, 2005; 2nd; 25-32

5. Mak, Tak W., saunders, Mary E. Tha Immune Response Basic and Clinical Principles, Elsevier inc, 2006; 51-68; 93-120; 211-218

6. Goldsby, Richard A., et all. Immunology; 2002; 5th; 76-104; 137; 247-254;264;361

7. Nairn, Roderick. Imunologi. In: Jawetz, Melnick, Adelberg's. Mikrobiologi Kedokteran, Buku 1. Bagian Mikrobiologi FKUNAIR, Penerjemah & Editor. Penerbit Salemba Medika, 2001; 22nd; 178-193

8. Cruse,Julius M., et all. B cell, Immunoglobulin Genes, and Immunoglobulin Strukture. In: Immunology Guidebook. Elsevier Academic Press, 2004; 277- 3102