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Antigens and Development of T A\and B Lymphocytes In Body

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Abstract: Any substance that causes the body to make an immune response against that substance. Antigens include toxins, chemicals, bacteria, viruses, or other substances that come from outside the body. Body tissues and cells, including cancer cells, also have antigens on them that can cause an immune response. These antigens can also be used as markers in laboratory tests to identify those tissues or cells. An antigen is any kind of marker - like a protein or string of amino acids - that your immune system can recognize.

Keywords: antigens, development, lymphocytes.

The terms antigen and immunogen are commonly used as synonyms. More specifically, the term antigen describes a molecule that can bind with antibodies or antigen receptors on B and T cells. A molecule that binds to receptors and will induce an immune response is an immunogen. Thus all immunogens are antigens but not all antigens are immunogens. Despite these specific definitions, the term antigen is used most often to describe molecules that are foreign to the host and cause an immune response. Common antigens include infectious agents, allergens, chemical agents (including some medications), and abnormal molecules on the surface of cells (cancers and infected cells). The ability of an antigen to induce an immune response is frequently related to the size of the antigen. In general, large molecules (those > 10,000 daltons), such as proteins and polysaccharides, are the most immunogenic antigens. Many low-molecular-weight molecules can function as haptens; they are too small to induce an immune response by themselves but become immunogenic after combining with larger molecules that function as carriers for the hapten. For example, poison ivy contains an oily sap called urushiol (molecular weight approximately 1500 daltons), that is an antigen, which, upon contact with the skin, is chemically altered, binds to large proteins in the skin, and becomes immunogenic, resulting in a T-cell response and onset of a classic poison ivy rash.

The immune response occurs in two phases: generation of clonal diversity and clonal selection. Clonal diversity is the production of a large population of B cells and T cells before birth and throughout life that have the capacity to recognize almost any foreign antigen found in the environment. This process mostly occurs in specialized lymphoid organs (the primary [central] lymphoid organs): bone marrow for B cells and the thymus for T cells. The result is the differentiation of lymphoid stem cells into B and T lymphocytes with the ability to react against almost any antigen that will be encountered throughout life. It is estimated that B and T cells can collectively recognize more than 108 different antigenic determinants. Lymphocytes are released from these organs into the circulation as immunocompetent cells that have the capacity to react with antigens and migrate to the circulation and other (secondary) lymphoid organs in the body.

Development of B Lymphocytes. Lymphocyte stem cells destined to become B cells circulate through the specialized regions of bone marrow, where they are exposed to hormones and cytokines that induce proliferation and differentiation into B cells. As the stem cell begins to mature, it progressively develops a variety of necessary surface markers important for the further differentiation and proliferation of the B cell. The next stage in development is formation of the B-cell receptor (BCR). The B-cell receptor (BCR) is a complex of antibody bound to the cell surface and other molecules involved in intracellular signaling. Its role is to recognize an antigen and communicate that information to the cell's nucleus. The BCRs in immunocompetent cells are membrane-associated immunoglobulin M (IgM) with or without IgD (IgD) antibodies that have identical specificities for

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antigen. The enormous repertoire of BCR specificities is made possible by rearrangement of existing deoxyribonucleic acid (DNA) during B-cell development in the primary lymphoid organs, a process known as somatic recombination. Multiple loci in the DNA that encode for BCRs are recombined to generate receptors that collectively can recognize and bind to any possible antigen. A single lymphocyte will synthesize antibodies that can recognize the identical antigen as the BCR on that cell. (Antibody synthesis is discussed in the Humoral Immunity (Antibodies) section.) Somatic rearrangement will frequently result in a BCR that recognizes the individual's own antigens, which may result in an inadvertent attack on “self” antigens expressed on various tissues causing autoimmune disease or hypersensitivities. Many of these “autoreactive” B cells are eliminated in bone marrow, where they undergo apoptosis. It is estimated that > 90% of developing B cells are eliminated in this way. This process is referred to as clonal deletion or central tolerance, so that the remaining pool of immunocompetent B cells target foreign antigens and are “tolerant” to self-antigens. Peripheral tolerance occurs in the tissues and is discussed in the T-Regulatory Lymphocytes section. B-cell differentiation also is characterized by the development of a variety of important. surface molecules that are markers for B cells. These include CD21 (a complement receptor) and CD40 (adhesion molecule required for later interactions with T cells). The designation “CD” refers to cluster of differentiation, specific cell surface proteins that are assigned a unique number (e.g. CD21 and CD40).

Development of T Lymphocytes. The process of T-cell proliferation and differentiation is similar to that for B cells. The primary lymphoid organ for T-cell development is the thymus. Lymphoid stem cells journey through the thymus, where, under influence of thymic hormones and the cytokine IL-7, they are driven to undergo cell division and gain receptors (T-cell receptors [TCRs]) against the diversity of antigens the individual will encounter throughout life. They exit the thymus through the blood vessels and lymphatics as mature (immunocompetent) T cells with antigen-specific receptors on the cell surface and establish residence in secondary lymphoid organs. The most common TCR consists of two protein chains, α- and β-chains, each of which has a variable region and a constant region and a complex of signaling molecules called CD3. As with BCR generation, each T cell expresses only one type of TCR and the diversity of TCRs generated through somatic recombination collectively can recognize and bind to any possible antigen. Differentiation of T cells in the thymus also results in expression of other important surface molecules. Initially proteins called CD4 and CD8 are concurrently expressed on the developing cells. As the cells mature, they retain either the CD4 molecule or the CD8 molecule, but not both. Those that retain the CD4 molecule develop into Th cells, whereas those that retain the CD8 molecule become T-cytotoxic (Tc) cells. Approximately 60% of immunocompetent T cells in the circulation express CD4, and 40% express CD8. Central tolerance also occurs in the thymus where > 95% of developing T cells are clonally deleted because they are potentially autoreactive.

In conclusion, antigens are usually proteins or sugars (polysaccharides) found on the outside of things like cells or viruses. Each has a unique shape that your immune system reads like a nametag to know whether it belongs in your body. Lymphocytes are a type of white blood cell. They play an important role in your immune system, which helps your body fight disease and infection. Your immune system is made up of an intricate web of immune cells, lymph nodes, lymph tissue and lymphatic organs.

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