General Internal Medicine and Clinical Innovations

Review Article

ISSN: 2397-5237

The T Lymphocyte

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Abstract

The T lymphocyte (T cell) is a part of the lymphocyte family which includes B cells. They are a white cell that are involved in cell mediated immunity. Like B cells they recognize antigens (pathogens) and respond with specific cell types in (sometimes) a non-specific fashion. There are a variety of different types of T cells including helper, memory, cytotoxic and regulatory. All originate in the bone marrow and have the T-cell receptor (TCR) on their surface.

T cell origination and development

Like all lymphocytes, T cells originate in the bone marrow as hematopoietic stem cells. There is no "bursa" equivalent for T cells. That is B cells were originally named for the Bursa of Fabrisious in birds where they were originally discovered [1]. There is no equivalent in birds or other animals for T cells. From the bone marrow T cells move to the thymus via the blood stream and mature. T cells will mature into one of several distinct groups of cells each with unique functions and surface antigens. Differentiation of T cells proceeds from a common progenitor cell, which is a precursor cell. This cell may become either a T cell, B cell or Natural Killer Cell.

Those cells that migrate to the thymus will become T cells, depending on the receptors they inherit. As each T cell (regardless of eventual outcome) matures the functional T cell receptor (TCR) will develop on the cell [2]. The TCR is unique and allows for the immune system to react to different antigen patterns. The TCR consists of the alpha and beta chains. It is the TCR that recognizes and reacts to the human MHC complex and that it does not react to self-protein. CD4+/CD8+ are considered double positive thymocytes that go into the thymus and are exposed to self-antigen They interact with MHC-I or MHC-II will have an MHC (Major Histocompatibility Complex) affinity and will progress further. Those that do not will die off. Most T cells undergo this fate. MHC II interactions lead to CD4+ and that those that interact with MHC-I will become CD8+ cells. This process represents positive lymphocyte selection. Negative selection is the process that removes T cells that can bind with MHC (self) peptides [3].

Activation of T cells

T cell activation is dependent on initial recognition of antigen by the TCR receptor. Specifically, for CD4+ T cells there is also co-stimulation by molecules such as CD28 by MHCII. Required also is stimulation by an antigen processing cell (APC) such as a macrophage. CD8+ signaling will usually require CD4+ signaling and engagement. There are two distinct signals that are necessary for activation [4]. The first is binding of the TCH receptor to its' "like" peptide on the APC, or to MHCII in the case of professional antigen-presenting cells such as dendritic cells or macrophages. The second signal is a co-stimulation of surface receptors on the APC by small by products of pathogens. This second signal allows for response to the antigen in question. Once activated the T cell surface is altered. T cell mobilization may occur in response to signaling from a mature B cell that has encountered and interacted with an antigen. At this point a number of outcomes may occur such as production of cytokines such as IL-2, which act as a positive feedback to produce and activate more T cells.

T cell function

There are a variety of T cell types that as mentioned are determined in the thymus and as a result of antigen stimulation. These subsets have an equal variety of function in the normal immune response.

Helper T cells

Helper T cells (T helper cells, T_H) are a subset of cells also known as CD4+ T cells whose primary function is assistance to other cell types. Included in this is the maturation and transformation of Mature B cells to plasma cells that produce specific antibody. T_H cells are presented with antigen by MHCII molecules which are found on antigen presenting cells [5]. Subsets of T_H cells will produce cytokines such as IL-4, 9, 21, 17 and interferon that act to stimulate transcription factors, and thus are active in other parts of the immune response in addition to antibody production.

Memory T cells

Memory T cells (T_M) cells are some of the longest-lived cells in the primate body [5,6]. Their definition is functional in that they can expand in larger numbers to effector cells to combat a previously seen antigen, thus the name. They may be either CD4+ or CD8+ and will express the CD45 Ro antigen. These types of T memory cells are found often in lymph nodes where they are likely to come into contact with processing antigen. This memory of an immune event is one of the bedrocks of how vaccines work. Exposure to an antigen in a controlled manner (vaccine) will provide in most cases immunity lasting years (polio).

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Keywords: *Lymphocyte, Effector, White Cell, Cytokine*

Received: October 26, 2021; **Accepted:** November 09, 2021; **Published:** November 16, 2021

Regulatory T cells

These types of T cells are important to regulate the immune system and response to antigens, but are primarily involved in immunological tolerance [7]. They will terminate T cell immunity and will act as a suppressor to T cells that were not processed by negative selection in the thymus and thus b involved in autoimmunity, thus the regulatory aspect of their function.

T cells and clinical disease

Low T cell counts may occur during conditions of trauma or after surgery. HIV will destroy T cells leading to low counts, leading eventually to opportunistic infections. High lymphocyte counts in general and increased T cell counts in specific (lymphocytosis) can be seen with viral infections. This occurs as the body attempts to fight the infection [8,9].

Summary

T-lymphocytes are an important cell type that are involved with regulation and stimulation of the human, and other animal immune response. There functions in this sense are conserved in nature. Further study will enhance the understanding of the complexities of the immune system and the diseases that the immune system reacts against.

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