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Journal of Clinical and Cellular Immunology

Perspective

Overview on Immunological Memory

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DESCRIPTION

Immunological memory refers to the immune system's ability to recognize an antigen that the body has previously initiated an immunological response in reaction to it. Secondary, tertiary, and other subsequent immune responses to the same antigen are the most common. Immunological memory is in charge of the adaptive immune system's T and B cells, also known as memory T and B cells. Vaccination is based on immunological memory. New evidence suggests that the innate immune system plays a role in immunological memory responses in both invertebrates and vertebrates.

Immunological memory develops after the antigen has elicited an initial immune response. After a previous initial encounter to a potentially harmful agent, each individual creates immunological memory. Secondary immune responses follow the same pattern as primary immune responses. After recognizing the antigen, the memory B cell transmits the peptide: MHC I complex to neighboring effector T cells. This causes these cells to become activated and proliferate rapidly. The immune response's effector cells are destroyed after the primary immune response has faded. However, antibodies that were previously generated in the body still exist and serve as the humoral component of immunological memory, as well as a key protective mechanism in subsequent infections. They remain in a resting state in the bloodstream, and when they are exposed to the same antigen again, they are able to respond quickly and destroy the antigen. Memory cells have a lengthy lifespan in the body, lasting up to several decades. Chickenpox, measles, and other infections provide lifetime immunity. The immune system's reaction to a few infections, such as dengue fever, has the unintended consequence of making the next infection worse (antibody-dependent enhancement).

Researchers are still trying to figure out why certain vaccines provide lifetime protection while others lose effectiveness in less than 30 years for mumps or less than six months for influenza. Memories of T and B cells are a common evolutionary idea; nevertheless, the conditions required to create this costly adaptation are unique. To begin, immunological memory must have a large initial molecular machinery cost, which will necessitate reductions in other host features. Second, organisms with a medium or long lifespan have a better probability of developing such machinery. Because the immunological memory must be effective early in life, the cost of this adaptation rises if the host has a short lifespan. In addition, study suggests that the environment influences the diversity of memory cells in a population. When comparing the impact of multiple infections on a specific disease versus disease diversity in the environment, it's clear that memory cell accumulate diversity based on the number of individual pathogens exposed, even if it comes at the expense of efficiency when confronted with more common pathogens. This suggests that the environment has a significant impact on memory cell population evolution. Measles can diminish previously acquired immunological memory in unvaccinated children, putting them at risk of infection by other diseases in the years following infection.

Despite not having the ability to make antibodies like the adaptive immune system, the innate immune system is engaged in parts of immunological memory. Many invertebrates, including freshwater snails, copepod crustaceans, and tapeworms, have been observed activating innate immunological memory to instigate a more efficient immune response to specific antigens without the use of the adaptive immune system in a process known as Trained Immunity. Mice lacking functional T and B cells were able to withstand a deadly dose of Candida albicans after being exposed to a much lower dose previously, demonstrating that vertebrates have this potential as well.

Memory B cells are plasma cells that can generate antibodies for an extended period of time. The memory B cell response differs slightly from the naive B cells involved in the first immune response. Because the memory B cell has already gone through clonal expansion, differentiation, and affinity maturation, it can divide several times faster and produce antibodies with significantly higher affinity, particularly IgG antibodies. The naive plasma cell, on the other hand, is fully differentiated and cannot be induced to divide or produce more antibodies by antigen. Memory plasma cells are found in the bone marrow after the germinal center reaction, which is the main source of antibody synthesis within the immunological memory. Research on these cells, such as migration and gene expression analysis, are possible, albeit such analyses have yet to identify a pattern that distinguishes mature from immature plasma cells.

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Received date: December 03, 2021; **Accepted date**: December 17, 2021; **Published date**: December 24, 2021

Citation: Simon D (2021) Overview on Immunological Memory. J Clin Cell Immunol.12:645.