42.2C: Cell-Mediated Immunity

Cell-mediated immunity involves cytotoxic T cells recognizing infected cells and bringing about their destruction.

Learning Objectives

- Summarize the cell-mediated immune response

Key Points

- Once a pathogen enters a cell, it can no longer be detected by the humoral immune response; instead, the cell-mediated immune response must take over to kill the infected cell before it can allow the virus or bacteria to replicate and spread.
- T cells recognize infected cells by interacting with antigen present on their MHC II molecules; before a T cell can do so, it must be activated via interaction with an antigen presenting cell, or APC.
- Once a cytotoxic T cell (Tc) is activated, it will clone itself, producing many Tc cells with the correct receptors; some portion of the cells are active and will help destroy infected cells, while others are inactive memory cells that will create more active Tc cells if the infection returns.
- Helper T cells (Th cells) also aid in cell-mediated immunity by releasing signaling molecules known as cytokines which can recruit natural killer cells and phagocytes to destroy infected cells and further activate Tc cells; they do not directly destroy pathogens.

Key Terms

- **cytotoxic T cell**: a subgroup of lymphocytes (white blood cells) that are capable of inducing death to infected somatic or tumor cells; part of cell-mediated immunity
• cytokine: any of various small regulatory proteins that regulate the cells of the immune system; they are released upon binding of PRRs to PAMPS

T cells

Just as the humoral immune response has B cells which mediate its response, the cellular immune response has T cells, which recognize infected cells and destroy them before the pathogen inside can replicate and spread to infect other cells. Unlike B cells, T lymphocytes (T cells) are unable to recognize pathogens without assistance. First, an antigen-presenting cell (APC, such as a dendritic cell or a macrophage) detects, engulfs (via phagocytosis in the case of macrophages or by entry of the pathogen of its own accord in the case of dendritic cells), and digests pathogens into hundreds or thousands of antigen fragments. These fragments are then transported to the surface of the APC, where they are presented on proteins known as Major Histocompatibility Complexes class II (MHC II, see ). T cells become activated towards a certain antigen once they encounter it displayed on an MHC II. After a virus or bacteria enters a cell, it can no longer be detected by the humoral immune response. Instead, the cellular immune response must take over. To do so, a T cell will become activated by interacting with an antigen of the infecting cell or virus presented on the MHC II of an APC.

Figure \(\PageIndex{1}\): APCs, MHCs and lymphocytes: An antigen-presenting cell (APC), such as a macrophage, engulfs a foreign antigen, partially digests it in a lysosome, and then embeds it in an MHC class II molecule for presentation at the cell surface. Lymphocytes of the adaptive immune response must interact with antigen-embedded MHC class II molecules to mature into functional immune cells.

Cytotoxic T cells mediate one arm of the cellular immune response

There are two main types of T cells: helper T lymphocytes (T\(_H\)) and the cytotoxic T lymphocytes (T\(_C\)). The T\(_H\) lymphocytes function indirectly to tell other immune cells about potential pathogens, while cytotoxic T cells (T\(_C\)) are the key component of the cell-mediated part of the adaptive immune system which attacks and destroys infected cells. T\(_C\) cells are particularly important in protecting against viral infections because viruses replicate within cells where they are shielded from extracellular contact with circulating antibodies. Once activated, the T\(_C\) creates a large clone of cells with
one specific set of cell-surface receptors, similar to the proliferation of activated B cells. As with B cells, the clone includes active T\(_C\) cells and inactive memory T\(_C\) cells. The resulting active T\(_C\) cells then identify infected host cells.

T\(_C\) cells attempt to identify and destroy infected cells by triggering apoptosis (programmed cell death) before the pathogen can replicate and escape, thereby halting the progression of intracellular infections. To recognize which cells to pursue, T\(_C\) recognize antigens presented on MHC I complexes, which are present on all nucleated cells. MHC I complexes display a current readout of intracellular proteins inside a cell and will present pathogen antigens if the pathogen is present in the cell. T\(_C\) cells also support NK lymphocytes to destroy early cancers.

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**Cytokines released by T\(_H\) cells recruit NK cells and phagocytes**

Cytokines are signaling molecules secreted by a T\(_H\) cell in response to a pathogen-infected cell; they stimulate natural killer cells and phagocytes such as macrophages. Phagocytes will then engulf infected cells and destroy them. Cytokines are also involved in stimulating T\(_C\) cells, enhancing their ability to identify and destroy infected cells and tumors. A summary of how the humoral and cell-mediated immune responses are activated appears in. B plasma cells and T\(_C\) cells are collectively called effector cells because they are involved in “effecting” (bringing about) the immune response of killing pathogens and infected host cells.

![Diagram of the immune response](https://bio.libretexts.org/Bookshelves/Introductory_and_General_Biology/Book%3A_General_Biology_(Boundless)/42%3A_T...)

Figure \(\PageIndex{1}\): **Helper T cells in the immune response**: A helper T cell becomes activated by binding to an antigen presented by an APC via the MHCII receptor, causing it to release cytokines. Depending on the cytokines released, this activates either the humoral or the cell-mediated immune response.