Effector T cells

Effector T cells are specialized immune cells that respond to specific antigens by carrying out various immune functions. They include cytotoxic T cells (CD8+ T cells) that kill infected cells, helper T cells (CD4+ T cells) that activate other immune cells and produce cytokines, and regulatory T cells (Tregs) that control the immune response.

Properties of Effector T Cells:

- **Short Lifespans:**
Effector T cells typically have shorter lifespans compared to memory T cells.
- **Antigen Specificity:**
They recognize and respond to specific antigens presented by antigen-presenting cells (APCs).

- **Effector Functions:**

They perform various immune functions, including:

  - **Cytotoxicity:** Cytotoxic T cells (CD8+ T cells) kill infected cells directly.
  - **Cytokine Production:** Helper T cells (CD4+ T cells) release cytokines that activate other immune cells and influence the immune response.
  - **Regulation of Immune Responses:** Regulatory T cells (Tregs) suppress the immune response and prevent excessive inflammation.

- **Expansion and Differentiation:**

Effector T cells can expand into large numbers upon antigen recognition and differentiate into various effector subsets.

- **Role in Immune Response:**

They are crucial for clearing infections, fighting cancer, and regulating the immune system.

- **Influence on other cells:**

They can influence the activity of other cells, including other T cells, B cells, and innate immune cells, through cell-to-cell contact and cytokine release.

- **Importance in inflammation:**

Effector T cells are involved in promoting inflammatory processes through cytokine release, contributing to the clearance of antigens.

- **Cytokine Production:**

They produce a wide range of cytokines, including pro-inflammatory cytokines like IFN-γ and TNF-α, which play a role in various immune responses.

- **Targeted Effector Actions:**

Effector proteins released by T cells are focused on specific target cells by mechanisms activated by antigen recognition.

- **Importance of Cytokine Profiles:**

Cytokine production is vital for classifying and understanding the functions of effector T cells.

- **Regulation by other cells:**

Effector T cells are regulated by cytokines produced by innate and adaptive immune cells.

Effector cytotoxic T cells

- Effector cytotoxic T cells (Tc cells), also known as killer T cells, are key components of the adaptive immune system that directly destroy infected or altered cells.
- They are primarily responsible for eliminating intracellular pathogens like viruses and intracellular bacteria, as well as cancer cells and cells involved in graft rejection.
- Tc cells express CD8 on their surface and interact with MHC class I molecules to recognize and eliminate target cells.

Properties of Effector Cytotoxic T Cells:

Direct Cytotoxicity:

- Tc cells induce apoptosis (programmed cell death) in target cells through the release of cytotoxic granules containing perforin and granzymes, or by expressing Fas ligand, which can activate apoptosis.

Antigen Specificity:

- Tc cells are highly specific for their target antigens, meaning they only recognize and eliminate cells that display the specific antigen they are programmed to target.

MHC Class I Restriction:

- Tc cells recognize antigens presented on MHC class I molecules by the target cells.

Role in Viral and Intracellular Pathogen Elimination:

- Tc cells are crucial in controlling infections by eliminating cells infected with viruses or intracellular bacteria.

Antitumor Immunity:

- Tc cells play a vital role in recognizing and eliminating tumor cells, making them a key target for cancer immunotherapy.

Graft Rejection:

- Tc cells are also involved in the rejection of tissue grafts, as they recognize foreign MHC class I molecules on the transplanted tissue.

Effector Functions:

- Tc cells are armed with a variety of effector molecules, including cytotoxins stored in lytic granules and cytokines, which are synthesized de novo.

T Cell Receptor (TCR) Interaction:

- Tc cells recognize antigen-MHC class I complexes on target cells through their TCR, which initiates their activation and ability to eliminate the target cell.

CD8 Co-receptor:

- The CD8 co-receptor on Tc cells helps to stabilize the interaction between the Tc cell and the target cell, further enhancing the recognition process.

Cytokine Production:

- Tc cells can produce cytokines like IFN-γ and TNF-α, which contribute to the overall immune response and can also enhance the cytotoxic activity of other immune cells, such as macrophages

Natural Killer T (NKT) cells

- Natural Killer T (NKT) cells are a unique subset of T lymphocytes that share characteristics with both conventional T cells and natural killer (NK) cells.
- They are innate-like lymphocytes that play a crucial role in the immune system, recognizing glycolipid antigens presented by the CD1d molecule.
- NKT cells can rapidly produce cytokines and modulate immune responses, making them an important part of the immune response against various pathogens, tumours, and autoimmune diseases.

Properties of NKT cells:

Distinct lineage:

- NKT cells are a distinct subset of T lymphocytes, sharing characteristics with both NK and T cells.

Glycolipid recognition:

- They recognize glycolipid antigens presented by the CD1d molecule, unlike conventional T cells that recognize protein antigens presented by MHC molecules.

Rapid cytokine production:

- Upon activation, NKT cells rapidly produce a wide range of cytokines, including IFN-γ and IL-4, which can modulate other immune cells.

Immunoregulatory role:

- NKT cells have a significant immunoregulatory effect, influencing the activation state and functional properties of other immune cells, leading to either amplification or dampening of immune responses.

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Functional subsets:

- NKT cells can be subdivided into functional subsets, such as TH1-like, TH2-like, and Treg-like, which can switch between different functions.

Role in various diseases:

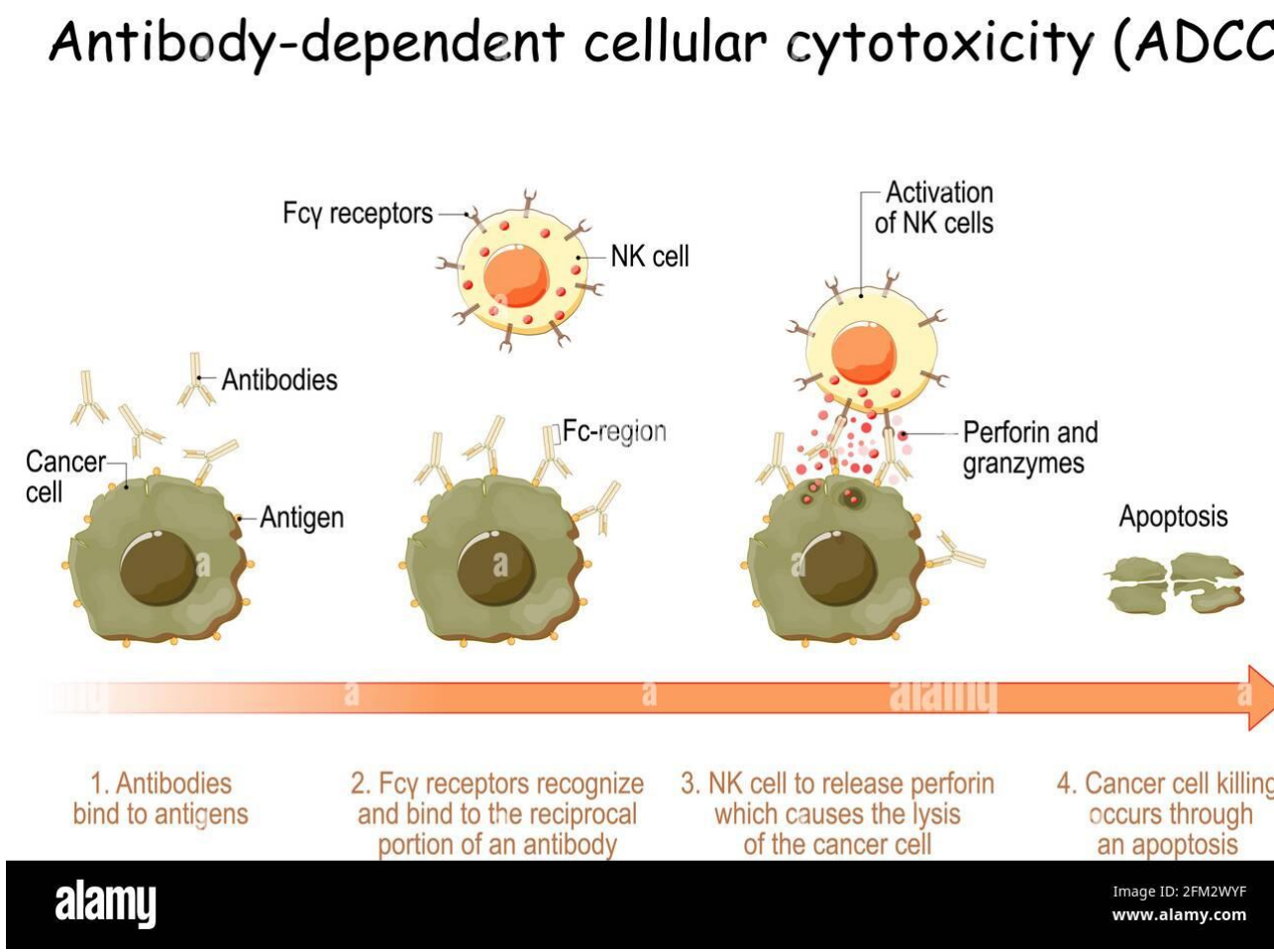
- NKT cells have been implicated in various diseases, including infections, autoimmune diseases, and cancer, and their potential as therapeutic targets is being explored.

Invariant and semi-invariant TCRs:

- Most NKT cells express an invariant or semi-invariant T cell receptor (TCR), which is crucial for their recognition of glycolipid antigens.
- In summary, NKT cells are a unique type of T lymphocyte that bridges the gap between innate and adaptive immunity, playing a critical role in immune regulation and defense against various pathogens and diseases.

Antibody-dependent cellular cytotoxicity (ADCC)

- Antibody-dependent cellular cytotoxicity (ADCC) is a mechanism where immune cells kill target cells that have been coated with antibodies.
- These antibodies, often IgG, bind to specific antigens on the target cell's surface, marking it for destruction by immune cells.
- The immune cells, which express Fc receptors, then bind to the Fc portion of the antibodies on the target cell, initiating a cascade that leads to cell death.



Key Players in ADCC:

1. Antibodies:

- These are proteins produced by the immune system that recognize and bind to specific antigens on the surface of target cells.

2. Target Cells:

- These are cells that are infected, cancerous, or otherwise undesirable and are coated with antibodies.

3. Effector Cells:

- These are immune cells, such as natural killer (NK) cells, that have Fc receptors on their surface.

4. Fc Receptors:

- These are proteins on the surface of effector cells that bind to the Fc portion of antibodies.

5. The ADCC Process:

- Antibody Binding: Antibodies bind to antigens on the surface of the target cell.

6. Effector Cell Recognition:

- Effector cells, expressing Fc receptors, recognize the antibody-coated target cell.

7. Target Cell Killing:

- Effector cells, upon recognition, release cytotoxic molecules, such as perforins and granzymes, that disrupt the target cell membrane and lead to cell death.

Role of ADCC:

Immune Defense:

- ADCC is a crucial part of the immune system's defense against various threats, including viral infections and tumors.

Therapeutic Applications:

- ADCC is also a mechanism of action for some therapeutic antibodies used in cancer treatment.

Examples of ADCC in Action:

HIV Infection:

ADCC plays a role in controlling viremia (viral load) in HIV infection.

Cancer Treatment:

Some monoclonal antibodies used in cancer therapy, like trastuzumab (Herceptin) and rituximab (Rituxan), work by inducing ADCC.

Viral Infections:

ADCC contributes to immunity against other viral infections, such as Dengue and Ebola.