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Commentary

Therapeutic applications, benefits of antibodies and antigens

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DESCRIPTION

Antibodies, also known as immunoglobulins, are crucial components of the immune system that play a vital role in defending the body against harmful pathogens, such as bacteria, viruses, and fungi. These Y-shaped proteins are produced by specialized white blood cells called B cells, and they recognize and bind to specific foreign substances known as antigens.

Therapeutic applications

Antibodies have revolutionized the field of medicine through the development of antibody-based therapies. Monoclonal antibodies, engineered to target specific antigens, are used for treating various diseases, including cancer.

Benefits

Importance of Antibodies: Antibodies are essential for the immune system's ability to recognize and eliminate pathogens. They provide several crucial benefits:

- ***Immunity:*** Antibodies play a central role in adaptive immunity, which provides long-term protection against specific pathogens. Once the immune system has encountered an antigen, it can produce antibodies specific to that antigen more rapidly and efficiently upon subsequent exposure. This immunological memory is the basis for vaccination and long-term protection against diseases (Al- Lazikani, et al., 1997).
- ***Defense against infections:*** Antibodies are instrumental in preventing and controlling infections. They can bind to pathogens in various ways, limiting their ability to cause disease. Additionally, antibodies can activate other components of the immune system, enhancing the body's ability to clear infections (Borghesi, et al., 2006).
- ***Diagnostic tools:*** Antibodies have extensive applications in diagnostic testing. They can be engineered to recognize specific molecules, making them valuable tools for detecting pathogens, identifying biomarkers, and diagnosing diseases. Antibody-based tests, such as enzyme-linked immunosorbent assays (ELISAs), are widely used in clinical laboratories (Fernández-Quintero, et al., 2021).

Antigens

Structure of antibodies: Antibodies are composed of four polypeptide chains: two heavy chains and two light chains, which are held together by disulfide bonds. Each chain consists of constant and variable regions (Litman, et al., 1993). The constant region determines the class of the antibody, such as IgG, IgM, IgA, IgD, or IgE (Immunoglobulin G, M, A, D, or E), while the variable region contains antigen-binding sites that confer specificity to the antibody (Nikoloudis, et al., 2014). The variable regions of the heavy and light chains form the antigen-binding site, which recognizes and binds to a specific antigen. The variability of these regions allows the immune system to produce a vast array of different antibodies, each capable of recognizing and binding to different antigens (North, et al., 2011).

Function of antibodies: The primary function of antibodies is to recognize and neutralize foreign substances in the body (Reth 2013). When an antibody encounters an antigen, it binds to it with high specificity, forming an antigen-antibody complex. This binding process can have various outcomes, including:

- ***Neutralization:*** Antibodies can neutralize pathogens by blocking their ability to infect host cells. They do this by binding to critical regions on the pathogen, preventing them from attaching to host cells or interfering with their ability to replicate (Santos, et al., 2011).
- ***Opsonization:*** Antibodies can coat pathogens, marking them for destruction by phagocytic cells, such as macrophages and neutrophils. This process enhances

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the recognition and uptake of pathogens by these cells, leading to their elimination (Spiess, et al., 2015).

- ***Complement activation:*** Antibodies can trigger the activation of the complement system, a group of proteins that work together to eliminate pathogens. The binding of antibodies to pathogens activates the complement cascade, leading to the formation of membrane attack complexes that destroy the pathogen's cell membrane (Woof, et al., 2004).
- ***Antibody-dependent cell-mediated cytotoxicity (ADCC):*** Some antibodies can recruit immune cells, such as natural killer (NK) cells, to destroy target cells directly. The fragment crystallizable region (Fc region) of antibodies binds to Fc receptors on NK cells, triggering their cytotoxic activity against the target cells.

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