

From Colds to Cancer: The Immune System's Role in Protecting You

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Introduction

The immune system of our body protects us from harmful substances, bacteria, viruses and other pathogens that might cause illness. Our body has defence mechanism that not only detect and combat infections, but also provide us immunological memory. Without an immune system, our body don't have any self defence mechanism to protect it from any harmful pathogen or antigen.

Keywords: Immune system, pathogen, antigen, MHC, T cells, B cells.

Immune system Function

Immune system comprises cells and organs with specialized roles in defending against pathogen. It is able to distinguish and differentiate between self or non-self-cells and once the threat is identified, it responds it by activating immune cells and generating antibodies to get rid of it. In addition, it eliminates aberrant or damaged cells, including malignant or cancer cells, before they can do any harm and after fighting with infections, it provides us immunological memory, which enables the body to remember prior encounters and subsequently respond in much more heightened way.

Types of immunity

The complex immune system is categorised into two types- Innate immunity and Adaptive immunity.

- A. Innate immunity:** The innate immune system is the first line of defence present since birth, which provides broad defensive mechanism against pathogenic microorganisms and chemicals. Innate immunity is characterised by the absence of an antigen-specific recognition mechanism. It does rely on prior exposure to pathogen and responds the same way to any foreign pathogen.

Key features of innate immunity:

- Rapid immune response within minutes to hours after pathogen enters the body.

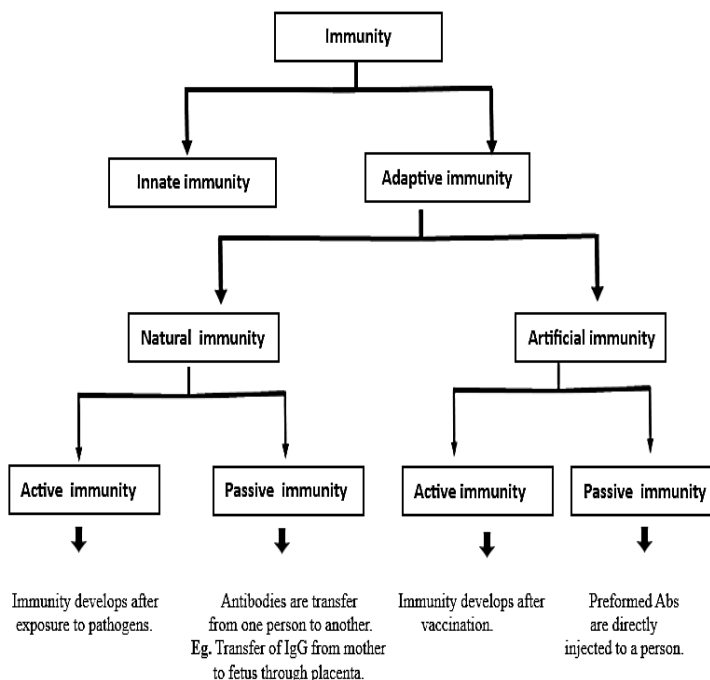
- It provides non-specific immune system and have no immunological memory against previous threats.
- It helps to activate the adaptive immune system by presenting antigen in order to generate antibodies against it.

Components of the Innate Immune System:

- 1. Physicals and chemicals barriers:** these barriers are the host's first defence against pathogen, includes skin, mucous membranes, tears, saliva and mucus. Skin and mucous membrane prevents infections by blocking pathogen from entering into the body. Saliva, mucus, and tears contain enzymes (lysozyme) that aid in breaking down the peptidoglycan layer of bacterial cell walls.
- 2. Cellular components:** such as dendritic cells, NK cells, and phagocytic cells (neutrophils, macrophages) constitute second line of defense. These includes various types of white blood cells that are used to identify and attack pathogen, especially Natural killer (NK) cells which detect and destroy the cancerous cells.
- 3. Complement system and inflammation:** The complement system contains group of protein, present in tissue and blood fluids, aids in improving the capacity of immune cells and antibodies to eradicate infections. It also helps to promote inflammation and facilitate the removal of damaged tissues and dead cells.
- 4. Cell associated pattern recognition receptors:** Includes Toll-Like Receptors (TLRs), RIG-I Like Receptors (RLRs), Nod

Like Receptors (NLRs) and C- type lectin Receptors (CLRs). These are unique proteins on immune cells that recognise patterns on pathogens (such as viral RNA or bacterial cell walls) and, when binding to a pathogen, initiate an immune response.

B. Adaptive (Acquired) Immunity: The adaptive immunity develops when a person's immune system reacts to a foreign substance or microbe, such as during an infection or vaccination and provides a targeted and long-lasting protection against specific pathogens. It allows highly strong and effective immune response.



Key features of adaptive immunity:

- It is antigenic specific, which have ability to recognize and discriminate among different pathogen and target specific antigen.
- When first exposed to a pathogen, the body takes longer time to respond against it (days to weeks), but the effects are accurate and long-lasting in nature.
- Upon re- exposure of pathogen, the immune system develops immunological memory against it, which show fast and robust response.

- It can recognize millions of different antigens and can able to differentiate between self and non- self-cells.

Components of the Adaptive Immune System:

The two main arm of adaptive immune system includes: **Humoral immunity** and **Cell-mediated immunity**, with the common aim to destroy the pathogen.

Humoral immunity is mediated mainly by B cells and they are mainly responsible for production of antibody. B cell mature in bone marrow and when it comes in contact with particular antigen, it will develop into plasma cells (which generate enormous amount of Abs) and memory B cells (which will provide long term immunity).

Cell-mediated immunity mediated by T cells, which will not generate antibodies but produce various effector cells which will help in destroying pathogen. T cells arise in bone marrow, but mature in thymus. T cell further divides into T Helper cell (CD4+ T cells) and T Cytotoxic cells (CD8+ cells). T helper cells further differentiate into various subsets of effector cells that will produce cytokines that help in activating B cells, T cytotoxic cells and other immune cells that will inactivate or destroy pathogen. Meanwhile, T cytotoxic cells provide protection by killing infected cells and pathogen such as viruses, bacteria or parasites.

How the Adaptive Immune System Works:

It begins with the process where body's immune system recognizes foreign substance as an antigen, and these antigens are presented to antigen presenting cells (APCs), such as dendritic cells and macrophages which will further present it on MHC (Major Histocompatibility Complex) molecules. MHC is tightly linked clusters of genes which play an important role in discriminating between self and non-self-cells. MHC molecules are classified into three classes- MHC class I, MHC class II and MHC class III.

Class II MHC present antigen to T cytotoxic cells which directly kill infected cells or cancerous cells and Class II MHC present

antigen to T helper cells which further activates other immune cells. B cells are also activated by B cell receptors. After recognising an antigen, T or B cell will undergo clonal expansion, producing a number lymphocyte clones that are all specific to the same antigen and after clonal expansion, it will move into the action and will destroy the antigen. Once the infection is cleared, some of the subset of B and T cells become memory cells.

Conclusion

Immune system consists of highly complex networks of specialized cells and organs which provide body with defence mechanism to fight against various pathogen including bacteria, viruses, etc. It will detect foreign substance as an antigen and will trigger the series of process that help in the destruction of specific antigen. Once the disease-causing pathogen come in contact with body, our remarkable immune system ensuring both immediate and long-lasting protection against pathogens.