

Basic Immune Cells

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ABSTRACT:

The immune system is spread throughout the body and involves many types of cells, organs, proteins, and tissues. Crucially, it can distinguish our tissue from foreign tissue — self from non-self. Dead and faulty cells are also recognized and cleared away by the immune system. If the immune system encounters a pathogen, for instance, a bacterium, virus, or parasite, it mounts a so-called immune response. The immune system includes a range of cell types with different roles in defending the body against infection. Occasionally, the immune system can make a mistake and attack itself, resulting in autoimmune disorders. Many of these cells arise in the bone marrow, circulate in the blood and can migrate into solid tissues¹. The primary parts of the immune system include the bone marrow and thymus. The bone marrow is extremely important to the immune system because all the body's blood cells (including T and B lymphocytes) originate in the bone marrow. B lymphocytes remain in the marrow to mature, while T lymphocytes travel to the thymus. Immune responses involve interactions between some of these cells and/or their secreted products. B and T lymphocytes specifically react to microbial antigens: activated B lymphocytes secrete antigen-binding antibodies, and subpopulations of T lymphocytes possess regulatory or cytotoxic functions².

INTRODUCTION:

The overall function of the immune system is to prevent or limit infection. The immune system is complex and pervasive. There are numerous cell types that either circulate throughout the body or reside in a particular tissue². Each cell type plays a unique role, with different ways of recognizing problems, communicating with other cells, and performing their functions. Natural killer cells are also cytotoxic cells of the lymphoid lineage, but they do not possess properties of antigen recognition. Different types of dendritic cells present antigens to T and B lymphocytes. Blood monocytes give rise to tissue macrophages that are phagocytes, as are circulating neutrophils, which are the most plentiful type of granulocyte. Other circulating granulocytes are eosinophils that secrete toxic mediators, and basophils that, in common with tissue mast cells, are important sources of inflammatory mediators³. Other cells contribute to immune and inflammatory responses, including endothelial cells, erythrocytes and platelets.

Types of Immunity:

There are two types of immunity, they are:

1. Innate immunity

2.Acquired immunity.

•Innate Immunity:

- 1 . Innate immunity (also called nonspecific or natural immunity) refers to the inborn-ability of the body to resist.
- 2 . It is genetically transmitted from one generation to the next.²
- 3 . Innate immunity lacks immunological memory.

Acquired Immunity:

Acquired immunity (also called specific or adaptive immunity) refers to an immunity that is developed by the host in its body after exposure to a suitable antigen or after transfer of antibodies or lymphocytes from an immune donor⁴.

There are two types of acquired immunity, they are:

1. Active immunity and
- 2.Passive immunity

Branches Of Acquired Immunity:

- i) Humoral and
- ii) Cellular immunity.

ACTIVE IMMUNITY:

Naturally Aquired Active Immunity:

Naturally acquired active immunity is obtained when a person is exposed to antigens in the course of daily life, direct exposure. The immune system then responds by producing antibodies and specialised lymphocyte¹.

Artificially Acquired Active Immunity:

This type of immunity is usually obtained through vaccination or through administration of toxoids.

PASSIVE IMMUNITY:

Naturally Acquired Passive Immunity

This can be acquired through trans-placental transfer of immunoglobulins (IgG) from mother to the foetus⁵. This immunity lasts for about six months after birth.

Artificially Acquired Passive Immunity:

It is achieved by administering specific anti-bodies or antiserum from one individual to another unimmunized individual, for a particular antigen.

Primaryorgansof The Immune System:

The primary parts of the immune system include the bone marrow and thymus. The bone marrow is extremely important to the immune system because all the body's blood cells(including T and B lymphocytes) originates in the bone marrow. B lymphocytes remain in the marrow to mature, while T lymphocytes travel to the thymus.The thymus is responsible for producing the hormone thymosin⁶,which inturn aids in the production of T cells. While in the thymus,T cells multiply and

differentiate into helper T cells and cytotoxic T cells. Various proteins are expressed on the T cell surface.

SECONDARY ORGANS OF THE IMMUNE SYSTEM:

After the T and B lymphocytes have matured in the thymus and bone marrow, then they travel to the lymph nodes and spleen where they remain until the immune system is activated. In addition to the lymph nodes and spleen, mucosal associated lymphoid tissues (MALTs) and gut associated lymphoid tissues (GALTs)⁶ play a vital role in the immune system³. MALTs are lymphoid tissues found in parts of the body where mucosa is present, such as the intestines, eyes, nose, skin and mouth. They contain lymphocytes and macrophages that defend against pathogens attempting to enter from outside the body². GALTs are lymphoid tissues found in the mucosa and submucosa of the gastrointestinal tract, tonsils, appendix and Peyer's patches in the small intestine⁶.

CELLS OF THE IMMUNE SYSTEM:

White Blood Cells:

White blood cells are also called as leukocytes.

1. Neutrophils
2. Basophils
3. Eosinophils
4. Monocytes
5. Lymphocytes

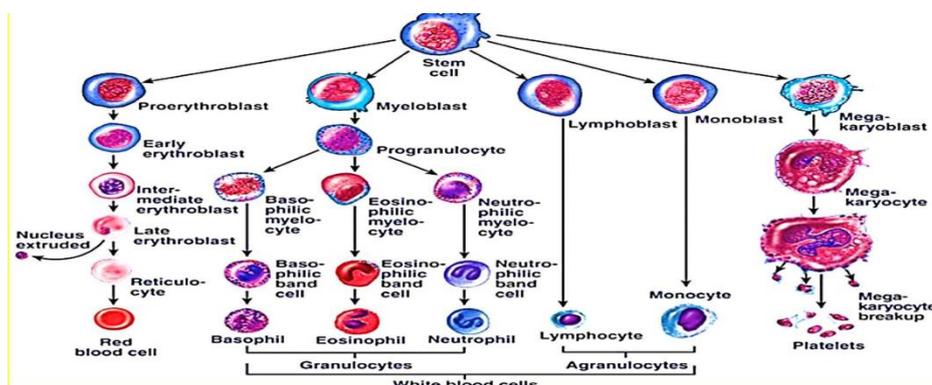
Classified according to the presence or absence of granules and the staining characteristics of their cytoplasm¹.

- Classified as granulocytes and agranulocytes.
- Granulocytes: Neutrophils, Eosinophils and Basophils.
- Agranulocytes: Monocytes and Lymphocytes.

Neutrophils:

Comprise the majority of white blood cells (60–70%).

They are also known as polymorphonuclear leucocytes. Derived from myeloid progenitors in the bone marrow. Granulocytes are released at a rate of seven million per minute. They are short-lived (2–3 days)⁵. During the acute phase of inflammation, particularly as a result of bacterial infection, neutrophils are one of the first-responders¹ of inflammatory cells to migrate towards the site of inflammation. They migrate through the blood vessels, then through interstitial tissue, following chemical signals such as interleukin 8 (IL-8), C5a, Leukotriene B4 in a process called chemotaxis²



Dendritic Cells:

Dendritic cells are antigen-presenting cells (APCs) which play a critical role in the regulation of the adaptive immune response. All dendritic cells are derived from bone marrow stem cells, but appear to be heterogeneous⁶, with various precursors (including monocytes) differentiating into dendritic cells when stimulated by appropriate combinations of cytokines. Immature dendritic cells are found in tissues throughout the body and are very efficient at capturing and processing antigens.

Basophils:

Basophilic granulocytes (basophils) derive their name from the affinity of their cytoplasmic granules for certain basic dyes. They constitute less than 1% of white blood cells.³ Basophils are of hematopoietic origin. Typically mature in the bone marrow and then circulate in the peripheral blood. Basophils have a short life-span of several days⁶.

Eosinophils:

The granulocytes whose granules stain with acidic dyes are called eosinophils. They comprise 2–5% of white blood cells and have bilobed nuclei. Eosinophils also produce cytokines, prostaglandins and leucotrienes, and enzymes which can inhibit the inflammatory products of mast cells. Eosinophils have Fc receptors for IgG and IgE antibodies and for C3b, enabling them to bind to opsonized targets⁷. They then secrete their antibiotic granule contents and reactive oxygen species to bring about damage to the target.

Monocytes:

Monocytes, which constitute 5–10% of mononuclear leucocytes in the blood, differentiate into macrophages when they migrate into tissues. Monocytes are larger than most lymphocytes and have a kidney-shaped nucleus⁷. The blood monocytes arise from myeloid progenitors in the bone marrow. The important functions of macrophage are in the induction and effector phases of adaptive immune responses.

Macrophage:

Macrophages that have phagocytosed microbes and protein antigens process the antigens and present peptide fragments to T cells. They are key effector cells in certain forms of cell-mediated immunity, the reaction that serves to eliminate intracellular microbes. In this type of response, T cells activate macrophages and enhance their ability to kill ingested microbes⁸. Macrophages also participate in the effector phase of humoral immunity.

Lymphocytes:

They are small, round 5-12 μm diameter spherical densely compact nucleus occupies almost entire cell.

Lymphocytes includes three types of cells.

1. T-lymphocytes or T cells which are derived from the thymus and play a role in cell-mediated immunity⁸.

2. B-lymphocytes or B-cells which are derived from liver, spleen and bone marrow are the precursors of plasma cells and play a role in humoral immunity.

3. Natural killer cells (NK) and killer (K) cells.

T CELLS:

About 70% of human blood lymphocytes are T cells. Those cells destined to be T cell, leave the bone marrow via the blood stream and move to the thymus. There the T cell become able to differentiate between self and non self antigens. The main functions of T lymphocytes are to exert effects on other cells, either regulating the activity of cells of the immune system or killing cells that are infected or malignant. T cells have surface antigen receptors⁹. Furthermore, T cells cannot recognize antigens in their native forms, but only when they are presented on the surface of antigen-presenting cells (APCs).

The T lymphocytes are associated with two types of immunological functions:

1. Effector
2. Regulatory.

Helper T Cells:

Helper T cells are the main regulators of the immune defense. Their primary task is to activate B cells and killer T cells. However, the helper T cells themselves must be activated. This happens when a macrophage or dendritic cell, which has eaten an invader, travels to the nearest lymph node to present information about the captured pathogen². The phagocyte displays an antigen fragment from the invader on its own surface, a process called antigen presentation. When the receptor of a helper T cell recognizes the antigen, the T cell is activated.

T-Suppressor Cells:

Suppressor effector T cells bind antigen and release factor that inactivate T-helper cells.

T-suppressor cells can: Suppress delayed –type hypersensitivity reactions, Prevent proliferation and antibody secretion by antigen-binding B cells, Suppress antibody secretion by some types of B cells.

T-Cytotoxic Cells:

These cells recognize certain histocompatibility antigens and are capable of killing foreign cells (i.e., virus) and altered self-cells (i.e. tumor antigens)². T-cytotoxic cells are important in the cytotoxicity of graft reactions and graft-versus host reactions.

B-Lymphocyte:

B lymphocytes represents 3 to 15% of circulating lymphoid cells and are primarily defined by surface immunoglobulins (Ig). B lymphocytes are common in areas of antibody production. The main function of a B cell is to secrete antibodies which specifically bind to an antigen recognized by that B cell. Throughout the life, bone marrow remains the major repository of stem cells for B lymphocyte. An important aspect of antigen recognition by B cells is that the antibodies they produce⁹, bind to antigens in their natural or native form.

Natural killer Cells:

Natural killer (NK) cells constitute up to 15% of human blood lymphocytes. Together with T cells and about 50% of CD8+ T cells they are known as large granular lymphocytes because, compared with most T and B lymphocytes, they have more cytoplasm and contain prominent granules. In contrast to all T and B cells, NK cells do not express antigen- specific receptors and do not possess the property of memory cell development. Their main function is to kill infected cells and tumor cells by inducing apoptosis of their targets¹⁰. Since they lack antigen receptors, NK cells do not recognize specific antigens on the surface of a target cell³. Instead, they detect molecular changes in the surface of a cell which are indicative of that cell being abnormal and therefore a potential threat to the body.

Conclusion:

The immune system responds to foreign pathogens and cancer cells by activating specific and nonspecific immune responses. The goal of immunotherapy is to enhance these responses to control the growth of cancer cells. Knowledge of the influence of stress on immune and cytokine response is evolving. The immune system is a complex array of cells and molecules operating in an orchestrated manner in order to protect the host from pathogenic microorganisms and exogenous noxious agents within our environment⁶. However, destruction of host tissue may occur if the immune response is inadequate due to intrinsic or extrinsic mechanisms in cell function, or if there is a hyper-responsiveness due to dysfunctional regulatory mechanisms¹⁰. The pathogenesis of periodontal disease is clearly of an inflammatory origin and, as such, has a close association with the Immune System.

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