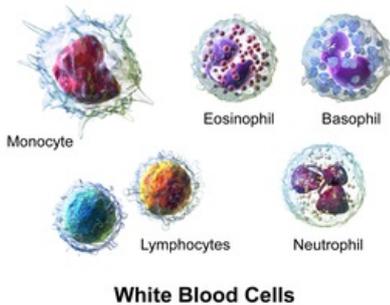


Leukocyte

A **leukocyte** is a white blood cell. The main function of the leukocytes is mediation of the immune reactions. The number of leukocytes in a healthy adult is $4-9 \times 10^9/l$ of blood, in newborns is up to $20 \times 10^9/l$. The white cell count most often increases in inflammations or in infectious diseases.

Leukocytes are divided into:

1. **granulocytes** – neutrophils, eosinophils and basophils
2. **agranulocytes** – lymphocytes and monocytes.



Leukocytes

Neutrophilic granulocytes

Neutrophilic granulocytes (neutrophils, polymorphonuclear leukocytes or microphages) are white blood cells which, together with eosinophils and basophils, are **granulocytes**.

The importance of **anti-infective defense** lies in defense against extracellular bacteria. Neutrophils are able to perform effector functions immediately, without signals from other cells.

They make up **60-70%** of peripheral blood leukocytes. They occur in the bloodstream for 6-12 hours and in the tissue for 4-5 days. Only 7% of the total number is found in the peripheral blood, 93% is found in the bone marrow (it changes under the influence of inflammatory cytokines and bacterial products). The major chemotactic agent is the chemokine IL-8.

Function

The main function of neutrophils is **phagocytosis**. Their *azurophilic* granules contain many **lytic enzymes**. When killing microbes, they can cause so-called oxidative **flare-ups** with a sufficient supply of energy. At the same time, they secrete substances that lead to the development of an inflammatory response.

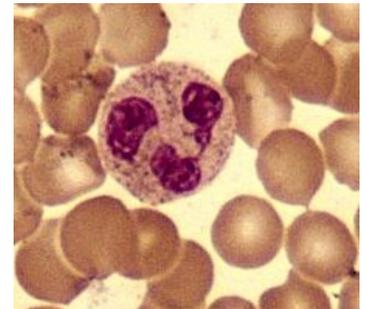
Neutrophils cannot divide or supplement their granular equipment. Activated neutrophils die after performing their functions and become part of the inflammatory deposit. Dead neutrophils form **pus**.

In addition to phagocytosis, neutrophils also form extracellular networks - **NETs (Neutrophil Extracellular Traps)**. Neutrophil granulocytes die other than by necrosis and apoptosis - a process called **NETosis** (also called suicidal NETosis). The action of foreign pathogens or cholesterol and urate crystals induces changes within the neutrophil: loss of heterochromatin arrangement, disruption of nuclear segmentation, disintegration of the nuclear envelope, disintegration of mitochondria. The karyoplasm and cytoplasm mix, the cell membrane ruptures and they are released into the ECT as part of the future network. Upon spreading the mixture released from the cell, NET is formed, which is a thin fiber derived from nuclear chromatin with granular and cytoplasmic neutrophil enzymes. This complex network serves mainly to capture and immobilize microorganisms, associates with antimicrobial peptides and helps eliminate bacteria. NETs are involved in both physiological and pathological inflammation and can cause alteration if the regulation of their production is disturbed. The pathological consequences of NETosis are, for example inflammatory changes in the development of atherosclerosis, the development of lung diseases (e.g. COPD) and autoimmune disorders (especially lupus erythematosus).

Neutrophils are not among APCs!

Development line

Bone marrow myeloid progenitor cell → myeloid precursor → **neutrophil**.



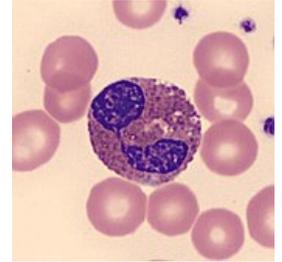
Neutrophilic granulocyte in May-Grünwald-Giemsa-Romanowski staining

The progenitor cell, not just neutrophils, has an adhesive molecule CD34. It is found in small numbers in the marrow for life.

Their nucleus is made up of 2-5 lobes, the number of lobes increases with the age of the cell (the youngest forms of neutrophils do not have a segmented nucleus and are therefore referred to as rods). There are small, light pink granules in the cytoplasm of neutrophils. Their main role is phagocytosis.

Eosinophilic granulocytes

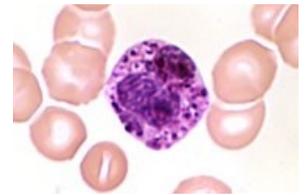
Eosinophilic granulocytes (eosinophils) are white blood cells that are classified as granulocytes (along with neutrophils and basophils). Eosinophils make up 1-3% of the total white blood cell count. They have a bilobed nucleus and dark pink granules in their cytoplasm. They play an important role in allergic reactions (they phagocytose the allergen-antibody complex) and in protection against parasitic diseases (they release substances that damage parasites from their granules).



Eosinophil

Basophilic granulocytes

Basophil granulocytes (basophils) are type of white blood cells, a subgroup of granulocytes (together with eosinophils and neutrophils). They represent less than 1% of circulating white blood cells. They have two lobed nucleus and dark purple granules in cytoplasm. The granules store a large amount of heparin and histamine. Basophilic granulocytes appear in the forming of allergic reaction and also play role in fighting parasitic infections.



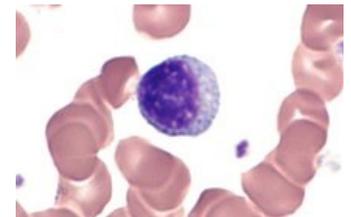
Basophil

Lymphocytes

A lymphocyte is a type of white blood cell that is an agranulocyte. In the blood of a healthy adult, lymphocytes make up 24-40% of the total number of all white blood cells. Lymphocytes, which are divided into T and B cells, are an effective tool for specific immunities.

T lymphocytes

T cells or T lymphocytes are white blood cells that are the part of the immune system. T cells develop from the precursors in the thymus. These precursors migrate from the hematopoietic tissues (mainly from the bone marrow) during prenatal development.



Lymphocyte

In the thymus, the immature T cells are selected. Reticular epithelial cells present antigens to the immature T cells. The survival of the T cell depends on their ability to distinguish HLA of the own body. Non-reactive and overly reactive cells are destroyed (about 95%). The T cells that aren't destroyed enter the bloodstream. Blood transfers them to the secondary lymphoid organs, where they meet their specific antigens. This leads to their activation and subsequent inflammation development.

The Specificity of the T cells is determined by the development of their **TcRs (T cell receptors)**. However, these alone are not enough to activate the lymphocyte (signal transmission), the membrane complex of TcR and CD3 is necessary .

After the immune response has ended, the lymphocytes circulate between the blood and the secondary lymphatic tissues and wait in the resting form for another encounter with the antigen.

According to the function of individual T lymphocytes and according to the CD markings that occur on their surface, we distinguish the following **basic groups of T lymphocytes:**

T helper cells

CD4+ cells produce many different cytokines. They react to the antigen-MHC class II complex presented by the APCs. They initiate a specific immune response. Based on the produced cytokines T helper cells are divided into:

- T1: activates the cytotoxic and cell immune reaction (macrophages, TC).
- T2: activates the antibody reaction (B-cells, antibody production).

T helper cells are the target of HIV.

Cytotoxic T cells

CD8+, are able to cause apoptosis of the cell, or can destroy the cell directly by cytotoxic mechanisms. They react to the MHC class I. They control the condition of the cells in the body (anti-tumor immunity).

Suppressor T cells

A non-uniform group of the T cells, during the inflammation most likely develop from the T helper cells, that's why they're also sometimes called as TH3(r) subset cells. They don't have the specific CD marker, some are CD4+ and CD8+, others carry either one of these markers or none of them. Their main task is to moderate and suppress the immune response. It is implemented by interleukins IL-10 and partially IL-4. Tissue reparation and fibroblast stimulation is accelerated by TGF- β (transforming growth factor).

Natural killer T cells, NKT

The main components of the cytotoxic cell immunity. They are able to destroy even without prior encounter with the antigen (this applies to newborns). Although they're lymphocytes, they belong to the innate immune system. They do not carry the CD3 character. Morphologically they're large lymphocytes (12-14 μm).

B lymphocytes

B lymphocytes represent the basic cells of antibody immunity.

They are formed in bone marrow, where they also mature. There is no selection during their development (as with T ly). Their maturation takes place after encountering antigen in secondary lymphatic organs. The final differentiation stage of B lymphocytes is "plasma cells" producing antibodies to protein and glycoprotein antigen and toxins.

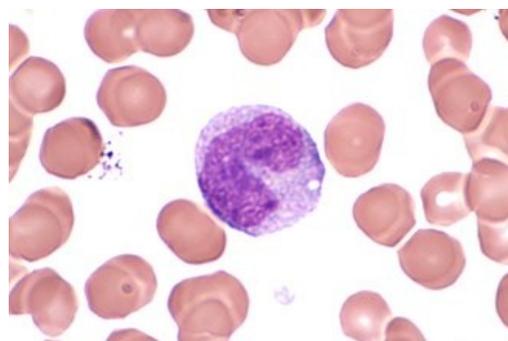
Development line

Pluripotent stem cell → lymphoid progenitor → B lymphocytes → plasma cells producing immunoglobulins and memory cells.

The B cell receptor is '*BcR*'. It consists of its own surface immunoglobulin (IgM, IgD) and associated signaling molecules. The IgM monomer is anchored to the membrane by its "Fc fragment", which is different from normal Fc (it is longer, it contains a component that holds it in the membrane). Other antigenic structures are CD19, CD20 (typical of mature B-lymphocytes), CD10 (only at some stage of immature cells, in some leukemic lines). Some B-lymphocytes change into "memory B ly" upon encounter with antigen and clonal proliferation. These are part of the '*immune memory*'. They are responsible for significantly accelerating the "secondary immune response" upon repeated encounters with antigen (important for vaccination).

Monocytes

A monocyte belongs to the agranulocytic white blood cells. It is the largest white blood cell, which after traveling from the bloodstream into the tissues or body cavities turns into a macrophage. In a healthy adult, monocytes make up 3-8% of the total number of leukocytes.



Monocyte

Links

Related articles

- White blood cells abnormalities: Leukemia
- Physiological values of blood elements

External links

- Leukocyte (Czech wikipedia)
- White blood cell (English wikipedia)

Source

- ŠVÍGLEROVÁ, Jitka. *Leukocyty* [online]. The last revision 18. 2. 2009, [cit. 13. 1. 2023]. <<https://web.archive.org/web/20160320045540/http://wiki.lfp-studium.cz/index.php/Leukocyty>>.