16.3A: Types of WBCs

The different types of white blood cells (leukocytes) include neutrophils, basophils, eosinophils, lymphocytes, monocytes, and macrophages.

Learning Objectives

- Distinguish between the two major types of leukocytes (white blood cells): granulocytes and agranulocytes

Key Points

- The two main types of leukocytes are granulocytes and mononuclear leukocytes (agranulocytes).
- Leukocytes arise from hemopoietic stem cells in the bone marrow.
- Leukocytes are involved in pathogen recognition, phagocytosis (ingestion of particles), pathogen destruction, inflammation mediation, and antigen presentation.
- Granulocytes include neutrophils, basophils, eosinophils, and mast cells. Their granules contain enzymes that damage or digest pathogens and release inflammatory mediators into the bloodstream.
- Mononuclear leukocytes include lymphocytes, monocytes, macrophages, and dendritic cells. This group is involved in both innate and adaptive immune system function.

Key Terms

- **endocytosed**: Engulfed during the process by which the plasma membrane of a cell folds inwards to ingest material.
- **antigen**: A substance, usually foreign, that induces an immune response.
• **pathogen**: Any organism or substance, especially a microorganism, capable of causing disease. Examples include bacteria, viruses, protozoa, or fungi. Microorganisms are not considered pathogenic until the population has grown large enough to cause disease.

White blood cells (WBCs), or leukocytes, are immune system cells that defend the body against infectious disease and foreign materials. There are several different types of WBCs. They share commonalities but are distinct in form and function. WBCs are produced in the bone marrow by hemopoietic stem cells, which differentiate into either lymphoid or myeloid progenitor cells. A major distinguishing feature is the presence of granules; white blood cells are often characterized as granulocytes or agranulocytes.

## Granulocytes

Granulocytes, also known as polymorphonuclear (PMN) leukocytes, are characterized by stained granules within their cytoplasm under a microscope. These granules are membrane-bound enzymes that act primarily in the digestion of endocytosed particles. They may also cause granule dependent cell-mediated apoptosis through the release of perforins, granzymes, and proteases. The nucleus contains multiple lobes (polymorphonuclear) as opposed to a single rounded lobe. Granulocytes contain toll-like receptors that allow them to recognize pathogen-associated molecular patterns (PAMPS). All categories except neutrophils contain IgE receptors that implicate them in allergic responses. There are four types of granulocytes:

- **Neutrophils** defend against bacterial or fungal infection and other very small inflammatory processes. They are usually the first responders to microbial infection. Their activity and death in large numbers from degranulation forms purulent necrosis (pus).
- **Eosinophils** primarily deal with parasitic infections. They are also the predominant inflammatory cells in allergic reactions.
- **Basophils** are chiefly responsible for short-term inflammatory response (particularly from allergy or irritation) by releasing the chemical histamine, which causes the vasodilation that occurs with inflammation.
- **Mast cells** function similarly to basophils in that they often mediate inflammation, but are more common and arise from a different hemopoietic lineage.

## Mononuclear Leukocytes

Mononuclear (MN) leukocytes are characterized by a single round nucleus within the cytoplasm. Some MN leukocytes contain granules while others do not, but the members of this group are sometimes considered agranulocytes by naming convention. MN leukocytes contain lysosomes, small vesicles containing digestive enzymes that break down foreign
matter that is endocytosed by the cell during phagocytosis. The cells include:

- **Lymphocytes**, which come in three types. B-lymphocytes produce antibodies in the humoral immune response. T-lymphocytes participate in the cell-mediated immune response. NK cells are cytotoxic cells that participate in the innate immune response by killing virally infected and tumor cells and mediating fever and long-lasting inflammation. B and T lymphocytes contain MHC antigen receptors and their activity is antigen-specific. Other leukocytes will attack any pathogen but cannot distinguish between different types of pathogens.

- **Monocytes** are large leukocytes that differentiate into macrophages and dendritic cells under varying conditions, while performing similar functions in phagocytosis and antigen presentation (the process by which molecular components are presented to lymphocytes to stimulate an adaptive immune response). Monocytes and their progeny contain toll-like receptors and granules.

- **Macrophages** are monocytes that have migrated out of the blood stream and into the internal body tissues. They destroy necrotic cell debris and foreign material including viruses and bacteria, and can present antigens to naive lymphocytes. They typically arrive at the site of inflammation one to three days after the initial neutrophil response to clean up dead neutrophils, cellular debris, and remaining pathogens.

- **Dendritic cells** are monocytes that have migrated to cells that are in contact with the external environment, such as the skin, intestines, or respiratory epithelium. Their name comes branched projections called dendrites, which increase their surface area. They phagocytize pathogens and present antigens to naive lymphocytes.

![A Macrophage: A macrophage phagocytizes two smaller particles, possibly pathogens](https://med.libretexts.org/Bookshelves/Anatomy_and_Physiology/Book%3A_Anatomy_and_Physiology_(Boundless)/16%3A_%20Innate%20Immune%20System/16.08%20Macrophages)