**White blood cell**

From Wikipedia, the free encyclopedia

|  |  |
| --- | --- |
| ***White blood cell*** | |
| [SEM blood cells.jpg](http://en.wikipedia.org/wiki/File:SEM_blood_cells.jpg)  A [scanning electron microscope](http://en.wikipedia.org/wiki/Scanning_electron_microscope) image of normal circulating human blood. In addition to the irregularly shaped leukocytes, both [red blood cells](http://en.wikipedia.org/wiki/Red_blood_cells) and many small disc-shaped [platelets](http://en.wikipedia.org/wiki/Platelets) are visible. | |
| [**Latin**](http://en.wikipedia.org/wiki/Latin) | *leucocytus* |
| **Code** | [TH](http://en.wikipedia.org/wiki/Terminologia_Histologica) [*H2.00.04.1.02001*](http://www.unifr.ch/ifaa/Public/EntryPage/ViewTH/THh200.html) |

**White blood cells** (**WBCs**), also called **leukocytes** or **leucocytes**, are the [cells](http://en.wikipedia.org/wiki/Cell_(biology)) of the [immune system](http://en.wikipedia.org/wiki/Immune_system) that are involved in defending the body against both [infectious disease](http://en.wikipedia.org/wiki/Infectious_disease) and foreign materials. Five[[1]](http://en.wikipedia.org/w/index.php?title=White_blood_cell&printable=yes#cite_note-isbn978-0-323-04950-4-1) different and diverse types of leukocytes exist, and several types (including [monocytes](http://en.wikipedia.org/wiki/Monocyte) and [neutrophils](http://en.wikipedia.org/wiki/Neutrophil_granulocyte)) are [phagocytic](http://en.wikipedia.org/wiki/Phagocyte). All leukocytes are produced and derived from a [multipotent](http://en.wikipedia.org/wiki/Multipotent) cell in the[bone marrow](http://en.wikipedia.org/wiki/Bone_marrow) known as a [hematopoietic stem cell](http://en.wikipedia.org/wiki/Hematopoietic_stem_cell). They live for about three to four days in the average human body. Leukocytes are found throughout the body, including the [blood](http://en.wikipedia.org/wiki/Blood) and [lymphatic system](http://en.wikipedia.org/wiki/Lymphatic_system).[[2]](http://en.wikipedia.org/w/index.php?title=White_blood_cell&printable=yes#cite_note-2)

The number of leukocytes in the [blood](http://en.wikipedia.org/wiki/Blood) is often an indicator of [disease](http://en.wikipedia.org/wiki/Disease). In the U.S. there are normally approximately 7000 white blood cells per [microliter](http://en.wikipedia.org/wiki/Microliter) of blood.[[3]](http://en.wikipedia.org/w/index.php?title=White_blood_cell&printable=yes#cite_note-3) They make up approximately 1% of the total blood volume in a healthy adult.[[4]](http://en.wikipedia.org/w/index.php?title=White_blood_cell&printable=yes#cite_note-alberts_table-4) An increase in the number of leukocytes over the [upper limits](http://en.wikipedia.org/wiki/Reference_ranges_for_blood_tests#White_blood_cells_2) is called [leukocytosis](http://en.wikipedia.org/wiki/Leukocytosis), and a decrease below the lower limit is called [leukopenia](http://en.wikipedia.org/wiki/Leukopenia). Physical properties of leukocytes (such as volume, [conductivity](http://en.wikipedia.org/wiki/Electrical_conductivity), and [granularity](http://en.wikipedia.org/wiki/Granule_(cell_biology))) may change. These changes can be due to activation, the presence of immature cells, or the presence of [malignant](http://en.wikipedia.org/wiki/Malignancy)leukocytes in [leukemia](http://en.wikipedia.org/wiki/Leukemia).

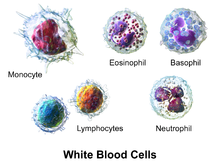
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**Etymology**

The name "white blood cell" derives from the physical appearance of a blood sample after [centrifugation](http://en.wikipedia.org/wiki/Centrifugation). White cells are found in the [*buffy coat*](http://en.wikipedia.org/wiki/Buffy_coat), a thin, typically white layer of nucleated cells between the sedimented [red blood cells](http://en.wikipedia.org/wiki/Red_blood_cells) and the [blood plasma](http://en.wikipedia.org/wiki/Blood_plasma). The scientific term *leukocyte* directly reflects its description. It is derived from the [Greek word](http://en.wikipedia.org/wiki/Greek_language) *leuko-* meaning "white" and *kytos* meaning "hollow vessel", with -cyte translated as "cell" in modern usage. [Buffy coat](http://en.wikipedia.org/wiki/Buffy_coat) may sometimes be green if there are large amounts of[neutrophils](http://en.wikipedia.org/wiki/Neutrophil_granulocyte) in the sample, due to the [heme](http://en.wikipedia.org/wiki/Heme)-containing enzyme [myeloperoxidase](http://en.wikipedia.org/wiki/Myeloperoxidase) that they produce.

**Types**

[](http://en.wikipedia.org/wiki/File:Blausen_0909_WhiteBloodCells.png)

3D rendering of various types of white blood cells

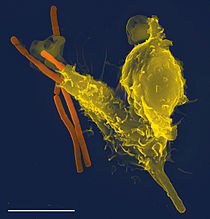
There are several different types of white blood cells. They all have many things in common, but all are distinct in form and function. A major distinguishing feature of some leukocytes is the presence of [granules](http://en.wikipedia.org/wiki/Granule_(cell_biology)); white blood cells are often characterized as [granulocytes](http://en.wikipedia.org/wiki/Granulocyte) or [agranulocytes](http://en.wikipedia.org/wiki/Agranulocyte):

* **Granulocytes** (polymorphonuclear leukocytes): leukocytes characterized by the presence of differently staining [granules](http://en.wikipedia.org/wiki/Granule_(cell_biology)) in their [cytoplasm](http://en.wikipedia.org/wiki/Cytoplasm) when viewed under light microscopy. These granules (usually [lysozymes](http://en.wikipedia.org/wiki/Lysozyme)) are[membrane-bound](http://en.wikipedia.org/wiki/Lipid_membrane) enzymes that act primarily in the digestion of [endocytosed](http://en.wikipedia.org/wiki/Endocytosis) particles. There are three types of granulocytes: [neutrophils](http://en.wikipedia.org/wiki/Neutrophil_granulocyte), [basophils](http://en.wikipedia.org/wiki/Basophil_granulocyte), and [eosinophils](http://en.wikipedia.org/wiki/Eosinophil_granulocyte), which are named according to their staining properties.
* **Agranulocytes** (mononuclear leukocytes): leukocytes characterized by the apparent absence of [granules](http://en.wikipedia.org/wiki/Granule_(cell_biology)) in their [cytoplasm](http://en.wikipedia.org/wiki/Cytoplasm). Although the name implies a lack of granules these cells do contain non-specific [azurophilic granules](http://en.wikipedia.org/wiki/Azurophilic_granules), which are [lysosomes](http://en.wikipedia.org/wiki/Lysosome).[[5]](http://en.wikipedia.org/w/index.php?title=White_blood_cell&printable=yes#cite_note-5) The cells include [lymphocytes](http://en.wikipedia.org/wiki/Lymphocyte), [monocytes](http://en.wikipedia.org/wiki/Monocyte), and [macrophages](http://en.wikipedia.org/wiki/Macrophage).[[6]](http://en.wikipedia.org/w/index.php?title=White_blood_cell&printable=yes#cite_note-wisc-online.com-6)

**Overview**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Type** | **Microscopic appearance** | **Diagram** | **Approx. % in adults See also:** [**Blood values**](http://en.wikipedia.org/wiki/Blood_values#Hematology) | **Diameter (**[**μm**](http://en.wikipedia.org/wiki/Micrometre)**)**[[7]](http://en.wikipedia.org/w/index.php?title=White_blood_cell&printable=yes#cite_note-isbn0-443-01657-7-7) | **Main targets**[[4]](http://en.wikipedia.org/w/index.php?title=White_blood_cell&printable=yes#cite_note-alberts_table-4) | **Nucleus**[[4]](http://en.wikipedia.org/w/index.php?title=White_blood_cell&printable=yes#cite_note-alberts_table-4) | **Granules**[[4]](http://en.wikipedia.org/w/index.php?title=White_blood_cell&printable=yes#cite_note-alberts_table-4) | **Lifetime**[[7]](http://en.wikipedia.org/w/index.php?title=White_blood_cell&printable=yes#cite_note-isbn0-443-01657-7-7) |
| [Neutrophil](http://en.wikipedia.org/wiki/Neutrophil_granulocyte) | [PBNeutrophil.jpg](http://en.wikipedia.org/wiki/File:PBNeutrophil.jpg) | [Neutrophil.png](http://en.wikipedia.org/wiki/File:Neutrophil.png) | 62% | 10–12 | * [Bacteria](http://en.wikipedia.org/wiki/Bacteria) * [Fungi](http://en.wikipedia.org/wiki/Fungi) | [Multilobed](http://en.wikipedia.org/wiki/Multilobed) | Fine, faintly pink (H&E stain) | 6 hours–few days (days in [spleen](http://en.wikipedia.org/wiki/Spleen) and other tissue) |
| [Eosinophil](http://en.wikipedia.org/wiki/Eosinophil_granulocyte) | [PBEosinophil.jpg](http://en.wikipedia.org/wiki/File:PBEosinophil.jpg) | [Eosinophil 1.png](http://en.wikipedia.org/wiki/File:Eosinophil_1.png) | 2.3% | 10–12 | * Larger [parasites](http://en.wikipedia.org/wiki/Parasite) * Modulate [allergic](http://en.wikipedia.org/wiki/Allergy) [inflammatory](http://en.wikipedia.org/wiki/Inflammation) responses | [Bi-lobed](http://en.wikipedia.org/wiki/Bi-lobed) | Full of pink-orange (H&E stain) | 8–12 days (circulate for 4–5 hours) |
| [Basophil](http://en.wikipedia.org/wiki/Basophil_granulocyte) | [PBBasophil.jpg](http://en.wikipedia.org/wiki/File:PBBasophil.jpg) | [Basophil.png](http://en.wikipedia.org/wiki/File:Basophil.png) | 0.4% | 12–15 | * Release [histamine](http://en.wikipedia.org/wiki/Histamine) for [inflammatory](http://en.wikipedia.org/wiki/Inflammation) responses | [Bi-lobed](http://en.wikipedia.org/wiki/Bi-lobed) or[tri-lobed](http://en.wikipedia.org/wiki/Tri-lobed) | Large blue | A few hours to a few days |
| [Lymphocyte](http://en.wikipedia.org/wiki/Lymphocyte) | [Lymphocyte2.jpg](http://en.wikipedia.org/wiki/File:Lymphocyte2.jpg) | [Lymphocyte.png](http://en.wikipedia.org/wiki/File:Lymphocyte.png) | 30% | Small lymphocytes 7–8 Large lymphocytes 12–15 | * [B cells](http://en.wikipedia.org/wiki/B_cell): releases antibodies and assists activation of T cells * [T cells](http://en.wikipedia.org/wiki/T_cell):   + [CD4](http://en.wikipedia.org/wiki/CD4)+ [Th (T helper) cells](http://en.wikipedia.org/wiki/T_helper_cell): activate and regulate T and B cells   + [CD8+](http://en.wikipedia.org/wiki/CD8) [cytotoxic T cells](http://en.wikipedia.org/wiki/Cytotoxic_T_cell): [virus](http://en.wikipedia.org/wiki/Virus_(biology))-infected and [tumor](http://en.wikipedia.org/wiki/Tumor) cells.   + [γδ T cells](http://en.wikipedia.org/wiki/%CE%93%CE%B4_T_cells): bridge between [innate](http://en.wikipedia.org/wiki/Innate_immune_system) and [adaptive](http://en.wikipedia.org/wiki/Adaptive_immune_system) immune responses; phagocytosis   + [Regulatory (suppressor) T cells](http://en.wikipedia.org/wiki/Regulatory_T_cell): Returns the functioning of the immune system to normal operation after infection; prevents[autoimmunity](http://en.wikipedia.org/wiki/Autoimmunity) * [Natural killer cells](http://en.wikipedia.org/wiki/Natural_killer_cell): [virus](http://en.wikipedia.org/wiki/Virus_(biology))-infected and [tumor](http://en.wikipedia.org/wiki/Tumor) cells. | Deeply staining, eccentric | NK-cells and cytotoxic (CD8+) T-cells | Years for memory cells, weeks for all else. |
| [Monocyte](http://en.wikipedia.org/wiki/Monocyte) | [Monocyte.jpg](http://en.wikipedia.org/wiki/File:Monocyte.jpg) | [Monocyte.png](http://en.wikipedia.org/wiki/File:Monocyte.png) | 5.3% | 12–20[[8]](http://en.wikipedia.org/w/index.php?title=White_blood_cell&printable=yes#cite_note-8) | Monocytes migrate from the bloodstream to other tissues and differentiate into tissue resident macrophages, [Kupffer cells](http://en.wikipedia.org/wiki/Kupffer_cell) in the liver. | Kidney shaped | None | Hours to days |
|  |  |  |  |  |  |  |  |

**Neutrophil**

[](http://en.wikipedia.org/wiki/File:Neutrophil_with_anthrax_copy.jpg)

Neutrophil engulfing [anthrax bacteria](http://en.wikipedia.org/wiki/Bacillus_anthracis).

Neutrophils defend against [bacterial](http://en.wikipedia.org/wiki/Bacterial) or [fungal](http://en.wikipedia.org/wiki/Fungal) infection. They are usually first responders to microbial infection; their activity and death in large numbers forms [pus](http://en.wikipedia.org/wiki/Pus). They are commonly referred to as polymorphonuclear (PMN) leukocytes, although, in the technical sense, PMN refers to all granulocytes. They have a multi-lobed nucleus that may appear like multiple nuclei, hence the name polymorphonuclear leukocyte. The cytoplasm may look transparent because of fine granules that are pale lilac. Neutrophils are active in phagocytosing bacteria and are present in large amount in the pus of wounds. These cells are not able to renew their [lysosomes](http://en.wikipedia.org/wiki/Lysosome) (used in digesting microbes) and die after having phagocytosed a few pathogens.[[9]](http://en.wikipedia.org/w/index.php?title=White_blood_cell&printable=yes#cite_note-9) Neutrophils are the most common cell type seen in the early stages of acute inflammation. They make up 60-70% of total leukocyte count in human blood.[[4]](http://en.wikipedia.org/w/index.php?title=White_blood_cell&printable=yes#cite_note-alberts_table-4)The life span of a circulating human neutrophil is about 5.4 days.[[10]](http://en.wikipedia.org/w/index.php?title=White_blood_cell&printable=yes#cite_note-10)

**Eosinophil**

Eosinophils primarily deal with [parasitic](http://en.wikipedia.org/wiki/Parasitic) infections. Eosinophils are also the predominant inflammatory cells in allergic reactions. The most important causes of eosinophilia include allergies such as asthma, hay fever, and hives; and also parasitic infections. In general, their nucleus is bi-lobed. The cytoplasm is full of granules that assume a characteristic pink-orange color with eosin stain.

**Basophil**

Basophils are chiefly responsible for [allergic](http://en.wikipedia.org/wiki/Allergy) and [antigen](http://en.wikipedia.org/wiki/Antigen) response by releasing the chemical [histamine](http://en.wikipedia.org/wiki/Histamine) causing [vasodilation](http://en.wikipedia.org/wiki/Vasodilation). The nucleus is bi- or tri-lobed, but it is hard to see because of the number of coarse granules that hide it. They are characterized by their large blue granules.

**Lymphocyte**

Lymphocytes are much more common in the lymphatic system than in blood. Lymphocytes are distinguished by having a deeply staining nucleus that may be eccentric in location, and a relatively small amount of cytoplasm. Lymphocytes include:

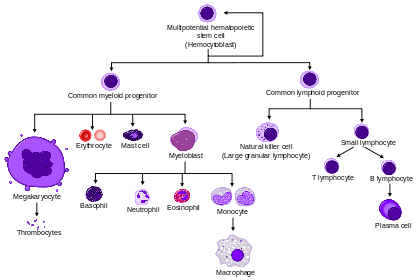
* [B cells](http://en.wikipedia.org/wiki/B_cell) make [antibodies](http://en.wikipedia.org/wiki/Antibody) that can bind to [pathogens](http://en.wikipedia.org/wiki/Pathogens), block pathogen invasion, activate the [complement system](http://en.wikipedia.org/wiki/Complement_system), and enhance pathogen destruction.
* [T cells](http://en.wikipedia.org/wiki/T_cell):
  + [CD4+](http://en.wikipedia.org/wiki/CD4) [helper T cells](http://en.wikipedia.org/wiki/Helper_T_cells): T cells displaying [co-receptor](http://en.wikipedia.org/wiki/Co-receptor) [CD4](http://en.wikipedia.org/wiki/CD4) are known as CD4+ T cells. These cells have [T-cell receptors](http://en.wikipedia.org/wiki/T-cell_receptor) and CD4 molecules that, in combination, bind [antigenic peptides](http://en.wikipedia.org/wiki/Antigens) presented on [major histocompatibility complex (MHC) class II](http://en.wikipedia.org/wiki/MHC_class_II)molecules on [antigen-presenting cells](http://en.wikipedia.org/wiki/Antigen-presenting_cells). Helper T cells make [cytokines](http://en.wikipedia.org/wiki/Cytokine) and perform other functions that help coordinate the [immune response](http://en.wikipedia.org/wiki/Immune_response). In [HIV](http://en.wikipedia.org/wiki/HIV) infection, these T cells are the main index to identify the individual's immune system integrity.
  + [CD8+](http://en.wikipedia.org/wiki/CD8) [cytotoxic T cells](http://en.wikipedia.org/wiki/Cytotoxic_T_cells): T cells displaying co-receptor [CD8](http://en.wikipedia.org/wiki/CD8) are known as CD8+ T cells. These cells bind antigens presented on [MHC I](http://en.wikipedia.org/wiki/MHC_I) complex of virus-infected or tumour cells and kill them. Nearly all nucleated cells display MHC I.
  + [γδ T cells](http://en.wikipedia.org/wiki/Gamma/delta_T_cells) possess an alternative [T cell receptor](http://en.wikipedia.org/wiki/T_cell_receptor) (different from the αβ TCR found on conventional CD4+ and CD8+ T cells). Found in tissue more commonly than in blood, γδ T cells share characteristics of helper T cells, cytotoxic T cells, and natural killer cells.
* [Natural killer cells](http://en.wikipedia.org/wiki/Natural_killer_cell) are able to kill cells of the body that do not display [MHC class I](http://en.wikipedia.org/wiki/MHC_class_I) molecules, or display stress markers such as [MHC class I polypeptide-related sequence A](http://en.wikipedia.org/wiki/MHC_class_I_polypeptide-related_sequence_A) (MIC-A). Decreased expression of MHC class I and up-regulation of MIC-A can happen when cells are infected by a virus or become cancerous.

**Monocyte**

Monocytes share the "vacuum cleaner" ([phagocytosis](http://en.wikipedia.org/wiki/Phagocytosis)) function of neutrophils, but are much longer lived as they have an extra role: they present pieces of [pathogens](http://en.wikipedia.org/wiki/Pathogen) to T cells so that the pathogens may be recognized again and killed. This causes an antibody response to be mounted. Monocytes eventually leave the bloodstream and become tissue macrophages, which remove dead cell debris as well as attacking microorganisms. Neither dead cell debris nor attacking microorganisms can be dealt with effectively by the neutrophils. Unlike neutrophils, monocytes are able to replace their [lysosomal](http://en.wikipedia.org/wiki/Lysosome) contents and are thought to have a much longer active life. They have the kidney shaped nucleus and are typically agranulated. They also possess abundant cytoplasm.

Once monocytes move from the bloodstream out into the body tissues, they undergo changes (differentiate) allowing [phagocytosis](http://en.wikipedia.org/wiki/Phagocytosis) and are then known as [macrophages](http://en.wikipedia.org/wiki/Macrophage).

**Fixed leukocytes**

[](http://en.wikipedia.org/wiki/File:Hematopoiesis_simple.svg)

HSC=[Hematopoietic stem cell](http://en.wikipedia.org/wiki/Hematopoietic_stem_cell), Progenitor=[Progenitor cell](http://en.wikipedia.org/wiki/Progenitor_cell), L-blast=[Lymphoblast](http://en.wikipedia.org/wiki/Lymphoblast), [Lymphocyte](http://en.wikipedia.org/wiki/Lymphocyte), Mo-blast=[Monoblast](http://en.wikipedia.org/wiki/Monoblast), [Monocyte](http://en.wikipedia.org/wiki/Monocyte),[Myeloblast](http://en.wikipedia.org/wiki/Myeloblast), Pro-M=[Promyelocyte](http://en.wikipedia.org/wiki/Promyelocyte), [Myelocyte](http://en.wikipedia.org/wiki/Myelocyte), Meta-M=[Metamyelocyte](http://en.wikipedia.org/wiki/Metamyelocyte),[Neutrophil](http://en.wikipedia.org/wiki/Neutrophil), [Eosinophil](http://en.wikipedia.org/wiki/Eosinophil), [Basophil](http://en.wikipedia.org/wiki/Basophil), Pro-E=[Proerythroblast](http://en.wikipedia.org/wiki/Proerythroblast), Baso-E=[Basophilic erythroblast](http://en.wikipedia.org/w/index.php?title=Basophilic_erythroblast&action=edit&redlink=1), poly-E=[Polychromatic erythroblast](http://en.wikipedia.org/w/index.php?title=Polychromatic_erythroblast&action=edit&redlink=1), Ortho-E=[Orthochromatic erythroblast](http://en.wikipedia.org/w/index.php?title=Orthochromatic_erythroblast&action=edit&redlink=1), [Erythrocyte](http://en.wikipedia.org/wiki/Erythrocyte), [Promegakaryocyte](http://en.wikipedia.org/wiki/Promegakaryocyte),[Megakaryocyte](http://en.wikipedia.org/wiki/Megakaryocyte), [Platelet](http://en.wikipedia.org/wiki/Platelet)

Some leukocytes migrate into the tissues of the body to take up a permanent residence at that location rather than remaining in the blood. Often these cells have specific names depending upon which tissue they settle in, such as fixed macrophages in the liver, which become known as [Kupffer cells](http://en.wikipedia.org/wiki/Kupffer_cell). These cells still serve a role in the immune system.

* [Histiocytes](http://en.wikipedia.org/wiki/Histiocyte)
* [Dendritic cells](http://en.wikipedia.org/wiki/Dendritic_cell) (Although these will often migrate to local lymph nodes upon ingesting antigens)
* [Mast cells](http://en.wikipedia.org/wiki/Mast_cell)
* [Microglia](http://en.wikipedia.org/wiki/Microglia)

**Disorders**

There are two major categories of white blood cell disorders: [proliferative](http://en.wikipedia.org/wiki/Cell_growth) and [leukopenias](http://en.wikipedia.org/wiki/Leukopenia).[[11]](http://en.wikipedia.org/w/index.php?title=White_blood_cell&printable=yes#cite_note-Al2010-11) In the proliferative disorders there is an increase in the number of white blood cells. This increase is commonly reactive (ex. due to [infection](http://en.wikipedia.org/wiki/Infection)) but may also be [cancerous](http://en.wikipedia.org/wiki/Cancer). In leukopenias there is a decrease in the number of white blood cells. Both proliferative disease and leukopenias are[quantitative](http://en.wikipedia.org/wiki/Quantitative) disorders of white blood cells. [Qualitative](http://en.wikipedia.org/wiki/Qualitative) disorders of white blood cells are another category. These are disorders in which the number of white blood cells is normal but the cells do not function normally.[[12]](http://en.wikipedia.org/w/index.php?title=White_blood_cell&printable=yes#cite_note-Williamshematology2010-12)

**Leukopenias**

A range of disorders can cause decreases in white blood cells. This type of white blood cell decreased is usually the neutrophil. In this case the decrease may be called [neutropenia](http://en.wikipedia.org/wiki/Neutropenia) or granulocytopenia. Less commonly, a decrease in lymphocytes (called [lymphocytopenia](http://en.wikipedia.org/wiki/Lymphocytopenia) or lymphopenia) may be seen.[[11]](http://en.wikipedia.org/w/index.php?title=White_blood_cell&printable=yes#cite_note-Al2010-11)

**Neutropenia**

[Neutropenia](http://en.wikipedia.org/wiki/Neutropenia) can be [acquired](http://en.wikipedia.org/wiki/Acquired_disorder) or [intrinsic](http://en.wikipedia.org/wiki/Congenital_disorder).[[13]](http://en.wikipedia.org/w/index.php?title=White_blood_cell&printable=yes#cite_note-13) A decrease in levels of neutrophils on lab tests is due to either decreased production of neutrophils or increased removal from the blood.[[11]](http://en.wikipedia.org/w/index.php?title=White_blood_cell&printable=yes#cite_note-Al2010-11) The following list of causes is not complete.

* Medications - [chemotherapy](http://en.wikipedia.org/wiki/Chemotherapy), sulfas or other [antibiotics](http://en.wikipedia.org/wiki/Antibiotics), phenothiazenes, [benzodiazepines](http://en.wikipedia.org/wiki/Benzodiazepines), antithyroids, [anticonvulsants](http://en.wikipedia.org/wiki/Anticonvulsants), quinine, quinidine, indomethacin, procainamide, thiazides
* Radiation
* Toxins - [alcohol](http://en.wikipedia.org/wiki/Alcohol), benzenes
* Intrinsic disorders - [Fanconi's](http://en.wikipedia.org/wiki/Fanconi_syndrome), [Kostmann's](http://en.wikipedia.org/wiki/Kostmann_syndrome), cyclic neutropenia, [Chediak-Higashi](http://en.wikipedia.org/wiki/Chediak-Higashi_syndrome)
* Immune dysfunction - disorders of collagen, [AIDS](http://en.wikipedia.org/wiki/AIDS), [rheumatoid arthritis](http://en.wikipedia.org/wiki/Rheumatoid_arthritis)
* Blood cell dysfunction - [megaloblastic anemia](http://en.wikipedia.org/wiki/Megaloblastic_anemia), [myelodysplasia](http://en.wikipedia.org/wiki/Myelodysplasia), marrow failure, marrow replacement, acute [leukemia](http://en.wikipedia.org/wiki/Leukemia)
* Any major infection
* Miscellaneous - [starvation](http://en.wikipedia.org/wiki/Starvation), [hypersplenism](http://en.wikipedia.org/wiki/Hypersplenism)

Symptoms of neutropenia are associated with the underlying cause of the decrease in neutrophils. For example, the most common cause of acquired neutropenia is drug-induced, so an individual may have symptoms of [medication overdose](http://en.wikipedia.org/wiki/Drug_overdose) or toxicity. Treatment is also aimed at the underlying cause of the neutropenia.[[14]](http://en.wikipedia.org/w/index.php?title=White_blood_cell&printable=yes#cite_note-Schafer_a-14) One severe consequence of neutropenia is that it can increase the risk of infection.[[12]](http://en.wikipedia.org/w/index.php?title=White_blood_cell&printable=yes#cite_note-Williamshematology2010-12)

**Lymphocytopenia**

Defined as total lymphocyte count below 1.0x109/L, the cells most commonly affected are CD4+ T cells. Like neutropenia, lymphocytopenia may be acquired or intrinsic and there are many causes.[[12]](http://en.wikipedia.org/w/index.php?title=White_blood_cell&printable=yes#cite_note-Williamshematology2010-12) This is not a complete list.

* Inherited immune deficiency - [severe combined immunodeficiency](http://en.wikipedia.org/wiki/Severe_combined_immunodeficiency), [common variable immune deficiency](http://en.wikipedia.org/wiki/Common_variable_immune_deficiency), [ataxia-telangiectasia](http://en.wikipedia.org/wiki/Ataxia-telangiectasia), [Wiskott-Aldrich syndrome](http://en.wikipedia.org/wiki/Wiskott-Aldrich_syndrome), immunodeficiency with short-limbed dwarfism, immunodeficiency with thymoma, [purine nucleoside phosphorylase deficiency](http://en.wikipedia.org/wiki/Purine_nucleoside_phosphorylase_deficiency), genetic polymorphism
* Blood cell dysfunction - [aplastic anemia](http://en.wikipedia.org/wiki/Aplastic_anemia)
* Infectious diseases - [viral](http://en.wikipedia.org/wiki/Virus) ([AIDS](http://en.wikipedia.org/wiki/AIDS), [SARS](http://en.wikipedia.org/wiki/SARS), [West Nile encephalitis](http://en.wikipedia.org/wiki/West_Nile_virus), [hepatitis](http://en.wikipedia.org/wiki/Hepatitis), [herpes](http://en.wikipedia.org/wiki/Herpes_simplex_virus), [measles](http://en.wikipedia.org/wiki/Measles), others), [bacterial](http://en.wikipedia.org/wiki/Bacteria) ([TB](http://en.wikipedia.org/wiki/Tuberculosis), [typhoid](http://en.wikipedia.org/wiki/Typhoid), [pneumonia](http://en.wikipedia.org/wiki/Pneumonia), [rickettsiosis](http://en.wikipedia.org/wiki/Rickettsiosis), [ehrlichiosis](http://en.wikipedia.org/wiki/Ehrlichiosis), [sepsis](http://en.wikipedia.org/wiki/Sepsis)), [parasitic](http://en.wikipedia.org/wiki/Parasite) (acute phase of [malaria](http://en.wikipedia.org/wiki/Malaria))
* Medications - chemotherapy (antilymphocyte globulin therapy, [alemtuzumab](http://en.wikipedia.org/wiki/Alemtuzumab), [glucocorticoids](http://en.wikipedia.org/wiki/Glucocorticoids))
* Radiation
* Major surgery
* Miscellaneous - [ECMO](http://en.wikipedia.org/wiki/Extracorporeal_membrane_oxygenation), kidney or [bone marrow transplant](http://en.wikipedia.org/wiki/Bone_marrow_transplant), [hemodialysis](http://en.wikipedia.org/wiki/Hemodialysis), [kidney failure](http://en.wikipedia.org/wiki/Renal_failure), severe burn, [celiac disease](http://en.wikipedia.org/wiki/Celiac_disease), severe acute [pancreatitis](http://en.wikipedia.org/wiki/Pancreatitis), [sarcoidosis](http://en.wikipedia.org/wiki/Sarcoidosis), [protein-losing enteropathy](http://en.wikipedia.org/wiki/Protein-losing_enteropathy), strenuous exercise, [carcinoma](http://en.wikipedia.org/wiki/Carcinoma)
* Immune dysfunction - [arthritis](http://en.wikipedia.org/wiki/Arthritis), [systemic lupus erythematosus](http://en.wikipedia.org/wiki/Systemic_lupus_erythematosus), [Sjogren syndrome](http://en.wikipedia.org/wiki/Sjogren_syndrome), [myasthenia gravis](http://en.wikipedia.org/wiki/Myasthenia_gravis), [systemic vasculitis](http://en.wikipedia.org/wiki/Systemic_vasculitis), [Behcet](http://en.wikipedia.org/wiki/Behcet_syndrome)-like syndrome, [dermatomyositis](http://en.wikipedia.org/wiki/Dermatomyositis), [Wegener granulomatosis](http://en.wikipedia.org/wiki/Wegener_granulomatosis)
* Nutritional/Dietary - [alcohol abuse](http://en.wikipedia.org/wiki/Alcohol_abuse), [zinc deficiency](http://en.wikipedia.org/wiki/Zinc_deficiency)

Like neutropenia, symptoms and treatment of lymphocytopenia are directed at the underlying cause of the change in cell counts.

**Proliferative disorders**

An increase in the number of white blood cells in [circulation](http://en.wikipedia.org/wiki/Circulatory_system) is called [leukocytosis](http://en.wikipedia.org/wiki/Leukocytosis).[[11]](http://en.wikipedia.org/w/index.php?title=White_blood_cell&printable=yes#cite_note-Al2010-11) This increase is most commonly caused by [inflammation](http://en.wikipedia.org/wiki/Inflammation).[[11]](http://en.wikipedia.org/w/index.php?title=White_blood_cell&printable=yes#cite_note-Al2010-11) There are four major causes: increase of production in bone marrow, increased release from storage in bone marrow, decreased attachment to veins and arteries, decreased uptake by tissues.[[11]](http://en.wikipedia.org/w/index.php?title=White_blood_cell&printable=yes#cite_note-Al2010-11) Leukocytosis may affect one or more cell lines and can be neutrophilic, eosinophilic, basophilic, monocytosis, or lymphocytosis.

**Neutrophilia**

Neutrophilia is an increase in the absolute neutrophil count in the [peripheral circulation](http://en.wikipedia.org/wiki/Systemic_circulation). Normal blood values vary by age.[[12]](http://en.wikipedia.org/w/index.php?title=White_blood_cell&printable=yes#cite_note-Williamshematology2010-12) Neutrophilia can be caused by a direct problem with blood cells (primary disease). It can also occur as a consequence of an underlying disease (secondary). Most cases of neutrophilia are secondary to inflammation.[[14]](http://en.wikipedia.org/w/index.php?title=White_blood_cell&printable=yes#cite_note-Schafer_a-14)

Primary causes[[14]](http://en.wikipedia.org/w/index.php?title=White_blood_cell&printable=yes#cite_note-Schafer_a-14)

* Conditions with normally functioning neutrophils – [hereditary](http://en.wikipedia.org/wiki/Hereditary) neutrophilia, chronic [idiopathic](http://en.wikipedia.org/wiki/Idiopathic) neutrophilia
* [Pelger–Huet anomaly](http://en.wikipedia.org/wiki/Pelger%E2%80%93Huet_anomaly)
* [Down syndrome](http://en.wikipedia.org/wiki/Down_syndrome)
* [Leukocyte adhesion deficiency](http://en.wikipedia.org/wiki/Leukocyte_adhesion_deficiency)
* [Familial cold urticaria](http://en.wikipedia.org/wiki/Familial_cold_urticaria)
* [Leukemia](http://en.wikipedia.org/wiki/Leukemia) ([chronic myelogenous (CML))](http://en.wikipedia.org/wiki/Chronic_myelogenous_leukemia) and other [myeloproliferative disorders](http://en.wikipedia.org/wiki/Myeloproliferative_disorders)
* [Surgical removal of spleen](http://en.wikipedia.org/wiki/Splenectomy)

Secondary causes[[14]](http://en.wikipedia.org/w/index.php?title=White_blood_cell&printable=yes#cite_note-Schafer_a-14)

* [Infection](http://en.wikipedia.org/wiki/Infection)
* Chronic [inflammation](http://en.wikipedia.org/wiki/Inflammation) – especially [juvenile rheumatoid arthritis](http://en.wikipedia.org/wiki/Juvenile_rheumatoid_arthritis), [rheumatoid arthritis](http://en.wikipedia.org/wiki/Rheumatoid_arthritis), [Still's disease](http://en.wikipedia.org/wiki/Still%27s_disease), [Crohn's disease](http://en.wikipedia.org/wiki/Crohn%27s_disease), [ulcerative colitis](http://en.wikipedia.org/wiki/Ulcerative_colitis), [granulomatous](http://en.wikipedia.org/wiki/Granulomatous) infections (for example, [tuberculosis](http://en.wikipedia.org/wiki/Tuberculosis)), and chronic [hepatitis](http://en.wikipedia.org/wiki/Hepatitis)
* [Cigarette smoking](http://en.wikipedia.org/wiki/Cigarette_smoking) – occurs in 25–50% of chronic smokers and can last up to 5 years after quitting
* Stress – exercise, surgery, general stress
* Medication induced – [corticosteroids](http://en.wikipedia.org/wiki/Glucocorticoids) (for example, [prednisone](http://en.wikipedia.org/wiki/Prednisone), β-agonists, [lithium](http://en.wikipedia.org/wiki/Lithium)
* Cancer – either by [growth factors](http://en.wikipedia.org/wiki/Growth_factor) secreted by the tumor or invasion of bone marrow by the cancer
* Increased destruction of cells in [peripheral circulation](http://en.wikipedia.org/wiki/Systemic_circulation) can stimulate bone marrow. This can occur in [hemolytic anemia](http://en.wikipedia.org/wiki/Hemolytic_anemia) and [idiopathic thrombocytopenic purpura](http://en.wikipedia.org/wiki/Idiopathic_thrombocytopenic_purpura)

**Eosinophilia**

A normal eosinophil count is considered to be less than 0.65×109/L.[[12]](http://en.wikipedia.org/w/index.php?title=White_blood_cell&printable=yes#cite_note-Williamshematology2010-12) Eosinophil counts are higher in newborns and vary with age, time (lower in the morning and higher at night), exercise, environment, and exposure to allergens.[[12]](http://en.wikipedia.org/w/index.php?title=White_blood_cell&printable=yes#cite_note-Williamshematology2010-12) Eosinophilia is never a normal lab finding. Efforts should always be made to discover the underlying cause, though the cause may not always be found.[[12]](http://en.wikipedia.org/w/index.php?title=White_blood_cell&printable=yes#cite_note-Williamshematology2010-12)

**See also**

* [Leukocyte-promoting factor](http://en.wikipedia.org/wiki/Leukocyte-promoting_factor)
* [Reference ranges for blood tests](http://en.wikipedia.org/wiki/Reference_ranges_for_blood_tests)

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**External links**

* [Atlas of Hematology](http://www.hematologyatlas.com/)
* [Leukocytes](http://www.nlm.nih.gov/cgi/mesh/2011/MB_cgi?mode=&term=Leukocytes) at the US National Library of Medicine [Medical Subject Headings](http://en.wikipedia.org/wiki/Medical_Subject_Headings) (MeSH)

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[Categories](http://en.wikipedia.org/wiki/Help:Category):

* [Hematology](http://en.wikipedia.org/wiki/Category:Hematology)
* [Human cells](http://en.wikipedia.org/wiki/Category:Human_cells)
* [Immune system](http://en.wikipedia.org/wiki/Category:Immune_system)
* [Immunology](http://en.wikipedia.org/wiki/Category:Immunology)
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