

WHITE BLOOD CELLS

White blood cells (WBCs, leukocytes) defend the body against foreign infections (bacteria, viruses). Most WBCs originate in bone marrow from undifferentiated stem cells. Lymphocytes proliferate primarily in the lymphatic organs (thymus, spleen, lymph nodes).

GRANULOCYTES

NEUTROPHILS, 60-70%

EOSINOPHILS, 2-4%

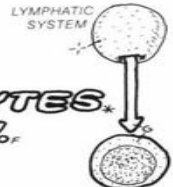
BASOPHILS, 0.5-1%

MAST CELL

The granulocytes (neutrophils, eosinophils, and basophils) constitute the majority of WBCs; their cytoplasm contains granules and their nuclei are polymorphic. Granulocytes as well as the monocytes take part in the natural immune responses (inflammation, phagocytosis) against invading microbes. Neutrophils constitute the bulk of granulocytes. They are phagocytes and capable of diapedesis. They recognize bacteria, adhere to them, expand, and produce pseudopods to engulf and digest them. The number of neutrophils in the blood increases markedly after infections. Eosinophils constitute 2-4% of WBCs; they are weakly phagocytic but exhibit strong chemotaxis (attraction to injury and infection sites). They may be specialized for digesting complex products of antigen-antibody reactions. Basophils constitute the smallest population of WBCs. They may release histamine (a vasodilator), heparin (an anticoagulant), and possibly serotonin and bradykinin (vasoconstrictors) into the blood. Mast cells are similar to basophilic WBCs but are found only in tissues; they release histamine and heparin from their granules.

RED BONE MARROW

STEM CELL



AGRANULOCYTES

MONOCYTES, 3-8%

TISSUE MACROPHAGE

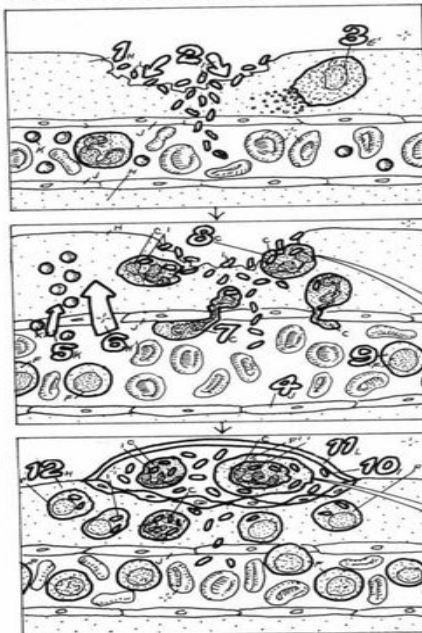
LYMPHOCYTES, 20-25%

B-LYMPHOCYTE

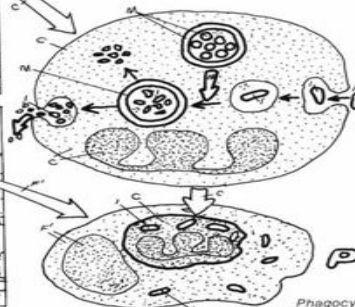
T-LYMPHOCYTES

Monocytes have a single large nucleus and few granules in the cytoplasm. They enter injured tissue and transform into tissue macrophages, phagocytizing bacteria and tissue debris. Monocytes may be the source of all permanent tissue macrophages, e.g., those in the liver and lung. Lymphocytes participate in acquired immune responses of the body against specific viruses and bacteria. Lymphocytes are divided into 2 types: B-cells deactivate bacteria and viruses by producing specific antibodies (humoral immunity); the antibodies are actually secreted by a differentiated form of B-cells, the plasma cells. T-cells attack all foreign cells (cell mediated immunity). T-cells originate in the thymus and are divided into killer (cytotoxic), helper and suppressor subtypes.

NATURAL IMMUNITY / NONSPECIFIC RESPONSE: INFLAMMATION & PHAGOCYTOSIS



1. TISSUE DAMAGE.
2. MICROBES ENTER BODY.
3. MAST CELLS RELEASE HISTAMINE.
4. VASODILATION.
5. PROTEIN PERMEABILITY.
6. FLUID SWELLS TISSUE.
7. DIAPEDESIS OF NEUTROPHILS.
8. PHAGOCYTOSIS OF MICROBES.
9. MONOCYTES FOLLOW.
10. DEATH OF MICROBES.
11. PUS SAC DEVELOPS.
12. TISSUE REPAIR.



After an injury (1), bacteria invade tissue space (2); local mast cells liberate histamine (3), promoting vasodilation (4) and vascular permeability; plasma proteins and fluids flow in (5), causing local edema (6); fibrin formation clots this fluid, trapping bacteria. Now stationary tissue macrophages (1st line of defense) begin to phagocytize bacteria. Next, blood neutrophils leave blood vessels by diapedesis (7) and begin massive phagocytosis (8) (2nd line of defense). In more extensive injuries, blood monocytes migrate to site (9), transform into macrophages, and help neutrophils eliminate microbes (10) (3rd line of defense). A pus sac containing dead cells and debris develops (11) and is either extruded or gradually cleared away during tissue repair (12) by epithelial and fibroblast cells.

PHAGOCYTOSIS LYSOSOME

Phagocytes engulf bacteria and digest them within their lysosomes.