Department of
Cellular and Physiological Sciences

# Blood

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## Blood

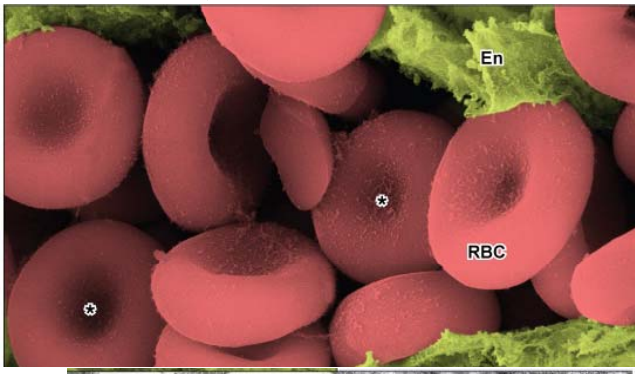
- A specialized type of connective tissue.
- Counts for about 7% of body weight.
- Formed elements: RBCs, WBCs, and platelets (45%)
- Extra-cellular matrix: Plasma (55%)
- Function: conveys nutrients, returns waste products, transport gases, ferries metabolites, cellular products (hormones) and electrolytes, regulates body temperature, maintains acid- base and osmotic balance, and finally acts as a pathway for migration of WBCs.

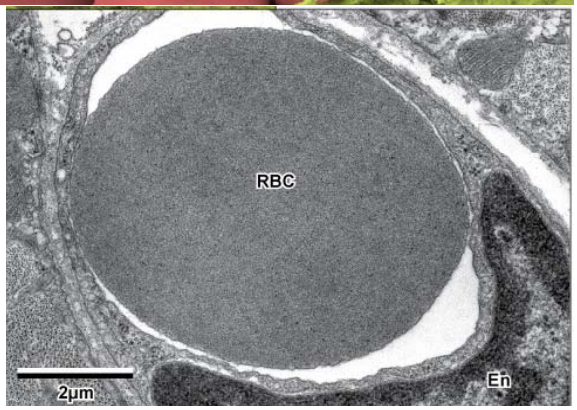
## Plasma

- A yellowish fluid that all other components are suspended or dissolved in it.
- Its major components are water (92%), and protein (7%).
- During coagulation, some organic and inorganic components leave the plasma to contribute into the clot. The remaining fluid is called "Serum".
- The fluid component of blood leaves the capillaries to enter the connective tissue space as "Extra-cellular fluid", which its main difference with plasma is in its protein content.

## Erythrocytes ($4.5 – 5 \times 10^{12}$ / L)

- A biconcave disk with 7 – 10 μm in diameter
- Transports O2 and CO2.
- Mature RBC has no nucleus or organelles.
- After 120 days, the old RBCs, will be destroyed by macrophages of the spleen, bone marrow, and liver.



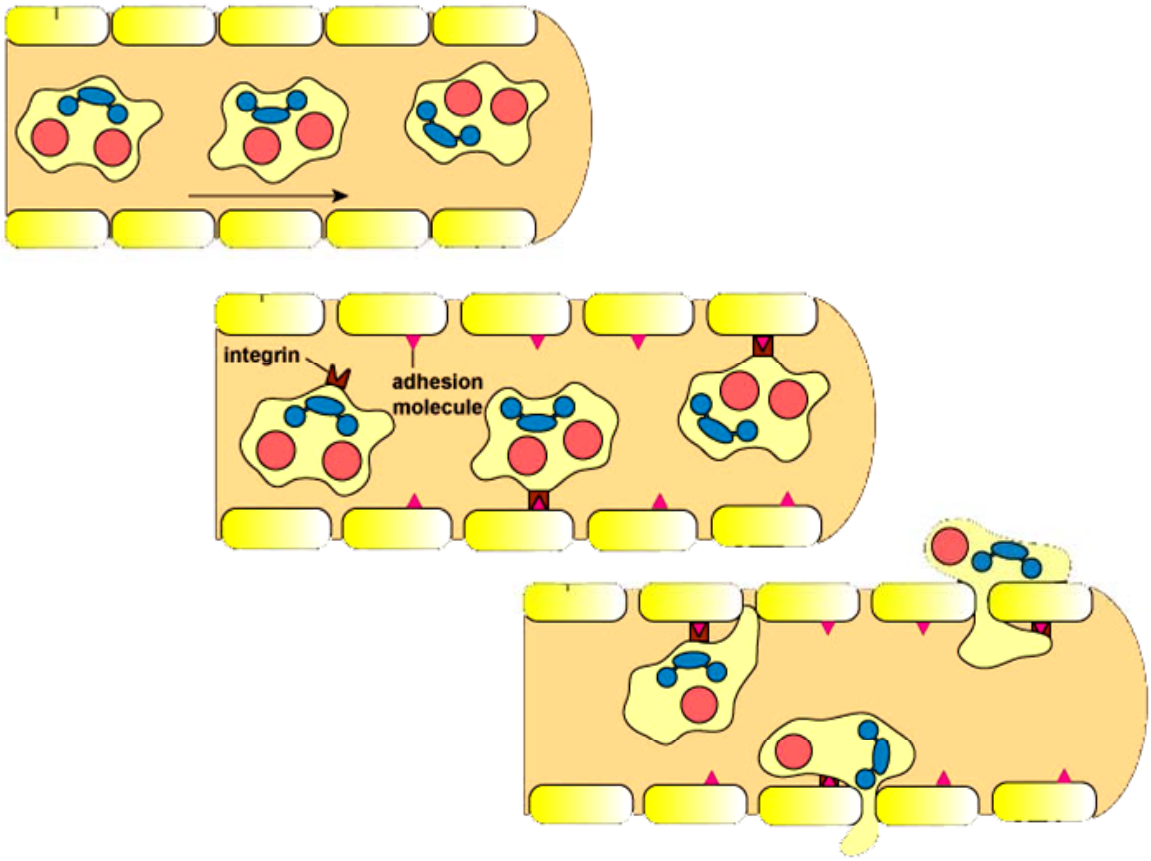



# Leukocytes (5 – 10× $10^9$ / L)

- Use the bloodstream as a vehicle to reach their destination. There they migrate (Diapedesis) to the CT and Perform their function.

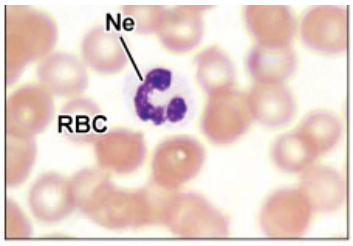
- Are divided into to groups:

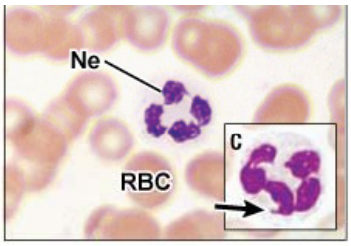
1. Granulocytes that contain specific granules in their cytoplasm and include: Neutrophils, Eosinophils, and Basophils.
2. Agranulocytes which lack specific granules and include: Lymphocytes and Monocytes.

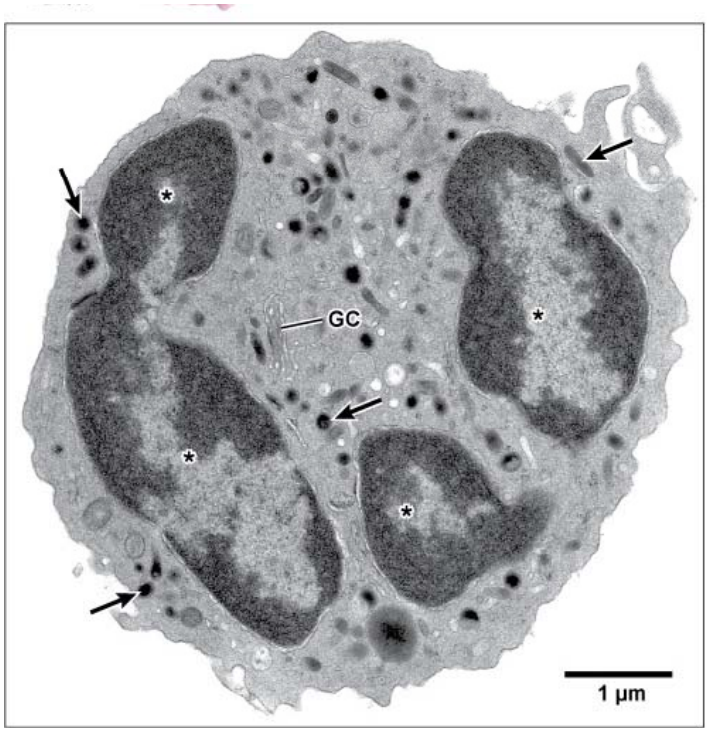


# Neutrophils (9 – 12 μm)

- The most populous (60% - 70%).
- Light pink cytoplasm and dark blue multilobed nucleus with thin connecting strands.
- Lifespan is less than a week.
- Phagocytosis and destruction of bacteria



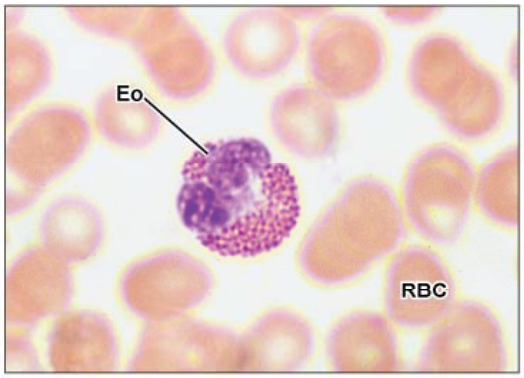

▲ **LMs of neutrophils in blood smears.** The young neutrophil (**Ne**) in **A** has a U-shaped, darkly stained nucleus. The neutrophil in **B** is more mature; its nucleus has four lobes connected by fine strands. The cytoplasm of both cells is pale and finely speckled. Their granules are difficult to distinguish. Surrounding erythrocytes (**RBC**) are smaller than neutrophils, which are 9-12 μm in diameter. 1000×. **C**. The inset shows a Barr body (**arrow**) on the neutrophil nucleus. It has a drumstick shape and appears to be attached to a lobe of the nucleus by a thin strand of chromatin. Present in females, it is inactive heterochromatin of one of the two X chromosomes. 1500×. *Wright's.*

◀ **EM of a neutrophil.** Four lobes (•) of the nucleus, but not connecting chromatin strands, are in the plane of section. The cytoplasm has a Golgi complex (**GC**) and many electron-dense granules (**arrows**) of various sizes, which are primary (azurophilic) lysosomes and specific granules. Although specific granules are hard to distinguish from each other at this magnification and without special stains, they are usually smaller than nonspecific azurophilic granules. 17,000×.

# Eosinophils (12 – 15 μm)

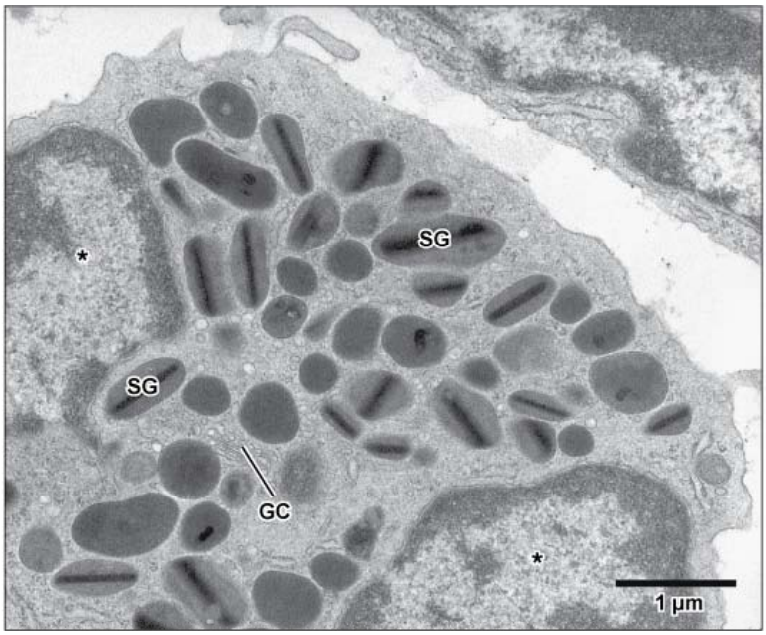
- Constitute 1% - 4% of total WBCs.
- Possesses numerous large round reddish-orange granules and a bi-lobed dark nucleus.
- Life span is less 8 – 10 days.
- Phagocytosis of antigen-antibody complex and destruction of parasites.

▼ **Eosinophil.**


◄ **LM of an eosinophil in a blood smear.** The distinctive, closely packed eosinophilic granules fill the cytoplasm of the eosinophil (**Eo**). The usually bilobed nucleus has an irregular shape. This granular leukocyte has a larger diameter than that of the erythrocytes (**RBC**). 1350×. *Wright's.*

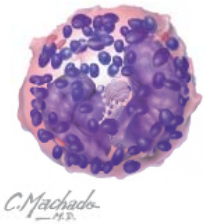
► **EM of part of an eosinophil.** Two nuclear lobes (*) contain euchromatin and a peripheral rim of heterochromatin. Large specific granules (**SG**) with electron-dense crystalloid cores occupy the cytoplasm. A small Golgi complex (**GC**) is between the lobes. 18,000×.

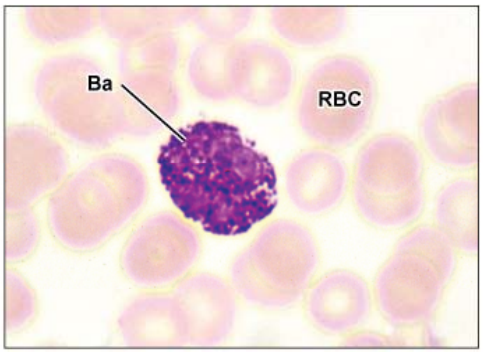


# Basophils (10 – 14 μm)

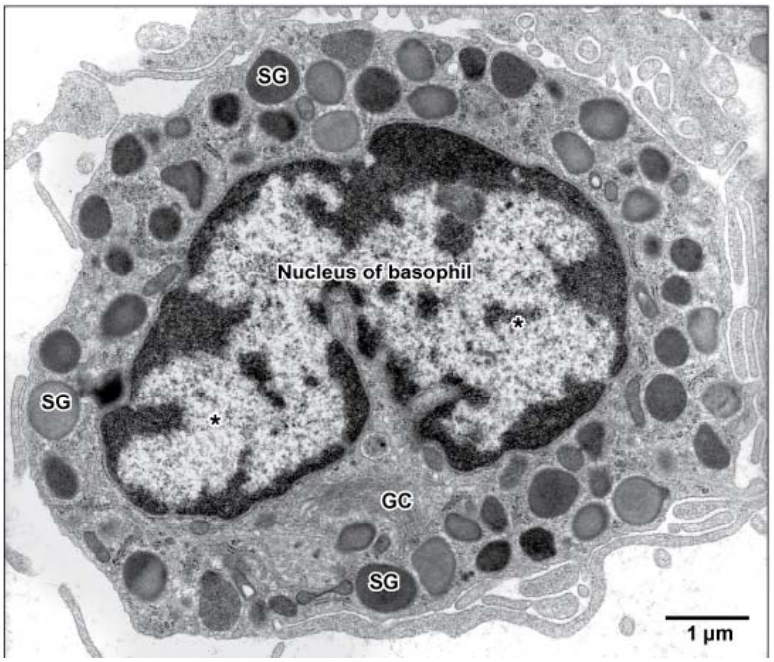
- The least numerous of all WBCs (0% - 1%).
- They have an "S" shaped nucleus an lots of large dark blue granules.
- Life span is 1 – 2years.
- Mediated inflammatory responses.

▼ **Basophil.**




◄ **LM of a basophil in a blood smear.** The easily recognized basophil (**Ba**) has many large basophilic specific granules that are blue. The nucleus, being masked by the granules, is less evident. The erythrocytes (**RBC**) are smaller than the basophil. 1200×. *Wright's.*

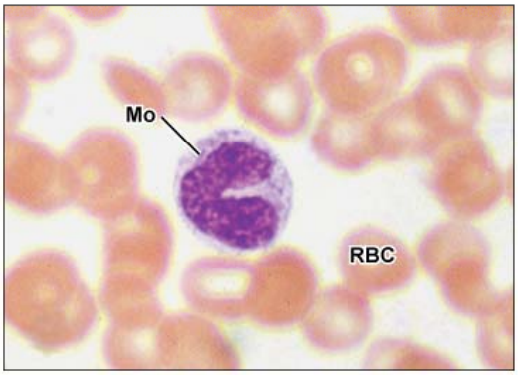



► **EM of a basophil.** Its nucleus is bilobed (*). A peripheral rim of heterochromatin surrounds central euchromatin. The cytoplasm has many prominent, closely packed specific granules (**SG**) that are derived from the Golgi complex (**GC**). These membrane-bound granules vary in size and density. 11,300×.

# Monocytes (12 – 20 μm)

- The largest blood cell that constitutes 3% - 10% of WBCs.
- They have greyish – blue cytoplasm containing azurophilic granules and a kidney shaped nucleus.
- Life span is between few days to several months (in blood or in CT).
- Differentiate to macrophages and their function is to present the antigen and also phagocytosis.

▼ **Monocyte.**

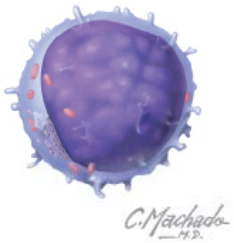

◄ **LM of a monocyte in a blood smear.** A monocyte (**Mo**) nucleus is highly indented and less densely stained than that of lymphocytes. Throughout the light blue cytoplasm are many faintly stained granules, so the cytoplasm looks dusty. The monocyte is twice as large as the erythrocytes (**RBC**). 1350×. *Wright's.*

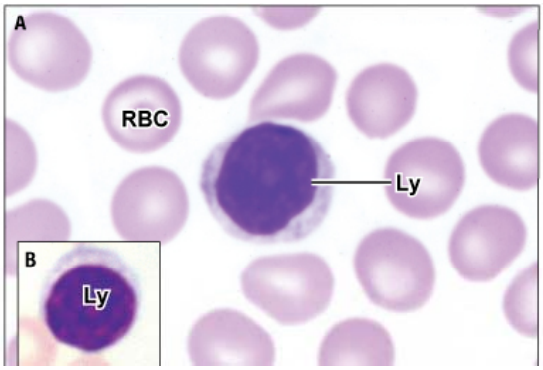
► **Colorized SEM showing a venule lumen.** Surface features of a monocyte (**Mo**) are clear. The cell attaches to the endothelium (**En**) by pseudopodia (**arrows**) as it begins migrating from the lumen on its way to becoming a macrophage. This migratory process—diapedesis—enables leukocytes to leave the circulation for functions in surrounding tissues. 3440×. (*Courtesy of Dr. M. E. Todd*)

# Lymphocytes (6 – 16 μm)

- Constitute 20% – 40% of WBCs.
- They possess a dense blue large nucleus, and a rim of light blue cytoplasm.
- The life span is few months (B) to several years (T).
- T-cells (60% - 80%) and B-cells (10% - 15%) are active in cell mediated and humorally mediated immune responses respectively.

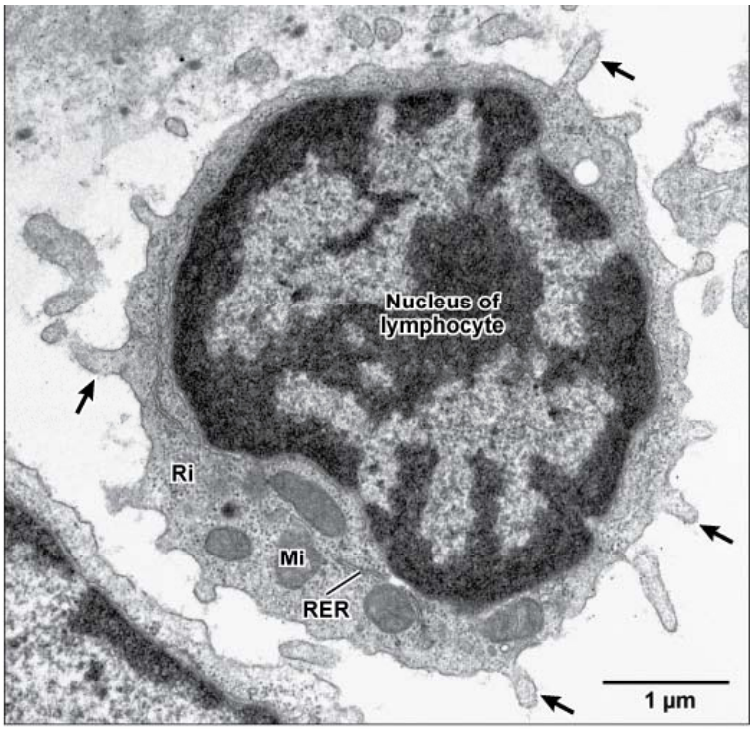
▼ **Lymphocyte.**




◄ **LMs of lymphocytes in a blood smear. A.** A rim of blue-gray cytoplasm caps a darkly stained round nucleus in a large lymphocyte (**Ly**). Erythrocytes (**RBC**) are also in view. **B.** A small lymphocyte at the same magnification is shown for comparison. 1275×. *Wright's.*

► **EM of a lymphocyte.** The spherical, slightly indented nucleus contains condensed heterochromatin with patches of euchromatin. The cytoplasm shows many free ribosomes (**Ri**), scattered mitochondria (**Mi**), and a few profiles of **RER**. A few short microvilli (**arrows**) are at the cell surface. 16,000×.




**F. 7.7**

# Platelets (2 – 4 μm)

- They are 150 – 400 × $10^9$ / L and are also called "Thrombocytes".
- Small round cell fragments that possess no nuclei but present a dark blue central granular region (granulomere), and a light blue peripheral region (hyalomere).
- Active in coagulation.