



HLS

Sheet #1

Lec Date : 3\3\2019 - Sunday .

Lec Title : Blood Elements .

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This sheet includes both slides and lecture notes , in addition to some extra figures were added to boost understanding .
Have fun studying it :)

Functions of the blood :

- Blood is considered to be liquid connective tissue , generally it performs 3 functions :
 1. **Transportation** “The most important related function “ .
Gases, nutrients, hormones, waste products .
 2. **Regulation** “ Homeostasis “ .
pH, body temperature, osmotic pressure
 3. **Protection**
Clotting, white blood cells, proteins

Components of Blood :

- **Blood Plasma** --> water liquid extracellular matrix
 - Components of the plasma :
 1. 92% **Water** .
 2. 8% **solutes** , these are primarily proteins and to a lesser extent electrolytes , nutrients , enzymes , hormones , gases and waste products .
 - Most **plasma proteins** (i.e. albumin , fibrinogen , antibodies) are synthesized by **hepatocytes** .
- **Formed elements** --> Cells and cell fragments
 1. Erythrocytes (RBCs).
 2. Leukocytes (WBCs).
 3. Platelets

Formation and Destruction of RBC's :

- Normal concentration in blood 3.9–5.5 million/ μL in **women** and 4.1–6 million/ μL in **men** .
- Most important component of RBCs is : Hemoglobin (i.e. oxygen-carrying protein) which accounts for their acidophilia

RBCs are the blood cells that carry oxygen , a function mediated by the hemoglobin which is the major component of these cells . Hemoglobin , aside from being a transport molecule , **is a pigment** . What gives the erythrocytes their red color , thus called Red blood cells .

- **Production = destruction** with at least 2 million new RBCs per second.
- RBCs have a biconcave disc shape .

The **biconcave disc** offers a greater surface area for the gas exchange on the RBC, than a spherical one would have.

- RBCs are 7.5 μm in diameter .” This is mainly a reference for us to distinguish different blood cells in blood smears , you have to be familiar with it “
- Thickness : 2.6 μm thick at rim and 0.8 μm thick in center .
- They have strong , flexible plasma membrane (Allowing it to be squeezed) .
- Glycolipids in plasma membrane responsible for ABO and Rh blood groups .
- Important characteristic of RBCs is that they lack nucleus and other organelles , they lack mitochondria meaning they aren't oxygen-dependent .

When a cell **lacks nucleus** this indicates its **inability to divide** . Generally speaking ,**mature blood cell are nondividing cells** (with exception of Lymphocytes) .

Lacking organelles , like in RBCs , this indicates that the cell's function is far away from production , **it is most likely to be transportation** .

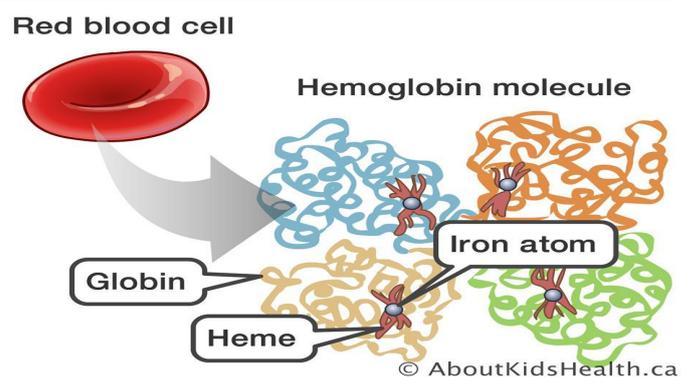
Hemoglobin :

- Hb is a **tetramer** consisting of:
4 **polypeptides** (2α , 2β) and heme group is found in each Of these chains .
- Iron ion can combine **reversibly** with **one** oxygen molecule .
- HB also transports 23% of total carbon dioxide.

HB , which is the carrier protein of RBCs , interestingly **doesn't carry CO_2 in the same way it does for O_2** .

O_2 binds to iron atoms in the protein whereas CO_2 is **bound to the amino acids of globin** . Remember always , **CO_2 is if greater affinity to Hb than O_2 does** .

Hemoglobin combine irreversibly with carbon monoxide ,that's why in cases of CO poisoning , CO displaces O_2 and quickly binds , so very little amount of oxygen is transported through the body .



- Nitric oxide (NO) binds to hemoglobin ,releasing NO causes vasodilatation to improve blood flow and oxygen delivery .

RBC life cycle :

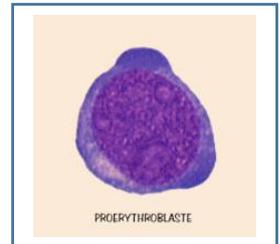
- Starts in red bone marrow with proerythroblast .

++Extra ++

Proerythroblast, aka pronormoblast , is the earliest stage in erythroid maturation .

Histological appearance :

1. It is a very round cell that is about the same size as a myeloblast .
2. It has a distinctive **deeply basophilic**, velvety cytoplasm .
3. A pronormoblast typically has a **round, centrally-located nucleus** .
(See the picture on the right)



- Cell near the end of development ejects nucleus and becomes a reticulocyte and released into blood stream .

Dr's Q :

RBCs first released into blood as ----- ? Reticulocyte .

RBCs production cascade in bone marrow is gonna lead to a cell called -----? Reticulocyte .

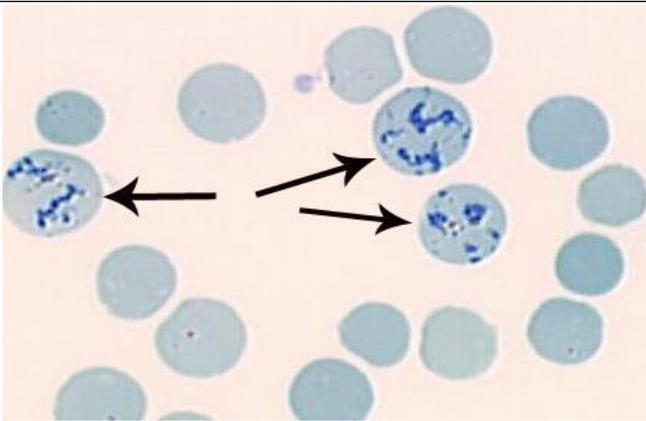
- Reticulocytes :

1. Contain residual ribosomal RNA, which is precipitated and stained by some dyes (eg, brilliant cresyl blue)

“Appear like few granules or net like structure in the cytoplasm”

2. Normally constitute about 1% of total circulating erythrocytes .

3. Develop **into mature RBC** within 1-2 days and lose its mitochondria, ribosomes and many cytoplasmic enzymes . (Notice that **Reticulocyte does contain some organelles whereas mature RBCs don't**)



Increase number of reticulocyte may reflect increase demand for O₂

- RBCs live only about **120 days** .
- They lack nucleus and other organelles , thus can't synthesize new components .
- Ruptured RBCs removed from circulation and destroyed by fixed phagocytic macrophages in spleen and liver
- Recycled breakdown products :
 1. **Globin's amino acids** reused .
 2. **Iron** reused .
 3. **Non-iron heme** ends as yellow pigment urobilin in urine or brown pigment stercobilin in feces .

White Blood Cells/ Leukocytes :

- General features :
 1. Leukocytes **have nuclei** .
 2. They **don't have Hb**.
 3. They are **spherical in shape** (RBCs : biconcave disc shape).
 4. About 6000-10000 leukocytes/ μL (**Far less numerous than RBCs**).
 5. Further classified based on staining highlighting large conspicuous granules into :
 - a) **Granulocytes** (PMN leukocytes) --> **Neutrophils, eosinophils, basophils**.
 - b) **Agranulocytes** (MN leukocytes) --> **Lymphocytes** and **monocytes** .
 6. Usually live a few days , Except for lymphocytes which live for months or years.
- Functions :
 1. **Leukocytosis** --> is a **normal protective response** to invaders, strenuous exercise, anesthesia and surgery .
 2. General function to combat invaders **by phagocytosis** or **immune responses** .

The 3 criteria for differentiation : 1) **Size** 2) **Shape of the nucleus** .
3) **Presence or absence of granules along with their appearance** .

Granulocytes : (neutrophils, eosinophils, basophils)

- There are 2 types of granules found within these cells :

1. Specific Granules

• Bind neutral, basic, or acidic components of dye mixture “ stained differently between cells , thus enabling us to distinguish cell type “ .

• Have specific functions .

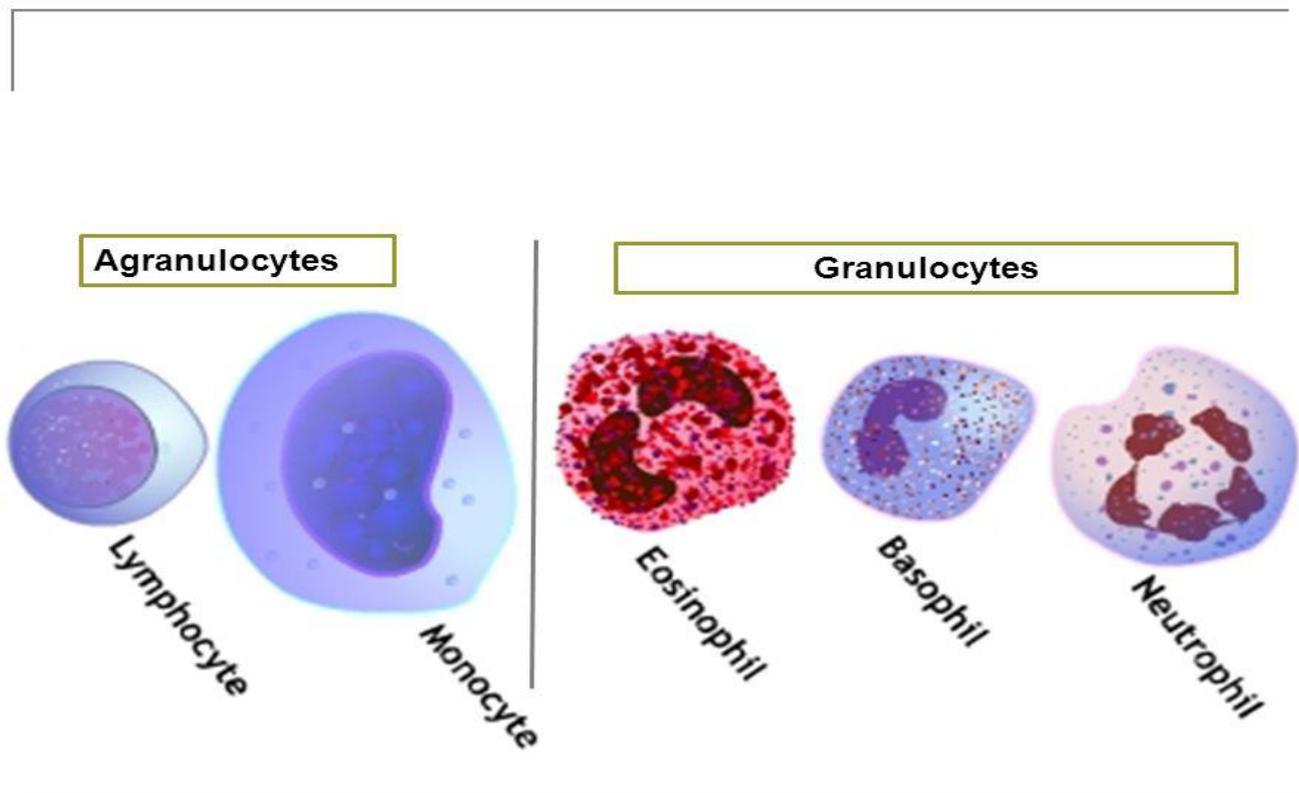
2. Azurophilic granules

• Stain purple and are lysosomes .

- These cells have nuclei with two or more lobes .
- They are terminal nondividing cells .

Agranulocytes : (lymphocytes and monocytes)

- Don't have specific granules . Instead , they contain azurophilic granules that bind azure dyes .
- Nucleus is round or indented .



Emigration of WBCs :

- WBCs are spherical, **non motile cells** but they are capable of becoming flattened and motile outside blood , by the effect of precise signals that vary for different types of WBCs .
- **Diapedesis** is of steps :
 1. **Rolling** of WBCs along endothelium.
 2. **Sticking** of WBCs to the endothelium.
 3. **Squeezing** of WBCs through the gap junctions between endothelial cells.

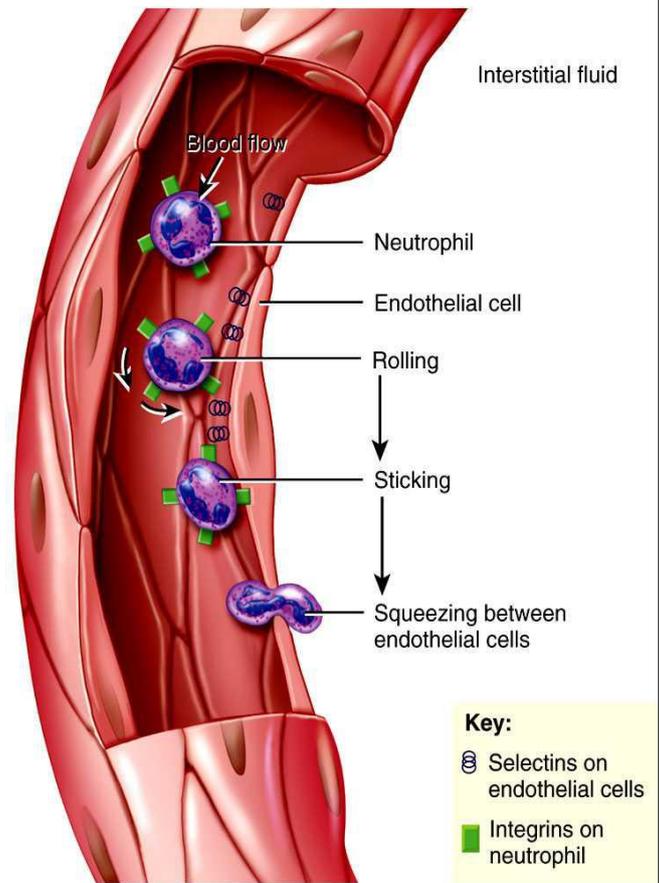
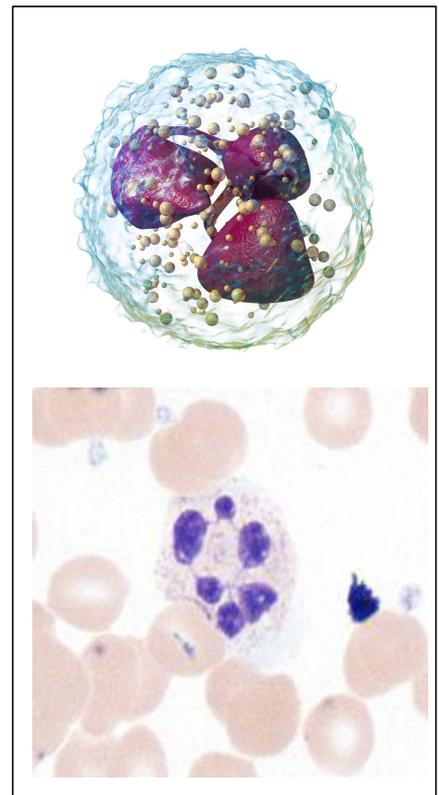


Figure 19.08 Tortora - PAP 12/e
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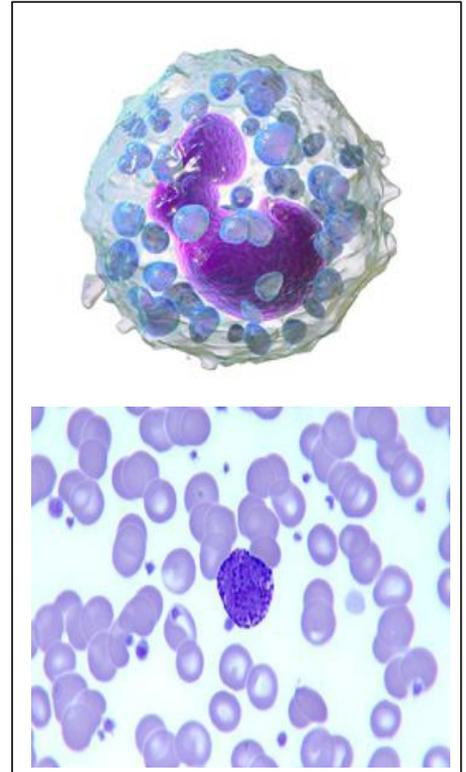
Neutrophils :

- **Constitute 60-70%** of circulating leukocytes (**Most abundant** type)
- **12-14µm** in diameter (in blood smear) (approx 2x RBC' size)
- They are active phagocytes .
- **Short lived cells** with half life 67 h in blood and 1-4 days in CT .
- Cytoplasm **contain glycogen for energy production** .
- **Appearance** :
 1. **Nucleus consisting of 2-5** (usually 3) **lobes** connected by **fine threads of chromatin** .
 2. **Specific granules** more abundant (**medium sized granules**)



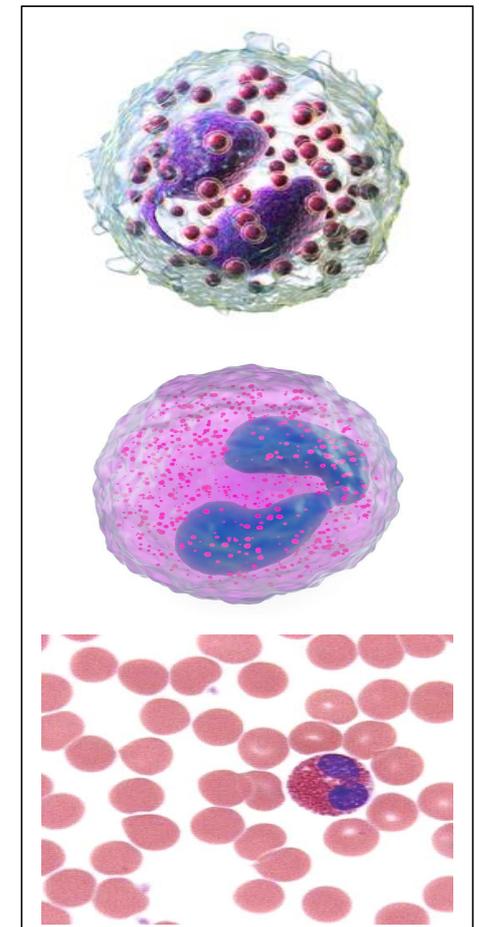
Basophils :

- Less than 1% of leukocytes in blood .
- 12-15 μm in diameter (Larger than RBCs).
- Basophils may supplement the function of mast cells in immediate Hypersensitivity reactions by migrating into CT.
- **Appearance :**
 1. Nucleus is divided into irregular lobes.
 2. the overlying specific granules usually obscure the division (0.5 μm in diameter).
- There is some similarity between granules of basophils and mast cells; both are metachromatic and contain heparin and histamine



Eosinophils :

- 2-4% of leukocytes in blood.
- Same size as neutrophils in blood (12-14 μm in diameter).
- **Appearance :**
 1. Bilobed nucleus .
 2. The main identifying characteristics is the presence of many large and elongated refractile specific granules (about 200/cell) that are stained by eosin. (its specific granules are gonna stained reddish).



Lymphocytes : (The only one that can be further divide after maturation)

- A family of spherical cells with similar morphological characteristics

- Lymphocytes are the major soldiers of the immune system

1. **B cells** –destroying bacteria and inactivating their toxins .

2. **T cells** –attack viruses, fungi, transplanted cells, cancer cells and some bacteria .

3. **Natural Killer (NK) cells** –attack a wide variety of infectious microbes and certain tumor cells .

- Vary in life span; some live few days and others survive in the circulating blood for many years .

- They are the only type of leukocytes that return from tissue back into the blood

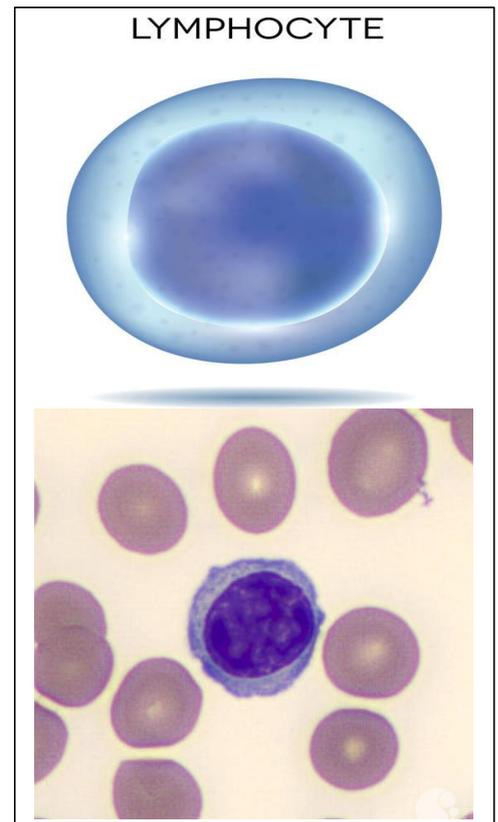
- Small lymphocytes with 6-8 μm in diameter , features :

1. Has spherical nucleus .

2. Its chromatin is condensed and appears as coarse clumps .

3. Cytoplasm is scanty and appear as thin rim around the nucleus .

- Some lymphocytes are medium-sized and large-sized with diameter up to 18 μm .



Monocytes :

- Bone marrow-derived agranulocytes .

- 12-20 μm in diameter .

- It is not terminal cell :

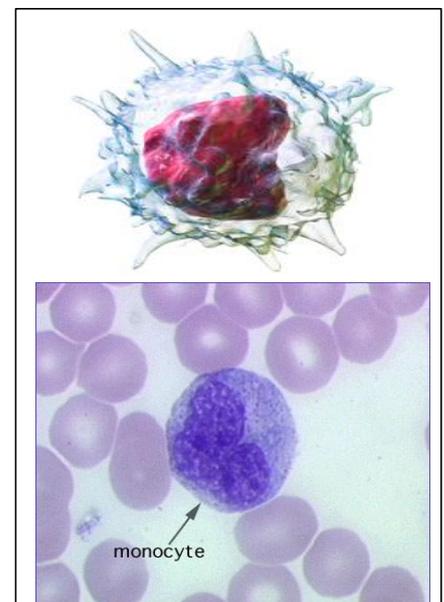
When inters CT, monocytes differentiate into macrophages .

- **Appearance** :

1. Nucleus is oval, horseshoe or kidney shaped and is generally eccentrically placed

2. The chromatin is less condensed than that of lymphocytes, and so nucleus stain lighter .

3. Cytoplasm is basophilic and may contain



very fine azurophilic granules,
which gives cytoplasm a bluish-gray color .

Platelets/ Thrombocytes :

- Help stop blood loss by forming platelet plug ;Granules contain blood clot promoting chemicals .
- Short life span : 5-9 days.
- 200000-400000/ μL .
- Development :
 1. Myeloid stem cells develop eventually into a megakaryocyte .
 2. Splinters into 2000-3000 fragments .
 3. Each fragment enclosed in a piece of plasma membrane , thus platelets are cell fragments (fragments of megakaryocyte).
- Appearance :
 1. Disc-shaped with many vesicles but no nucleus .
 2. In stained blood smears, platelets often appear in clumps (platelets clumps) .

