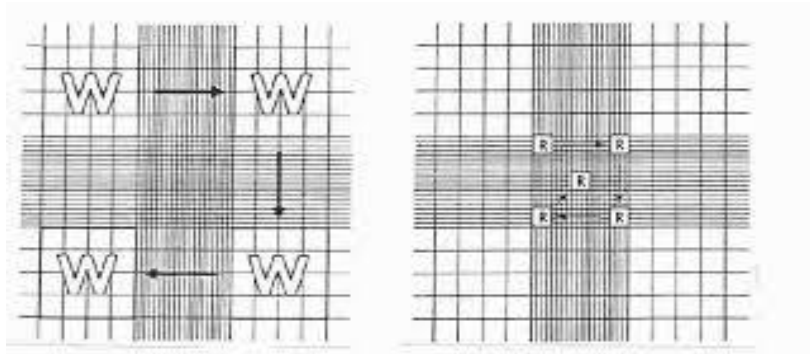


Note : In this lecture the Dr explained what we have studied in the lab briefly then he discussed the topic of leukocytes

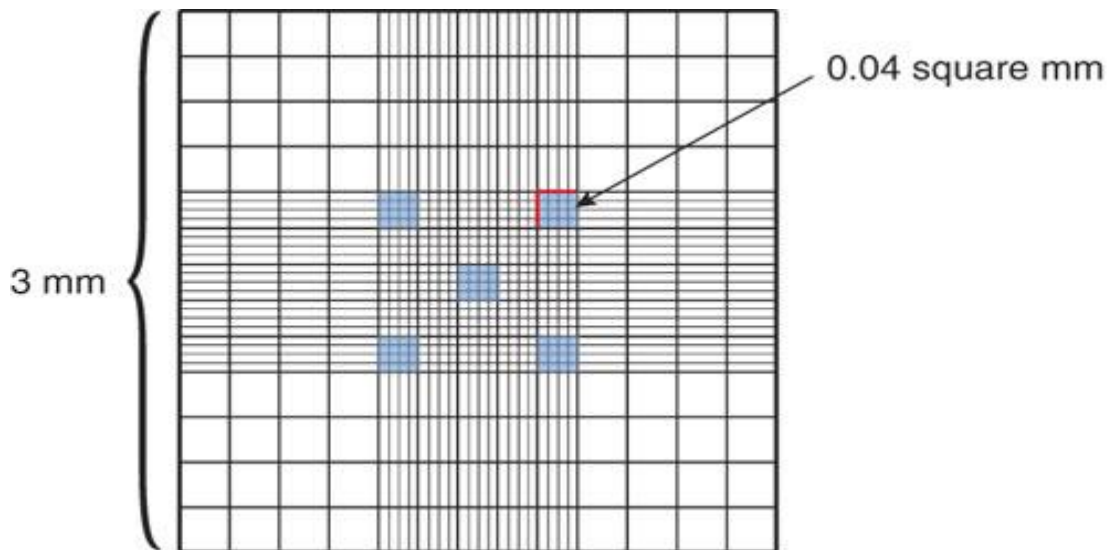
Hemocytometer



The picture above demonstrates the counting chambers

- When we use the microscope we can see these counting chambers which are used to count the number of WBC and RBC
- We count the WBC in the four large squares in the corner and we count the RBC in the square in the centre

The square in the centre is divided into 25 squares; each square of them is more divided to 16 small squares as in the figure below



So when we are going to count RBC we count them in the five squares shown above

- The number of RBC in these 5 squares is divided by 80 (every square of the 5 squares has 16 smaller squares , the total number of the smaller squares in these 5 bigger squares is $5 * 16 = 80$ thus we here are calculating the average number of RBC per smaller square)
 - Now we have to calculate the volume of the smaller square which is (Volume = Area * Depth)
 - The volume of the small square is 0.004 cubic mm
 - Keep in mind that the blood we use here is diluted 1:200

 - ❖ The count of RBC = (average number of RBC per the smaller square * 200) / 0.004
-

Leukocytes

- ❖ Now we move to our topic about white blood cells

You have to remember that the normal range value of **Total WBC count** is (4000 – 11000 cells/ μL), If the Total WBC count is above the normal this condition is called **leukocytosis** , But If the WBC count is below the normal it is called **leukopenia**

- ✓ White blood cells are divided into two categories depending on the presence of granules in the cytoplasm :
- **Granulocytes:**
 1. **Neutrophils**
 2. **Basophils**
 3. **Eosinophils**
- **Agranulocytes :**
 1. **Lymphocytes**
 2. **Monocytes**

- Keep in mind that even **Agranulocytes** have a few number of granules especially old cell

❖ *Note:-*

We know from the histology class that the "Agranulocytes" mentioned above is an old term, the new term is **mononuclear cells**.

- ✓ In contrast to erythrocytes , the leukocytes are nucleated , larger in size , have no Hemoglobin and the count of leukocytes doesn't differ between males and females.
- ✓ The life span of leukocytes is short in general (there are few exceptions like memory cells) , neutrophils as an example have an intravascular life span of about 6 hours , But monocytes circulate in the blood for about 70 hours (mentioned in the slides) and when reach the tissues (now they are called **Macrophages**) they can live up to months .

We have said that the count of WBC doesn't differ between males and females but there is some variability in the count in the same individual from time to time, the count differs slightly in the morning from that in the afternoon, it also increases after exercise or during pregnancy.

- ✓ leukocytes differ in their count in the blood

Cell	Approximate average percentage in the blood (%)
neutrophils	60%
Eosinophils	4%
Basophils	1%
lymphocytes	30%
Monocytes	5%

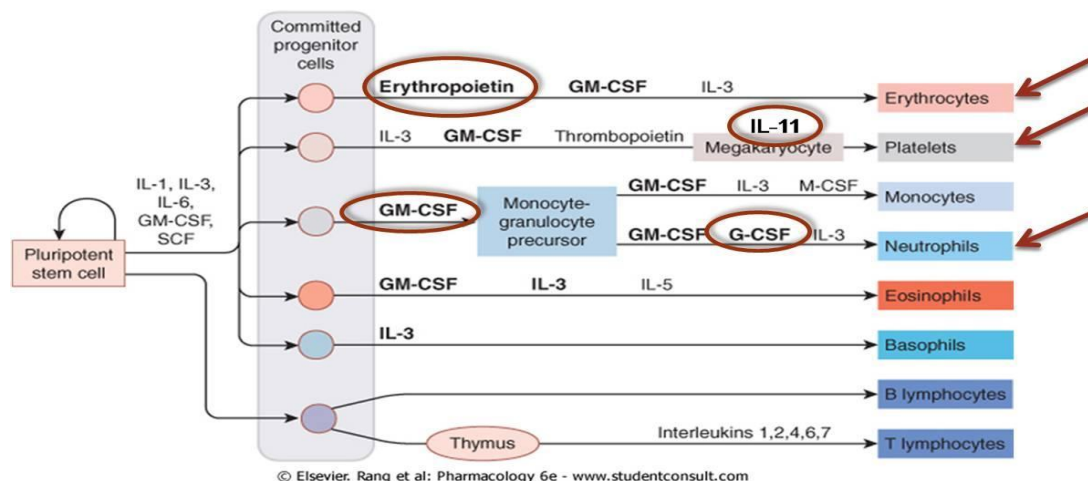
❖ *Note* :-

The measured count of WBC is 50% of the actual number of WBC because the other 50% of WBC are adhering to the inner walls of blood vessels and this adhered part is called **Marginal pool**

Leukopoiesis

- ✓ The leukopoiesis duration is similar to erythropoiesis that lasts about 6 days , But the leukocytes after maturation they remain for some time in the bone marrow before being released in the blood

- All white blood cells are produced in the bone marrow with an exception of lymphocytes which are also produced in the lymphatic tissues (spleen , lymph nodes ...etc)
 - 75 % of cells of the bone marrow are going to produce white blood cells and just 25% are going to produce red blood cells even though that there are over 500 times as many red cells in the circulation as there are white cells !
- ✓ **Leukopoiesis** is a very complicated process, the mother stem cell is affected by more than 5 factors, also in each stage of leukopoiesis there are many factors affecting the cells so there is an overlapping in the actions of these factors; They can affect more than one type of cells, Some types of factors can also affect the production of red blood cells and platelets.



- Note in the figure above that erythropoiesis is affected by GM-CSF and IL-3 factors , so any problem with them the erythropoiesis will be affected

The properties of white blood cells

- They can pass through the walls of blood capillaries to enter the tissues in a process called **diapedesis**
- The ability to move through the tissues in a pattern resembles the motion of Amoeba so it is called **amoeboid motion**
- They can be attracted by certain chemicals released by bacteria or inflamed tissues in a

Process called **chemotaxis**

- The ability to engulf and digest foreign bodies and damaged cells by **phagocytosis**

All leukocytes have these properties but in different degrees

High and low count WBC indications

- In general ; the WBC count is increased in infants
 - Neutrophils increase mainly in bacterial infections
 - Lymphocytes increase mainly in viral infections
 - Monocytes increase in parasitic infections (the doctor said that and I searched for it , monocytes may increase in parasitic infections but mainly the eosinophils are increased)
 - Eosinophils increase in allergic reactions , basophils also increase in allergic reactions but not as much as eosinophils , they also increase in infections (remember that the function of basophils is releasing of chemicals such as heparin and histamine)
- This table summarizes some of the causes of low and high WBC count for each type of cells (I think this table is important)

WBC type	High count indications	Low count indications
Neutrophils	Bacterial infection burns stress inflammation.	Radiation exposure drug toxicity vitamin B12 deficiency and systemic lupus erythematosis (SLE).
Lymphocytes	Viral infections Some leukemias.	Prolonged illness, immunosuppression, and treatment with cortisol.
Monocytes	Viral or fungal infections, tuberculosis, some leukemias, other chronic diseases.	Bone marrow Suppression treatment with cortisol.
Eosinophils	Allergic reactions, parasitic infections, Autoimmune diseases.	Drug toxicity, stress

Basophils	Allergic reactions, leukemias, cancers, stress, hypothyroidism	Pregnancy, ovulation, hyperthyroidism
-----------	--	---------------------------------------

Leukemia

- ✓ Sometimes the increase in the count of WBC is too great which usually indicates a malignant condition of white blood cells called **leukemia**
 - **Leukemia occurs in two forms :**
 - **Acute** : often occurs in children and the symptoms appear suddenly
 - **Chronic** : often occurs in old ages , sometimes the disease develops slowly and silently over a period of 10-20 years
 - **Causes of leukemia :**
 - Exposure to ionizing radiation
 - Genetic factors
 - Some types of chemicals such as benzene
 - Other environmental factors
 - **Symptoms of Leukemia :**
 - Pale skin (pallor)
 - Bleeding tendency
 - Frequent infections
 - Flu-like symptoms : fever , chills and fatigue
 - **Leukemias are divided into two general types :**

1- *Lymphocytic leukemias*

2. *Myelocytic leukemias*

The leukemia cells are bizarre (unusual in appearance) and undifferentiated and not identical with any of the normal white blood cells, Usually the more undifferentiated the cells the more acute is the leukemia, Leukemic cells especially the very undifferentiated are nonfunctional .

Effects of leukemia on the body

The Dr read them literally from the slides

- Metastatic growth of leukemic cells in abnormal areas of the body.
- Almost all leukemias spread to the spleen, the lymph nodes, the liver and vascular regions.
- In each of these areas the rapidly growing cells invade the surrounding tissues, utilizing the metabolic elements of these tissues and consequently causing tissue destruction
- Frequent infections , severe anemia and bleeding tendency caused by thrombocytopenia
- The most important effect of leukemia on the body is the excessive use of metabolic substrates by the growing cancerous cells.
- Tremendous demands are made on the body for foodstuffs, especially the amino acids and vitamins. Consequently, the energy of the patient is greatly depleted, rapid deterioration of the normal protein tissues of the body.

The END

