

Sheet No. **7**



Physiology

Hematolymphatic System



WRITER:

CORRECTOR: Noor Almomani

DOCTOR: Saleem Alkhreisha

Leukocytes

Unlike red blood cells, white blood cells (leukocytes) have a **nucleus**, **do not** contain **hemoglobin** and they are **larger** in size.

WBCs are classified as either granular or agranular, depending on whether they contain conspicuous chemical-filled cytoplasmic vesicles (called granules) that are made visible by staining.

→ (Remember from histology lectures , we classify them according to the presence or absence of **specific granules** in their cytoplasm)

If they have specific granules , they are Granular leukocytes and they include neutrophils, eosinophils, and basophils.

If they don't have specific granules , they are Agranular leukocytes and they include lymphocytes and monocytes.

☞ **Remember : both granulocytes and agranulocytes have non-specific granules .**

■ The normal total white blood cells count ranges from 5,000-10,000/mm³ or 4,000-11,000/mm³.

✚ Low levels of WBCs is termed **leukopenia**.

✚ High level of WBCs is termed **leukocytosis**.

- Healthy individuals might still have a count that is slightly out of the normal range (whether higher or lower).

- **Gender** has no effect on the WBC count, but even in the same individual the count changes physiologically, for example:

1- WBCs count is high in the evening and low in the morning.

2- It increases after meals, exercises, excitement and during pregnancy.

- WBCs move from capillaries to tissues to perform their functions.

☞ **Remember: they reach the tissues by diapedesis**

- WBCs have **short half-lives** ranging from hours (6 hours for neutrophils) to months (like in monocytes) to years (like in lymphocytes)

■ Average WBC count/mm³:

Neutrophils: 5,400 (60%) Eosinophils: 275 (4%) Basophils: 35 (1%)

Lymphocytes: 2750 (30%) Monocytes: 540 (5%)

📌 In general neutrophils are the most abundant followed by Lymphocytes then monocytes, eosinophils and finally basophils.

☞ Remember : **Never Let Monkeys Eat your Banana** 😊

📌 The leukocytes that we can count and can be detected (4000-11000) make up only 50% of the total number of leukocytes , as the remainder adhere to the inner surfaces of the blood vessels. These adhering leukocytes are referred to as the **marginal pool** and they are **only** released in some conditions like hemorrhage or lysis of WBCs (**We can't detect them in normal cases**).

📌 **Leukopoiesis** : is the production of white blood cells (Leukocytes)

-The duration required for the production of WBCs via leukopoiesis is **6 days**, which is the same amount of time needed for the production of RBCs, but WBCs remain in the bone marrow **for 6 more days** after they're produced so that they can be "computerized" and activated to do their functions before being released to the circulation.

-WBCs are only produced in the bone marrow, **except the lymphocytes**, which are produced and mature in both the bone marrow and thymus. Therefore, if there's a problem in the bone marrow all WBCs will significantly decrease except lymphocytes (they will decrease but not as much as other WBCs)

-All WBCs have enzymes to kill foreign bodies. However, **basophils have extra chemicals such as: Heparin, Histamine and Serotonin.**

-Normally 75% of the bone marrow cells are **WBC-producing myeloid cells** and only 25% are maturing red cells .

Clarification :RBCs are more evident than WBCs **in the circulation** , but in **bone marrow** we will see that WBC- producing myeloid cells are much more than maturing red blood cells , this indicates that the average life span of WBCs is short compared to that of RBCs so the bone marrow will continuously be active to produce WBC !!

For more more clarification , see the slide below from histology lectures 🤖

How many RBCs are in 1 ul of peripheral blood?

5 million/ul

How many WBCs are in 1 ul of peripheral blood?

4500-11000/ul

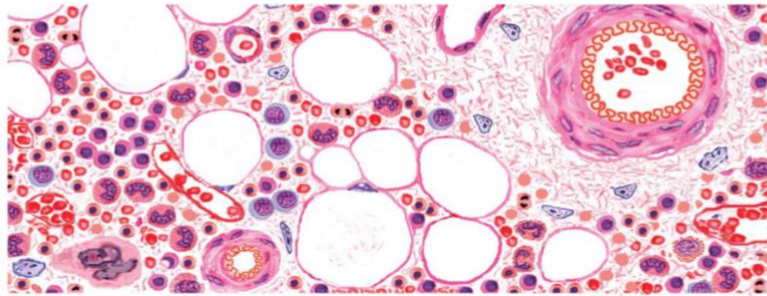
But in the bone marrow (myeloid tissue)!!!

Myeloid: Erythroid

3:1

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Remember the life span!!!!



Dr. Heba Kalbounh

*The process of **leukopoiesis** is the most complicated process in the body because:

1-There are many factors involved in the production of WBCs.

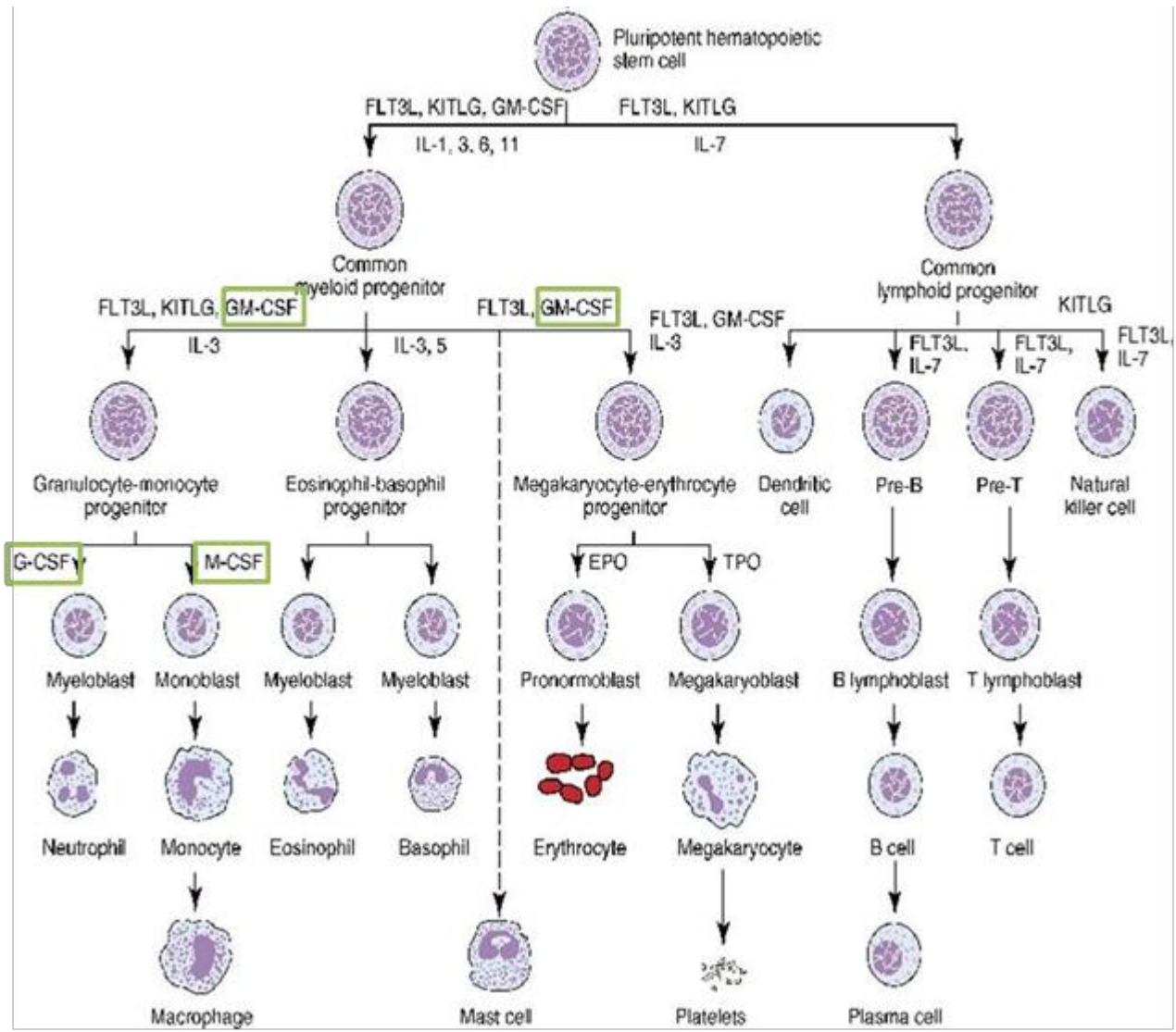
These factors include: IL-1, IL-3, IL-6, and CSFs (colony stimulating factors)

(Colony stimulating factors are called like that because if you add any of them to a stem cell in the lab you'll find many cells produced (colony))

2-Each one of these factors is produced by many sources.

3-There is an overlap between factors, and each factor affects more than one cell lineage as you can see in the figure below.

4-The process has many stages, and in each stage many cell types are produced.



Test yourself

1) Lymphocytes , choose the correct statement :

- a- Are produced only in the BM
- b- Are the most abundant type of leukocytes
- c- Are granular leukocytes
- d- Are produced only in the lymphoid tissue
- e- Are produced in the bone marrow&lymphoid tissue

Answer: e

2) If there is a problem in the BM , you expect to see low counts of all leukocytes except :

a- neutrophils

b-basophils

c- lymphocytes

d- monocytes

Answer : C

3) Leukopenia is :

a- decrease in WBCs

b- increase in WBCs

C- increase in lymphocytes

d- in change in WBCs

Answer : A