This lecture was done by 432 Physiology Team

4/11

White blood cells

432 ***Hematology*** *Team*

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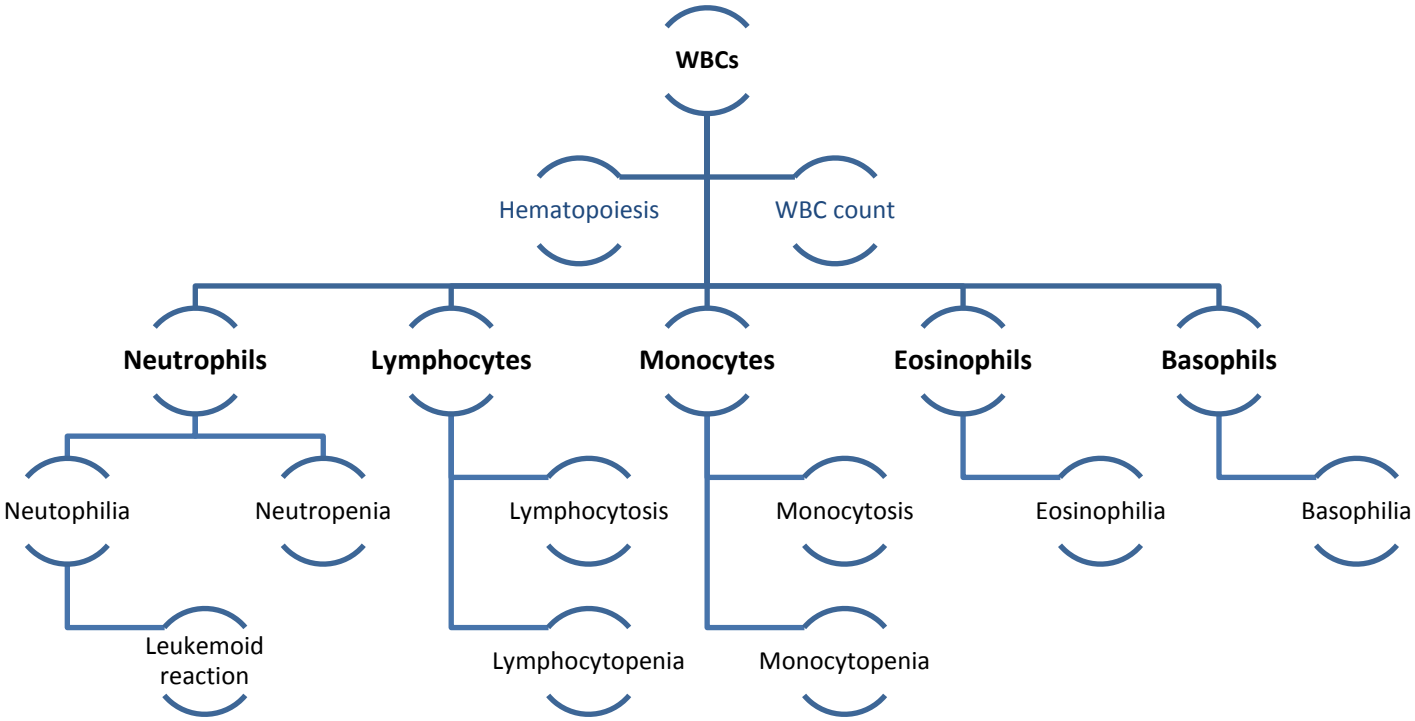
Reviewed By: Ibrahim *Abunohaiah*

Color Index: Female notes are in Green. Male notes are in Blue. Red is important. Orange is explanation.

White blood cells

Mind Map:

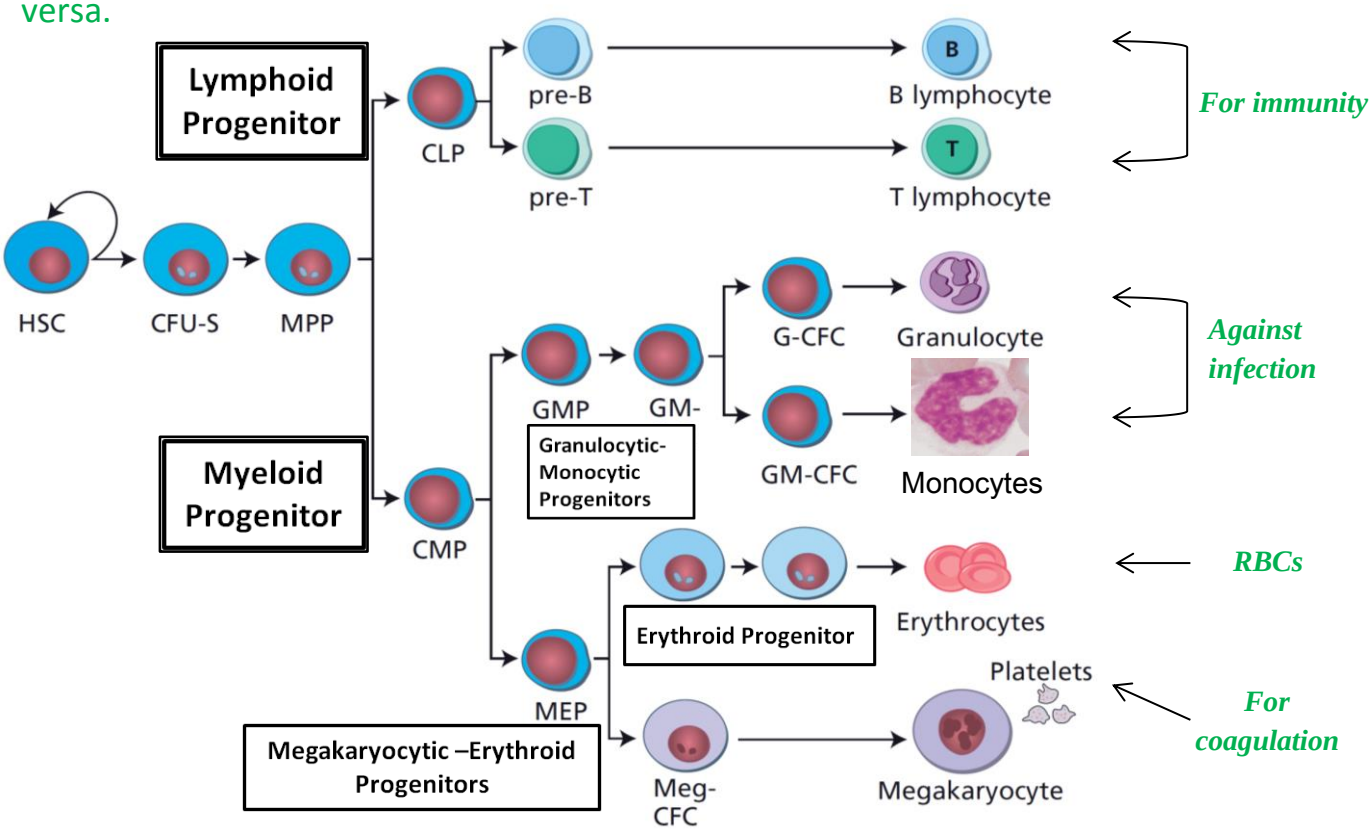


White blood cells

Hematopoiesis

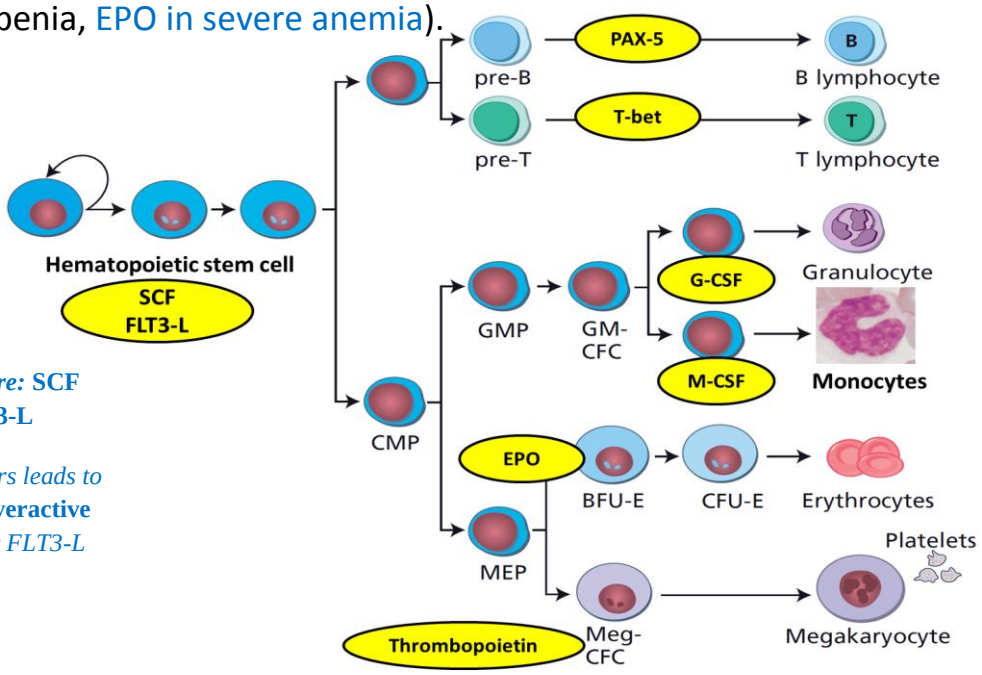
Haemopoietic stem cells (HSCs) are the foundation of the adult blood system and sustain the lifelong production of all blood lineages.

The haemopoetic stem cell (mother): differentiates to give another type of cells and proliferates. If proliferate without differentiation it will cause a disease and vice versa.



Hematopoietic growth factors:

- Hormones that **regulate the proliferation and differentiation of HSC.**
- Can be administered clinically to stimulate the hematopoiesis (G-CSF in severe neutropenia, EPO in severe anemia).



Most important factors are: **SCF** *(Stem cell factor)* **& FLT3-L**

Deficiency *in these factors leads to* **aplastic anemia**, *while* **overactive** *of these factors especially FLT3-L will lead to* **Leukemia**.

NOTE:

- **EPO: erythropoiten hormone.**
- **G-CSF: granulocyte colony stimulating factor. Artificially given as an IV injection for patients who have neutropenia.**

REMEMBER:

- WBCs are important for immunity and as a defensive mechanism against infection.

WBC count (normal range):

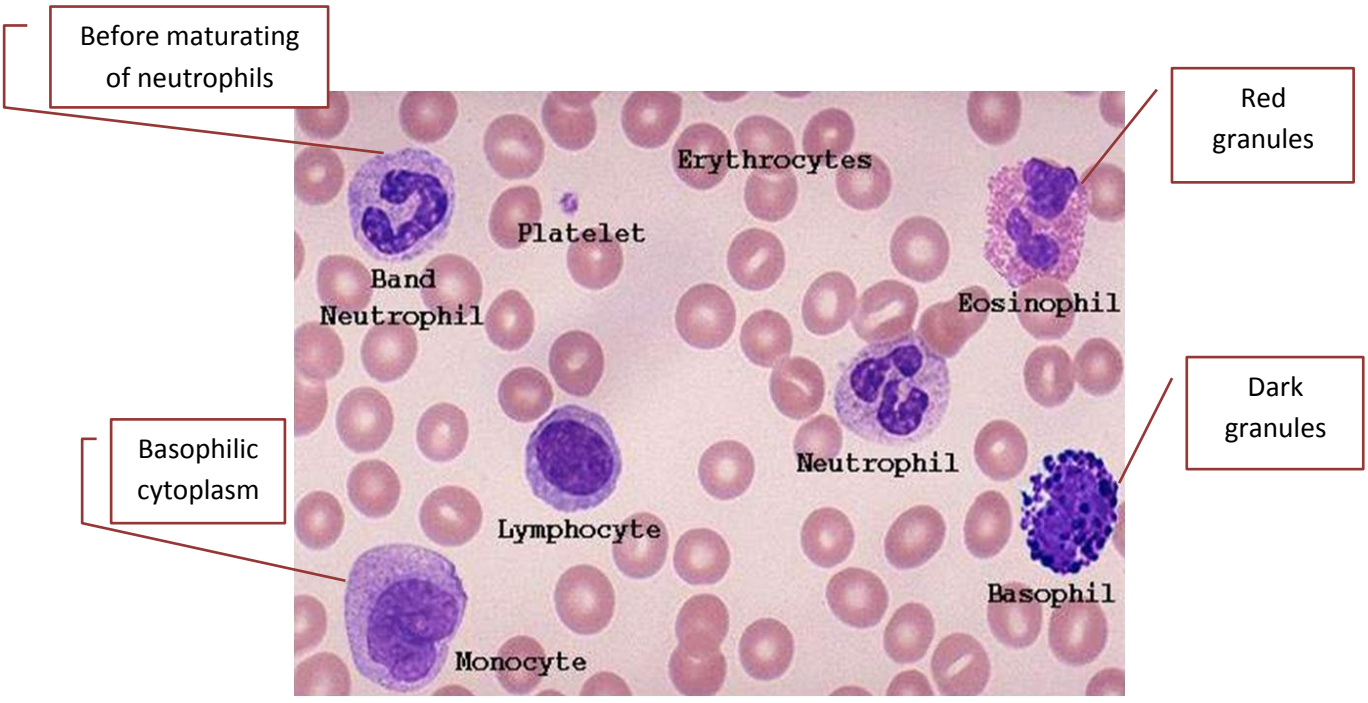
WBC count: **4-11 x 10^9/L**

Leukocytosis: Increased WBC count above normal range

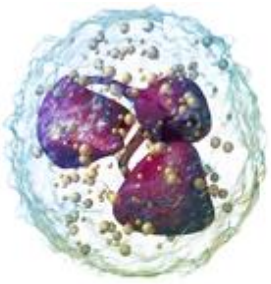
Leukocytopenia: decreased WBC count below normal range

Remember these only

Cells	Differential count %	Absolute count (x10^9/L)
Neutrophils	50-70	1.5-6.5
Lymphocyte	20-44	1.2-3.4
Monocytes	2-9	0.1-0.6
Bands	0-6	0-0.7
Eosinophils	0-5	0-0.5
Basophils	0-2	0-0.2



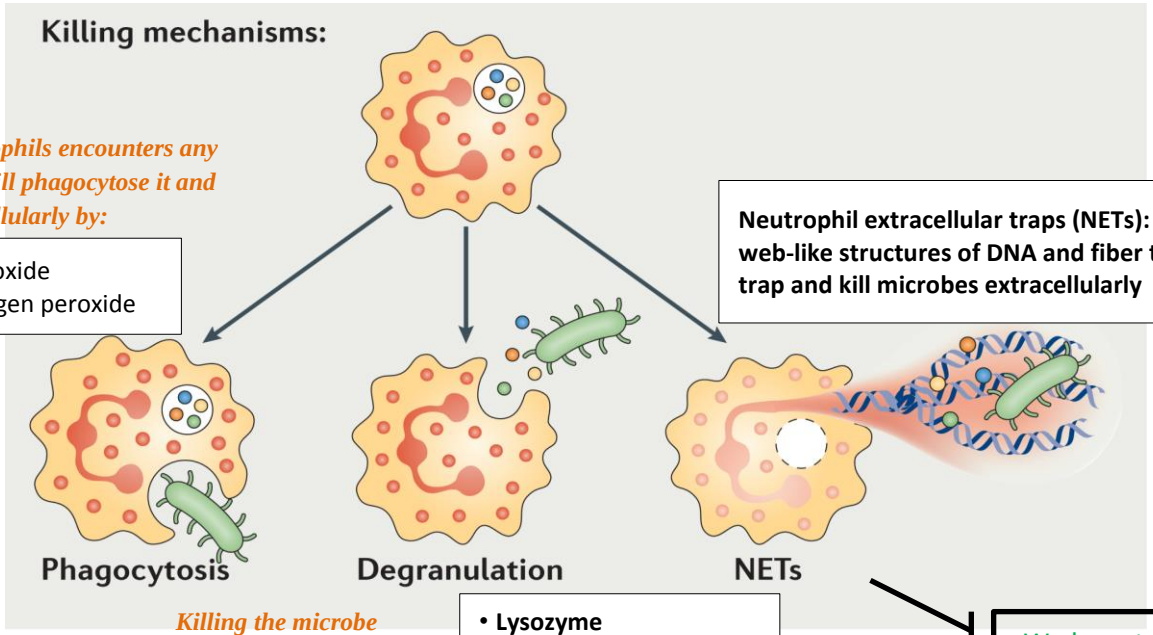
Neutrophils



Neutrophil

- **Phagocytic cell** contain a nucleus divided into **2–5 lobes** (this is why we call it polymorphic) if more or less indicates a disease with pale granulated cytoplasm.
- Stain a neutral pink (Basophils dark blue while eosinophil is bright red).
- They are short lived (≈6 days) and highly motile.

Chemotaxis: Migration toward sites of infection or inflammation through detection of IL-8, TNF γ & C5a. Killing foreign bodies



1-Neutrophilia: is increase in neutrophil count (more than 1.5 – 6.5 $x10^9/L$)

- **Causes:**

1-Benign:	2-Malignant:
- Bacterial infection (Pyogenic).	- Chronic Myeloid leukemia.
- Inflammation and tissue necrosis.	- Polycythemia vera, Essential Thrombocythemia.
- Acute hemorrage or hemolysis.	- Chronic Myelomonocytic Leukemia.
- Steroid therapy (inhibits margination as a side effect).	- Non hematological neoplasm. (other solid tumors)
- G-CSF treatment.	
- Rare inherited disorders.	
- Asplenia. No spleen	

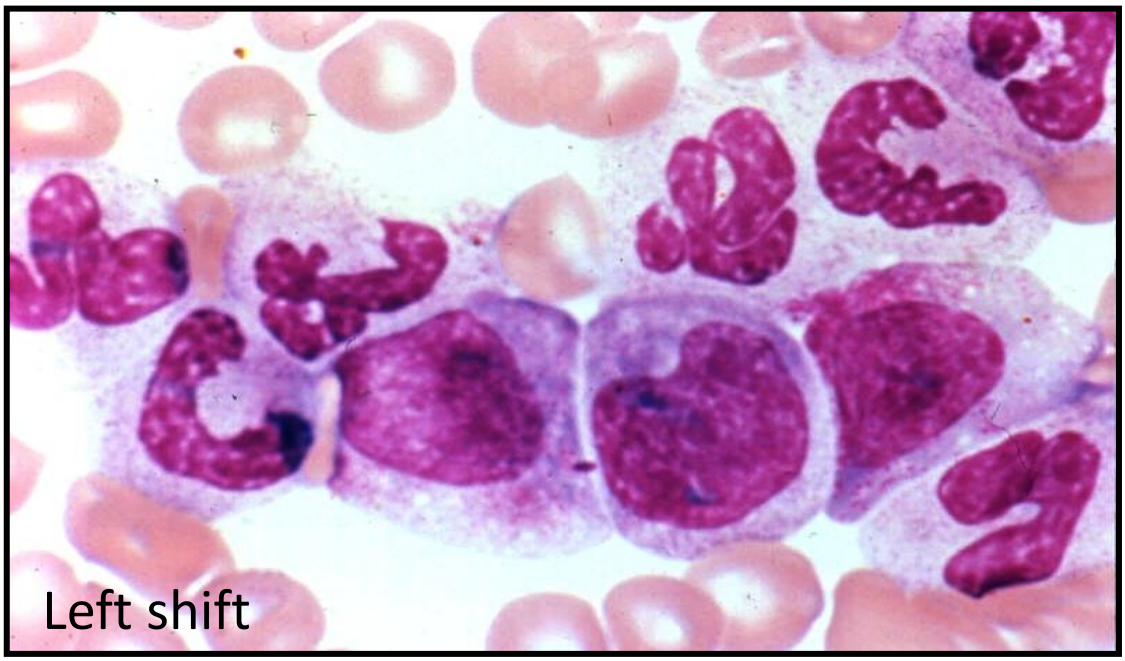
- Leukemoid reaction:

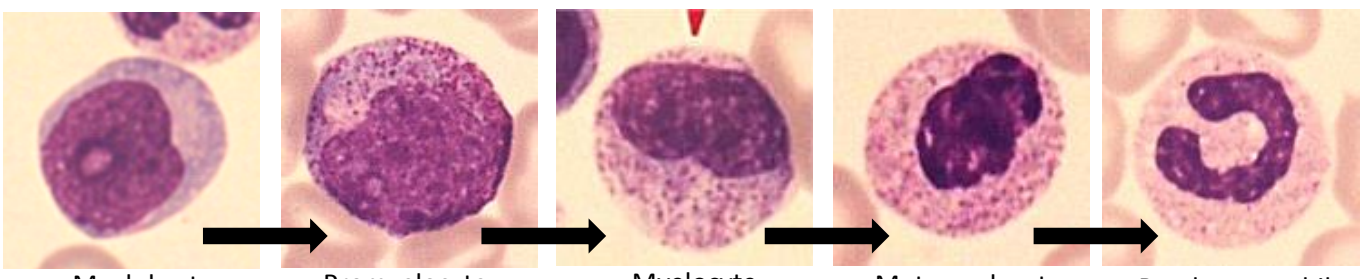
Leukocytosis = increase WBCs (mainly neutrophilia with left shift) due to physiological response to stress or infection.

Left shift = increased numbers of less mature cells (precursors) released from the bone marrow to the peripheral blood.

Common with: sever or chronic infection, sever hemolysis & metastatic cancers.
Increase WBCs count + left sift = sign of infection.
Associated with:

(1) Toxic granulation (increase granulation).
(2) Vaculation (it is the appearance of phagocytiosed microbes).
(3) Döhle bodies (pale round to linear blue aggregates in the cytoplasm, caused by whorls of rough endoplasmic reticulum).





2- Neutropenia:

Lower limit of normal is: $1.5 \times 10^9/L$

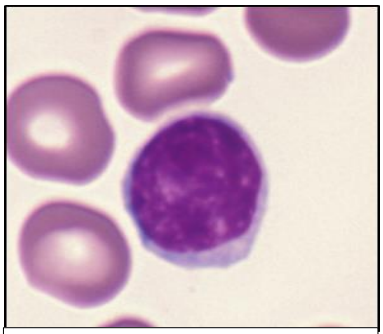
Sever neutropenia: $\leq 0.5 \times 10^9/L$

Selective neutropenia	Part of general pancytopenia (decrease the number of all hematopoietic cells)
- Congenital: • Kostmann syndrome • Benign neutropenia • Cyclical neutropenia - Drug induced - Autoimmune (SLE) - Viral infection (hepatitis, HIV) - Some Bacterial infections(Typhoid)	- Bone marrow failure. - Chemotherapy. - Acute Leukemia. - Lymphoma. - Metastatic carcinoma.

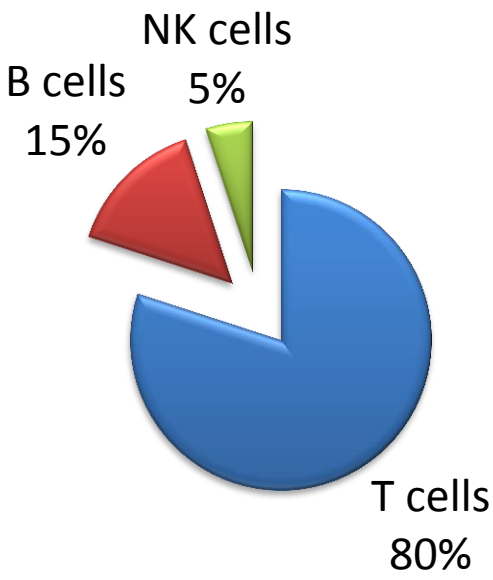
Lymphocytes:

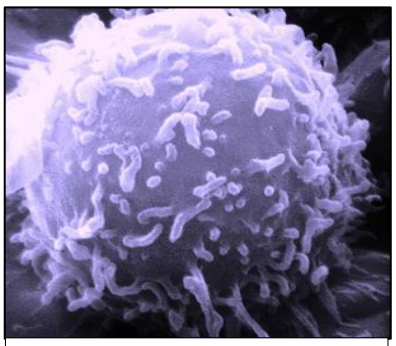
Lymphocytes are small WBCs having spherical nucleus surrounded by a thin layer of non-granular cytoplasm. Similar to RBCs

It has fundamental importance in the immune system (Innate & Adaptive).



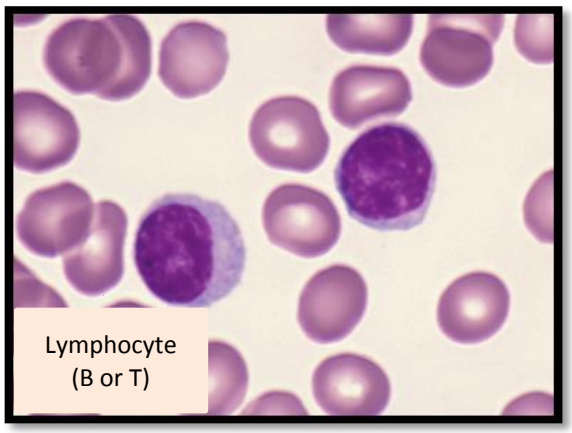
Same size as RBCs

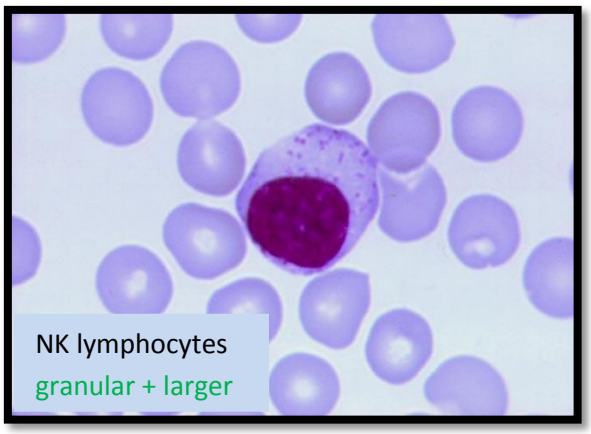


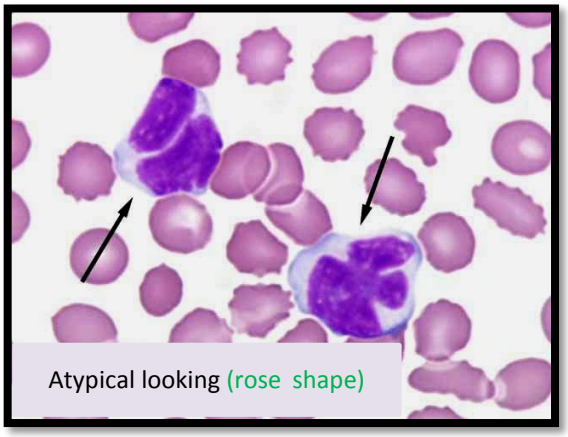


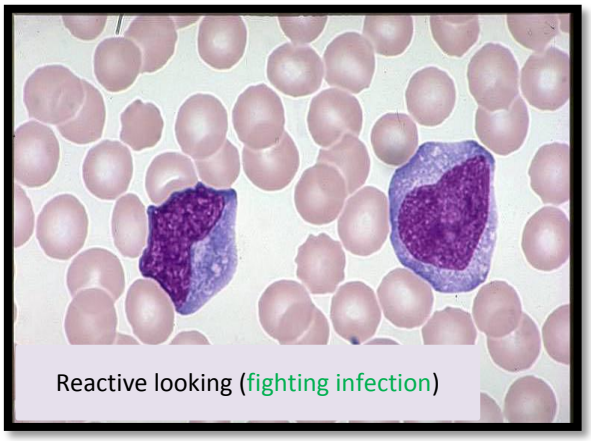
EM of Lymphocyte

NK = natural killer
(NK cells involved in innate immune system along with any phagocytic cells, neutrophils, eosinophils)

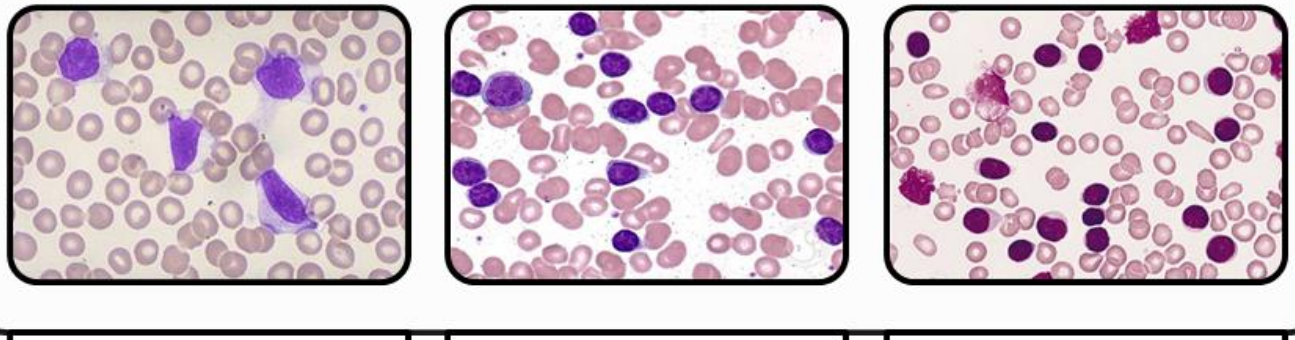








1-Lymphocytosis:



1- Viral infection :**Infectious mononucleosis** cytomegalovirus ,rubella, hepatitis, adenoviruses, varicella.

2- Some bacterial infection:

(Pertussis ,brucellosis)

3- Other conditions: Allergic drug reactions, splenectomy, dermatitis ,hyperthyroidism metastatic carcinoma

4- **Chronic lymphocytic leukemia (CLL)**

5-Other lymphomas:

Mantle cell lymphoma ,Hodgkin lymphoma

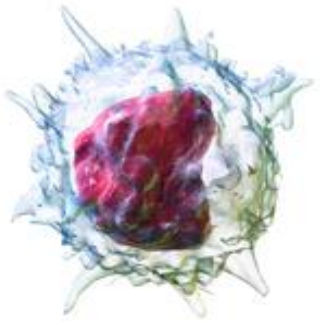
2-Lymphocytopenia (or Lymphopenia):

Selective Lymphocytopenia	Part of general pancytopenia
- Bacterial or fungal sepsis. - Post-operative state. - Post steroid therapy. - Immunodeficiency (congenital or acquired). - Autoimmune disorders (SLE).	- Bone marrow failure. - Chemotherapy or radiotherapy. - Acute Leukemia. - Lymphoma. - Metastatic carcinoma.

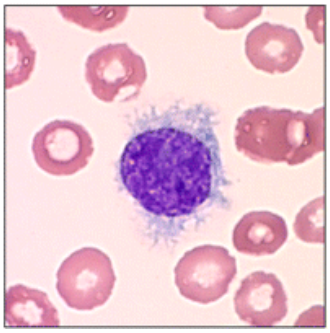
Effect of steroid therapy:
On Neutrophils it will cause ***Neutrophilia,*** but here in Lymphocytes it will cause ***Lymphopenia.*** **Why?**
Because steroid melts the lymphocytes, hence it is part of all chemotherapy regiments in Lymphoma.

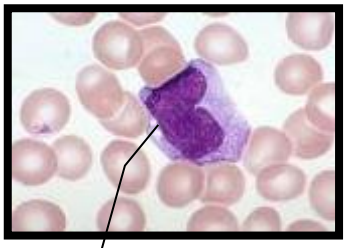
Monocytes:

- Large, phagocytic WBC, having a single well-defined nucleus and very fine granulation in the cytoplasm.
- Represents about 2-9% of WBC.
- Matures into different types of macrophages at different anatomical locations (skin, spleen, liver).



Monocyte

1-Monocytosis	2-Monocytopenia
• **Chronic infection: (TB, Brucellosis)** • Autoimmune: SLE.. • Chronic neutropenia • **Acute leukemia (AML M5)** • **Chronic Myelomonocytic leukemia**	• Selective monocytopenia: • **Hairy cell leukemia** 

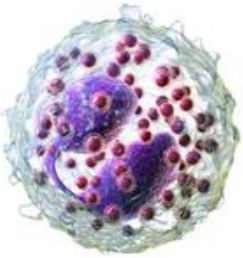


Normal vaculation

REMEMBER:

- The most important cause of monocytosis is **Acute leukemia (AML M5)** the number is very important, other causes are: Chronic infection: (TB, Brucellosis), Chronic Myelomonocytic leukemia.
- The most important cause of Monocytopenia is **Hairy cell leukemia.**

Eosinophil:

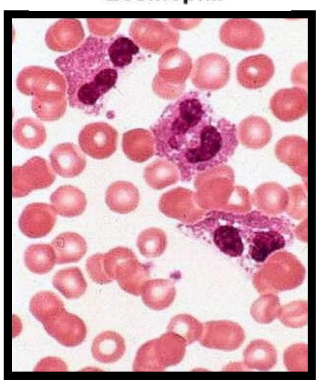


- Granular leukocyte having a nucleus with two lobes (2 to 3 lobes are normal) and cytoplasm containing bright red coarse and round granules.

Major functions:

1- **Anti-Parasitic** and bactericidal activity.
2- Participating in immediate **allergic** reactions.
3- Modulating inflammatory responses.

Eosinophil



Eosinophilia:

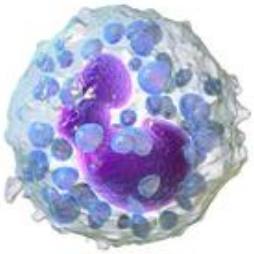
Causes: C H I N A

- **C**onnective tissue diseases.
- **H**elminthic parasitic infections.
- Idiopathic (most important cause): **Hypereosinophilic syndrome**.
- **N**eoplasia: eosinophilic leukaemia, lymphoma or **MPN (Myelo proliferative neoplasm).**
- **A**llergy.

REMEMBER:

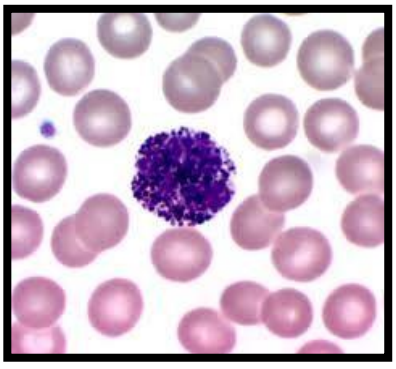
- Major functions of eosinophils are: **Antiparasitic** and participating in immediate **allergic** reactions.
- 3 important causes of eosinophilia are: Idiopathic (Hypereosinophilic syndrome), eosinophilic leukaemia and **MPN (Myelo proliferative neoplasm).**

Basophil:



- Phagocytic leukocyte of characterized by numerous coarse **bluish-black granules** of variable size (it appears bluish due to the presence of heparin and histamine).
- Mature to tissue mast cells.

Basophil



Functions of Basophils:

- Major role in immediate allergic reaction (IgE).
- Anticoagulant activity **(Heparin)**.
- Vasodilatation **(Histamine)**.

Basophilia (very dangerous):

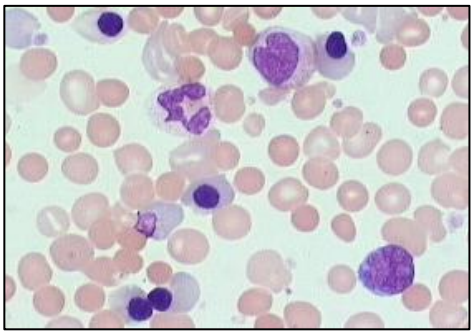
Causes:

1- **Neoplasia (CML (chronic myeloid leukemia))**, mastocytosis, basophilic leukaemia, MPN).
2- Hypothyroidism.
3- Some viral infections (Chickenpox).
4- Inflammatory conditions.
5- Drugs (IL3, oestrogen).
6- Hyperlipidaemia.

REMEMBER:
- Basophil contains **(Heparin)** and **(Histamine)**.
- The most important cause is Neoplasia especially (CML chronic myeloid leukemia)

Leukoerythroblastic Picture:

Bone marrow response in which nucleated red blood cells and immature leukocytes are released in the blood.



Causes:

- Metastatic neoplasm
- Primary Myelofibrosis
- Severe hemolysis (Thalassemia major)
- Severe infection (Miliary TB)

Summary

- Main function of white blood cells is immunity and defensive mechanism against infections
- Hematopoiesis is the production of all blood lineages by differentiating and proliferating and it is under the control of hematopoietic growth factors.
- Neutrophils contain 2-5 lobes. They are short lived and highly motile.
- Main function of neutrophils is killing foreign bodies (chemotaxis) by 3 pathways; phagocytosis, degranulation and NETs
- Neutrophilia is increase in neutrophils count. Most important cause is chronic myeloid leukemia
- Neutropenia is decrease in neutrophil count. Mainly congenital such as Kostmann syndrome, benign neutropenia and cyclical neutropenia.
- Lymphocytes are important for the immune system.
- The most important cause of lymphocytosis is chronic lymphoid leukemia
- Monocytes are large, phagocytic WBC, having single nucleus. Matures to give macrophages
- Monocytosis is caused by TB, acute leukemia and chronic myelomonocytic leukemia. While monocytopenia is caused by hairy cell leukemia
- Major functions of eosinophils are antiparsitic activity and participation allergic reactions
- 3 important causes of eosinophilia are: Idiopathic, eosinophilic leukemia and MPN (Myelo proliferative neoplasm).
- Basophil contains (Heparin) and (Histamine).
- The most important cause of basophilia is neoplasia especially (CML chronic myeloid leukemia)

Questions

1/ how many lobes that neutrophils contain?

A- 4

B- 6

C- 8

2/ which one of the following neoplasms causes Neutrophilia?

A- Colon cancer

B- Chronic myeloid leukemia

C- Prostate cancer

3/ which one of the following is a cause of Lymphocytosis?

A- Chronic lymphocytic leukemia

B- Chronic myeloid leukemia

C- Steroids

4/ which one of the following is a cause of Monocytosis?

A- AML M3

B- MPN (Myelo proliferative neoplasm).

C- Hairy cell leukemia

D- AML M5

5/ 5 years boy came to ER Suffering from a severe asthma which one of the following cells will be increased?

A- Monocytes

B- Eosinophils

C- Lymphocytes

D- Band neutrophils

Answers:

- 1- A
- 2- B
- 3 -A
- 4- D
- 5- B

اللهم إني استودعك ما قرأت و ما حفظت و ما تعلمت فرده عليَ عند حاجتي إليه انك على كل شيء قدير

If there is any mistake or feedback please contact us on: 432PathologyTeam@gmail.com