Medical Biology

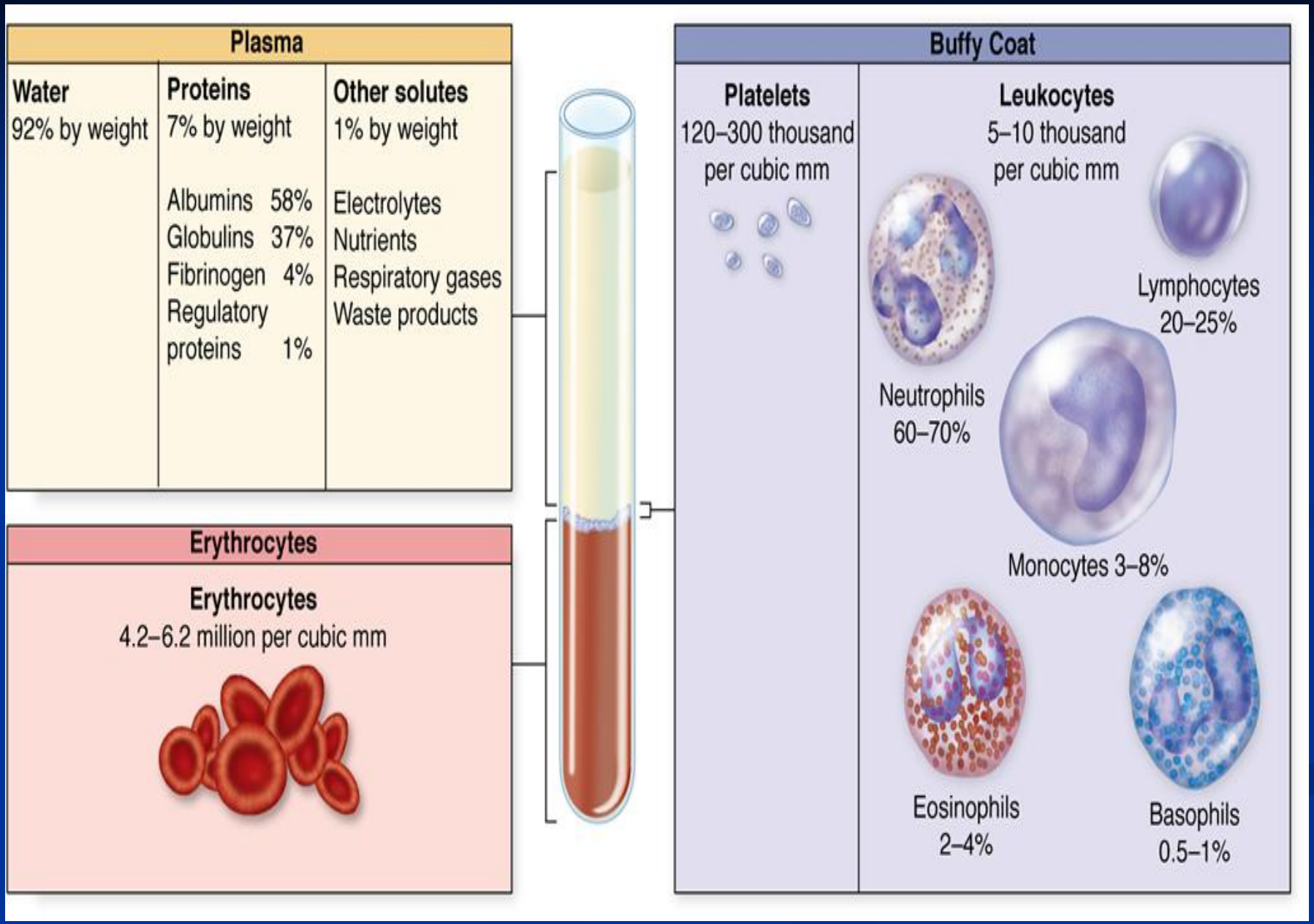
Blood

- Blood is a fluid connective tissue consisting of cells suspended in a liquid fibrous matrix. The cells are called formed elements, and the liquid matrix is known as plasma. The formed elements consist of erythrocytes (red blood cells), leukocytes (white blood cells) and platelets.
- If blood is centrifuged, it divides into 3 portions:

(1) Plasma makes up roughly 55% (upper layer).

(2) Packed RBCs make up roughly 45% (lower layer).

(3) the buffy layer (containing WBCs and platelets) makes up <1% (middle layer).


Plasma
Water
92% by weight
Proteins
7% by weight
Albumins 58%
Globulins 37%
Fibrinogen 4%
Regulatory proteins 1%
Other solutes
1% by weight
Electrolytes
Nutrients
Respiratory gases
Waste products
Erythrocytes
Erythrocytes
4.2–6.2 million per cubic mm
Buffy Coat
Platelets
120–300 thousand per cubic mm
Leukocytes
5–10 thousand per cubic mm
Neutrophils
60–70%
Lymphocytes
20–25%
Monocytes 3–8%
Eosinophils
2–4%
Basophils
0.5–1%

- The % of blood consisting of packed RBCs is known as the haematocrit.
- Blood's colour ranges from scarlet (oxygen-rich) to dark red (oxygen poor).
- Its viscosity is 5X that of water, due primarily to the presence of formed elements.
- Blood pH normally ranges from 7.35-7.45 (slightly alkaline).
- Blood temperature is typically 100°F.
- Typical blood volume is 4-5 L for females and 5-6 L for males.

Blood functions:

- Blood has 3 main distribution functions:
- Blood has 3 main regulatory functions:
- Blood has 2 main protective functions:

Plasma:

- It is the straw-colour liquid part of blood. Blood plasma is about 55% of blood volume. 90% of plasma is water. Water acts as a solvent and suspending medium. Solutes dissolved in plasma include plasma proteins, nutrients, electrolytes, respiratory gases, hormones and wastes.

- Albumin
- Alpha, beta & gamma globulins
- Fibrinogen

Blood cells:

The blood has 3 major formed elements:

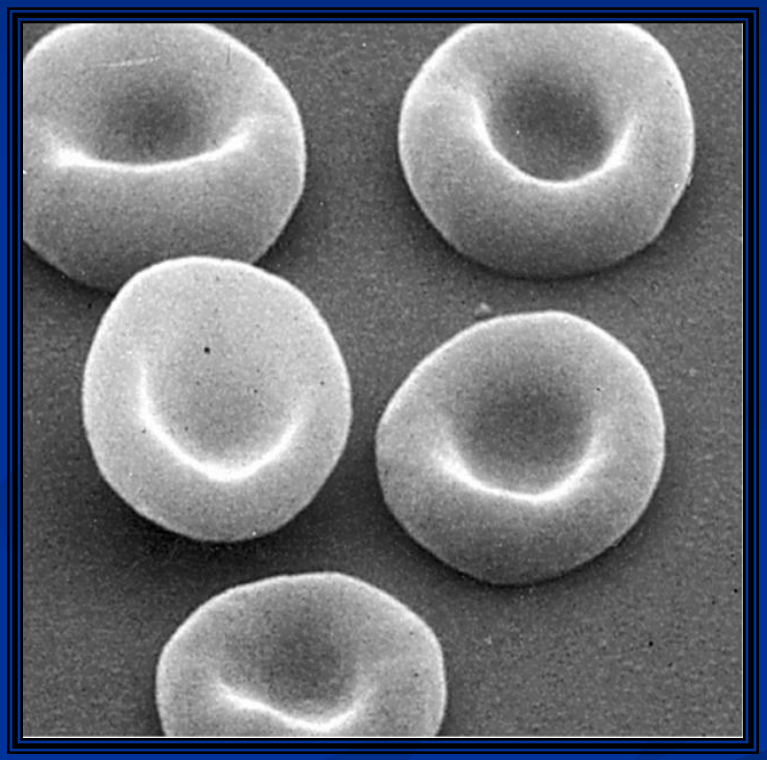
- Erythrocytes (RBC):
- Leukocytes (WBC):
- Thrombocytes (platelets):

Erythrocytes:

- These are rounded biconcave disks, bright red in color due to the presence of hemoglobin.

- their biconcave shape will maximize their surface area/ volume ratio so facilitate the gaseous exchange.

- RBCs are about 7.5 μm. in diameter, those RBCs with a diameter more then 9 μm. are called Macrocytes, while those with a diameter less then 6μm. are called Microcytes.



- RBC count in adult female is about 3.9-5.5 million/microliter, while in adult male it is about 4.1-6 million/microliter.

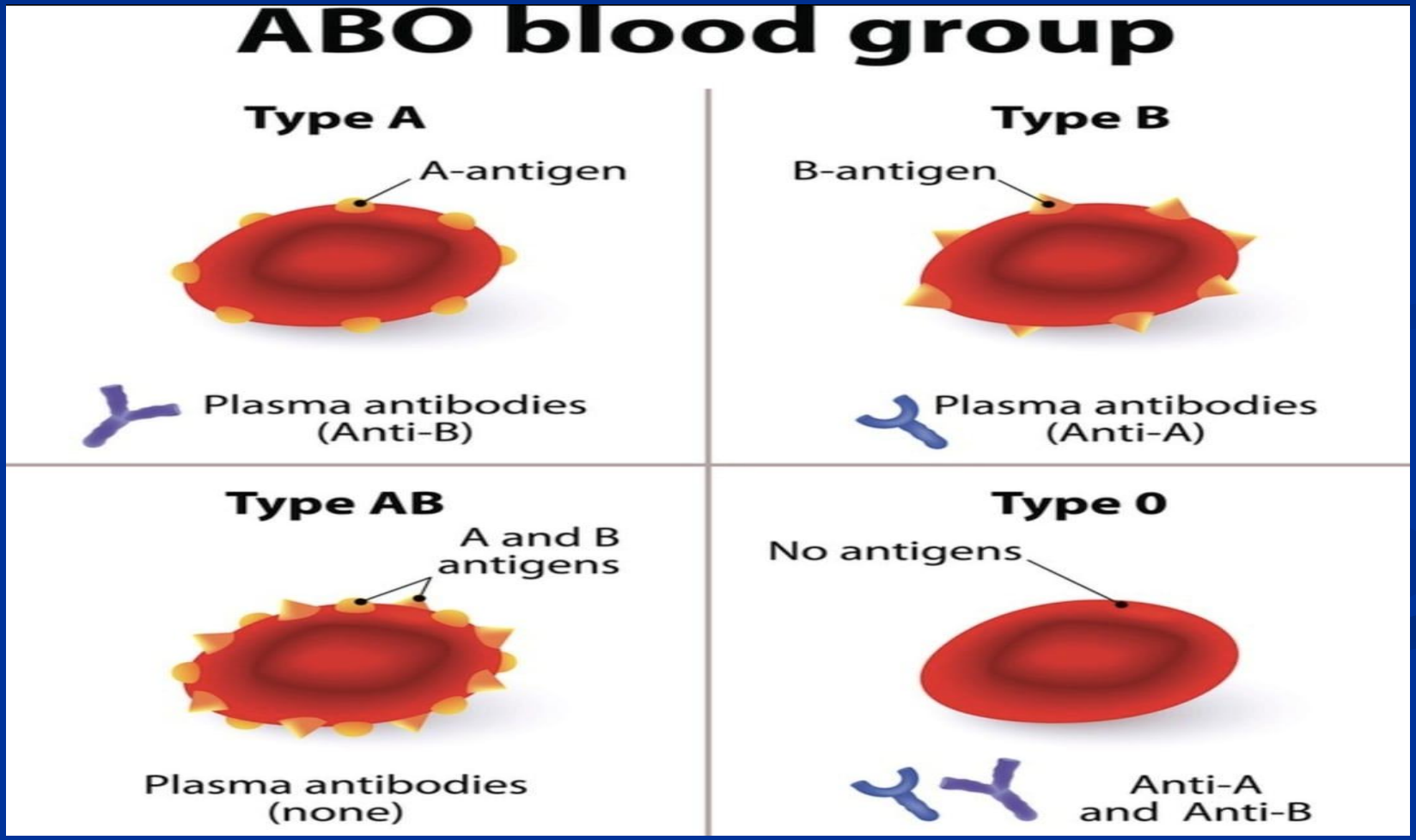
- Hemoglobin (iron containing protein) is contained in abundance within RBCs
- Oxyhemoglobin
- deoxyhemoglobin
- carbaminohemoglobin

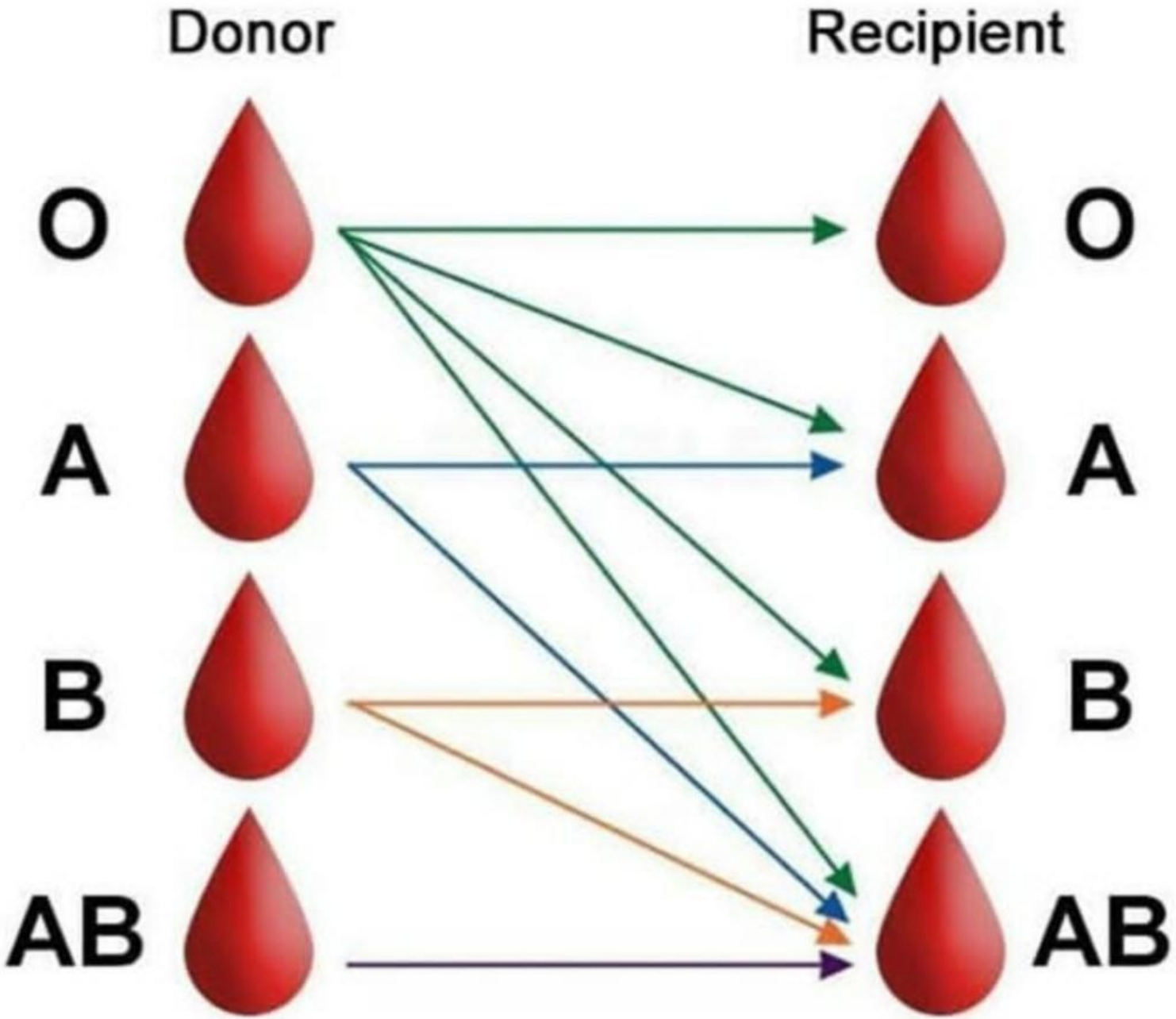
- RBCs have no nuclei as they are lost during the process of formation.

- These cells are highly flexible (deformable) so they can pass through the irregular and smallest capillaries.

- RBCs have a short life span of only 100-120 days in the circulation, with aging RBCs become less deformable until they cannot pass through the splenic microcirculation and so they will be removed by phagocytosis.

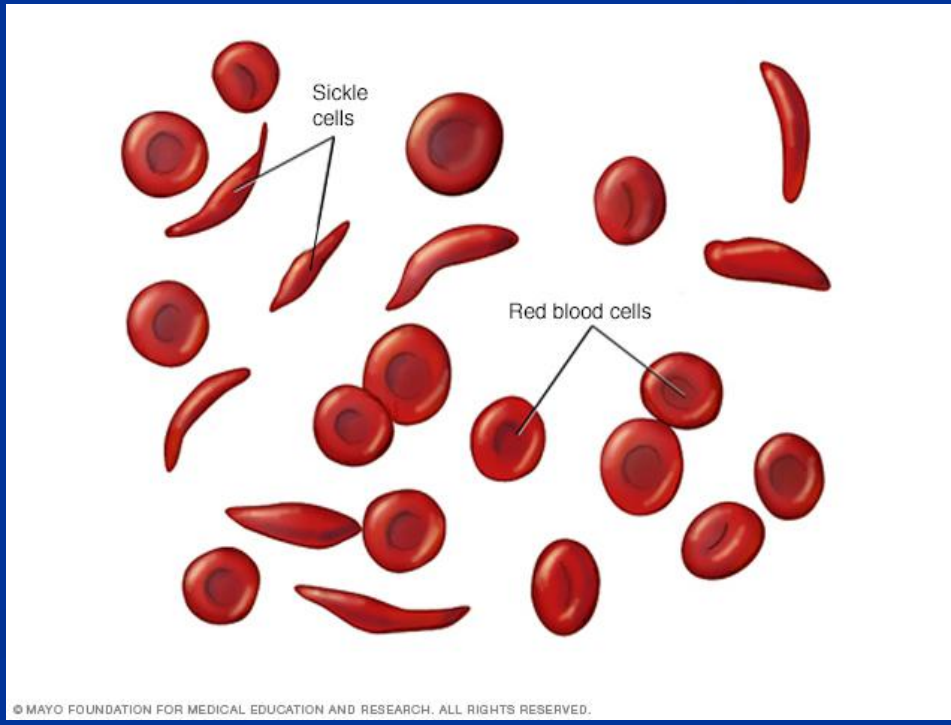
- The extracellular surface of the RBC plasmalemma have specific inherited antigens, and thus determine the blood group. The most notable of these are the A and B antigens, which determine the 4 blood groups, A, B, AB, and O.




Donor
Recipient
O
A
B
AB
O
A
B
AB

Disorders Involving Red Blood Cells

- **Anemia**
- *Iron-deficiency anemia*
- *pernicious anemia*
- *Folic-acid-deficiency anemia*
- *Autoimmune hemolytic anemia*
- *Sickle-cell anemia*

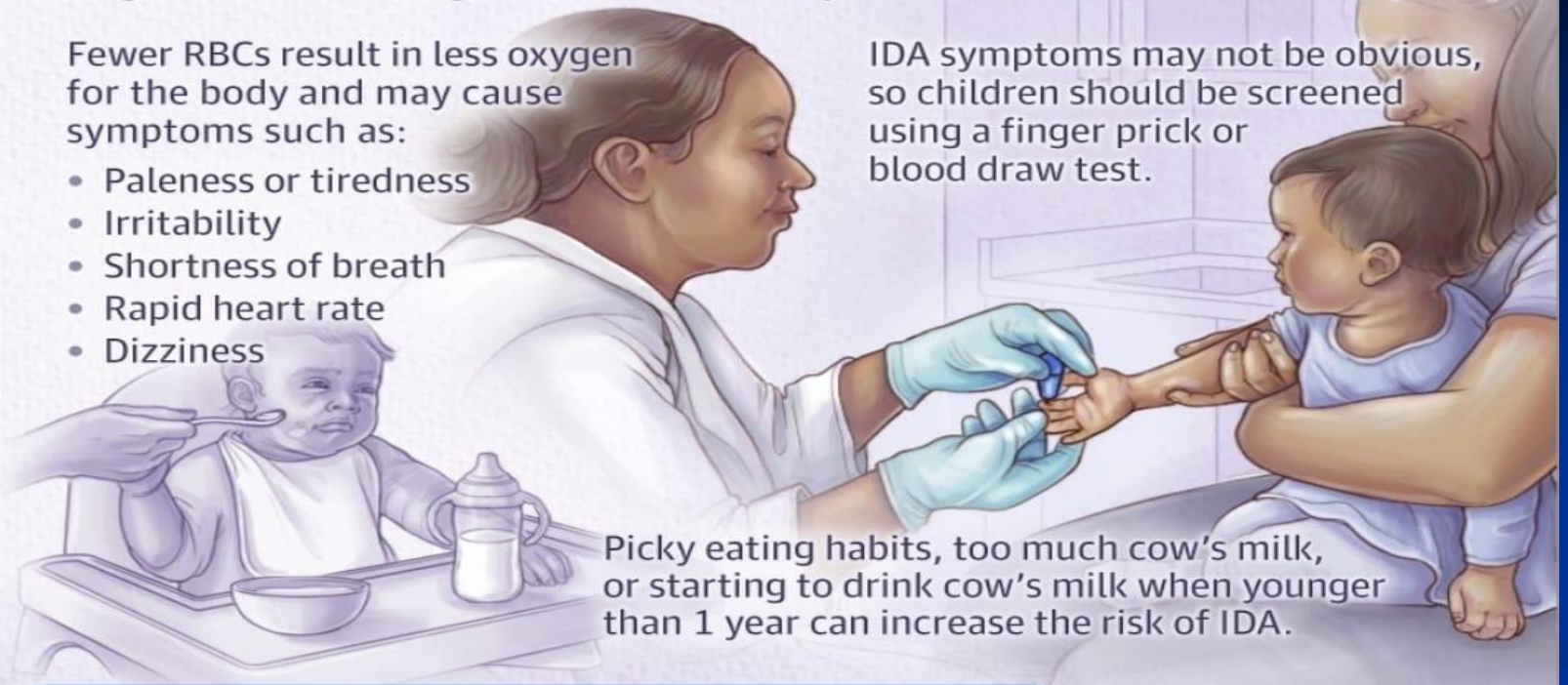


Iron-deficiency anemia (IDA) can occur in children when they do not eat enough foods containing iron, which the body needs to make red blood cells (RBCs).

Fewer RBCs result in less oxygen for the body and may cause symptoms such as:

- Paleness or tiredness
- Irritability
- Shortness of breath
- Rapid heart rate
- Dizziness

IDA symptoms may not be obvious, so children should be screened using a finger prick or blood draw test.



Picky eating habits, too much cow's milk, or starting to drink cow's milk when younger than 1 year can increase the risk of IDA.

Iron-rich foods in a child's diet can help prevent IDA.

L. Kethu

Meat, poultry, and fish

Dark-green leafy vegetables

Chickpeas, lentils, and white beans

Fortified grain products

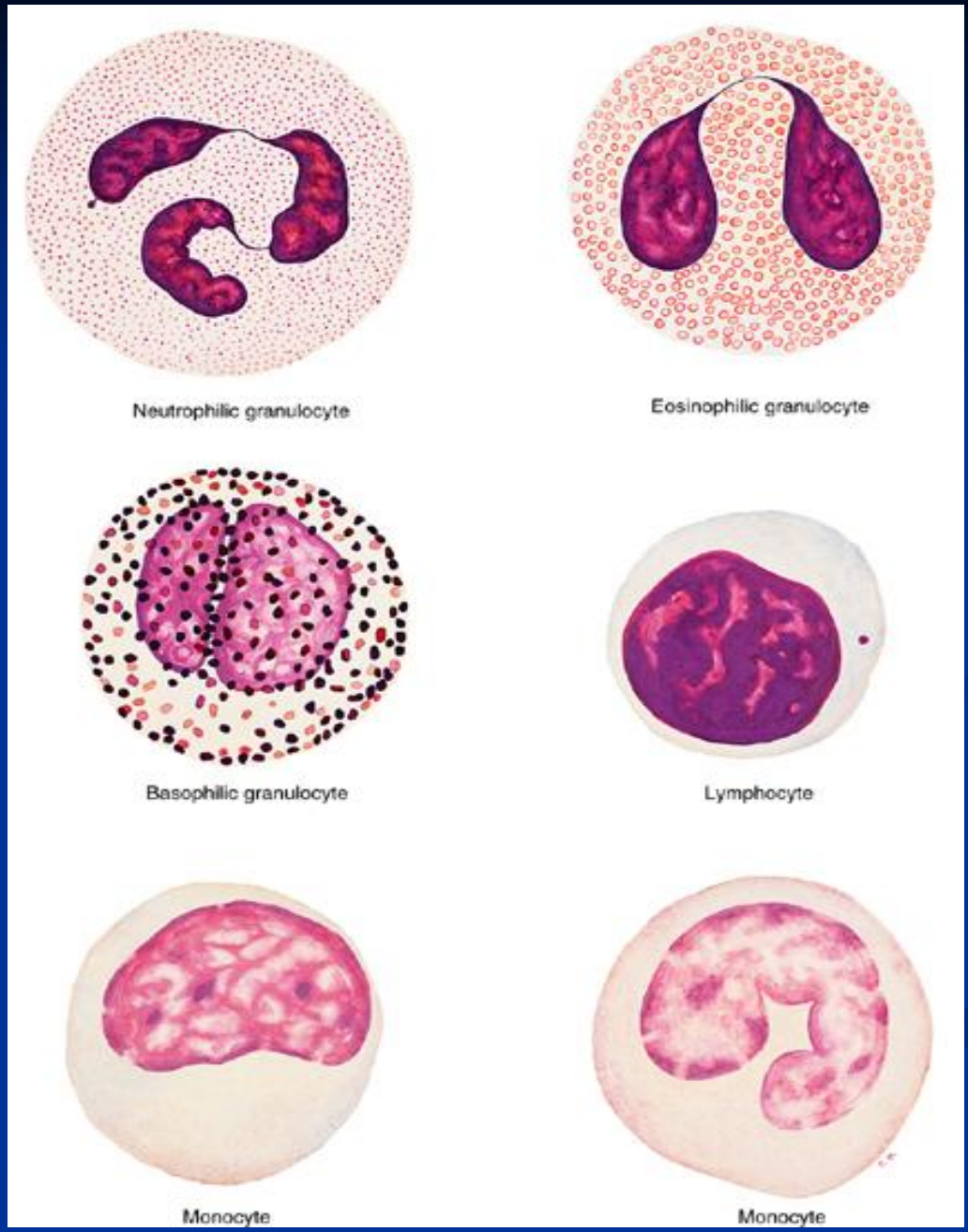
Citrus fruits and certain vegetables containing vitamin C help the body absorb iron from other foods

Iron supplements can be prescribed when a child still needs more iron.

Leukocytes:

- Those are spherical cells that circulate in the blood until they migrate to the tissues.
- According to the presence or absence of granules in their cytoplasm & according to the shape of the nucleus, the WBCs are classified into two groups:
  - ***Granulocytes:*** (polymorphonuclear leukocytes)
  - ***Agranulocytes:*** (mononuclear leukocytes)

•The no. of leukocytes (WBC) is much smaller than that of RBCs, in fact in a normal adult there are only between (6000-10,000) WBCs per μL of blood.



"Never Let Monkeys Eat Banana"

(60,30,6,3,1)

Neutrophils - 60%

Lymphocytes - 30%

Monocytes - 6%

Eosinophils - 3%

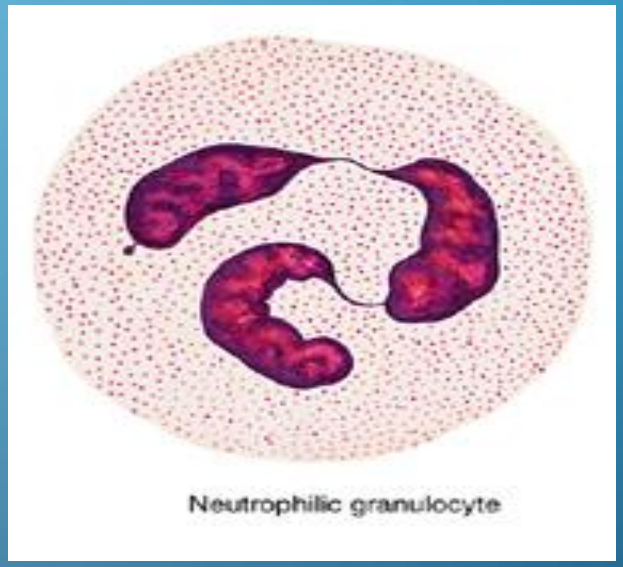
Basophils - 1%

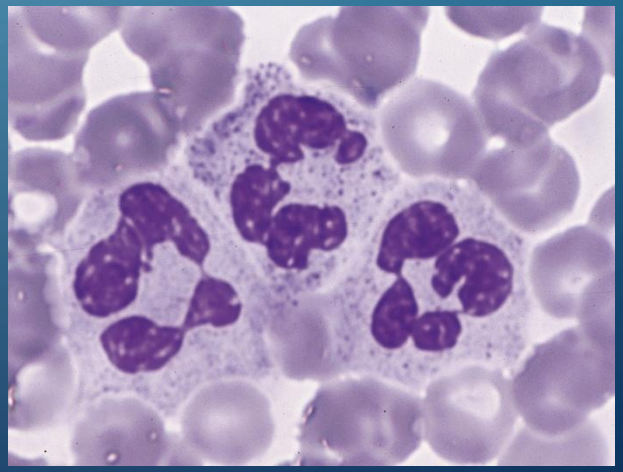
NEUTROPHILS:

- Are called also polymorphonuclear leukocytes,

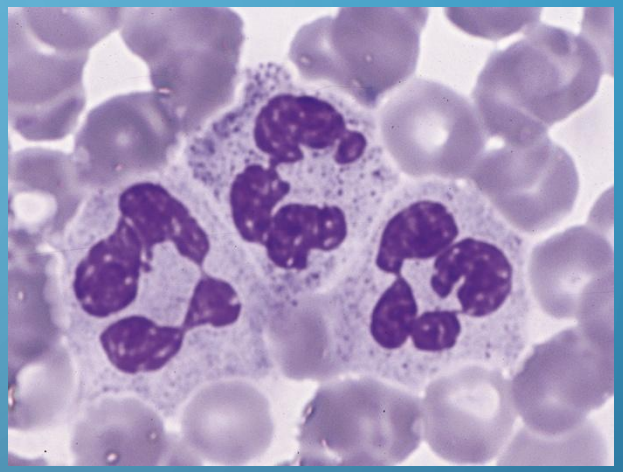
- they constitute about 60-70% of the circulating leukocytes,

- their nucleus consist of 2-5 lobes (usually 3) linked together by fine chromatine thread.

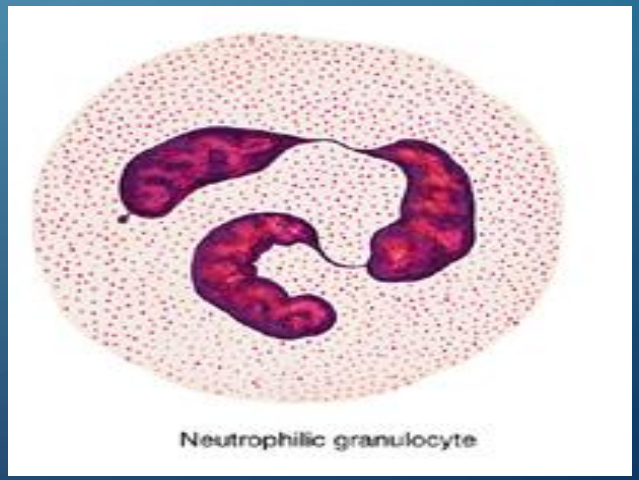




- These cells circulate in the blood in a resting state but with appropriate activation they leave the blood and enter the tissues where they become highly motile, phagocytic cells and their primary function is to ingest and destroy the invading organisms.

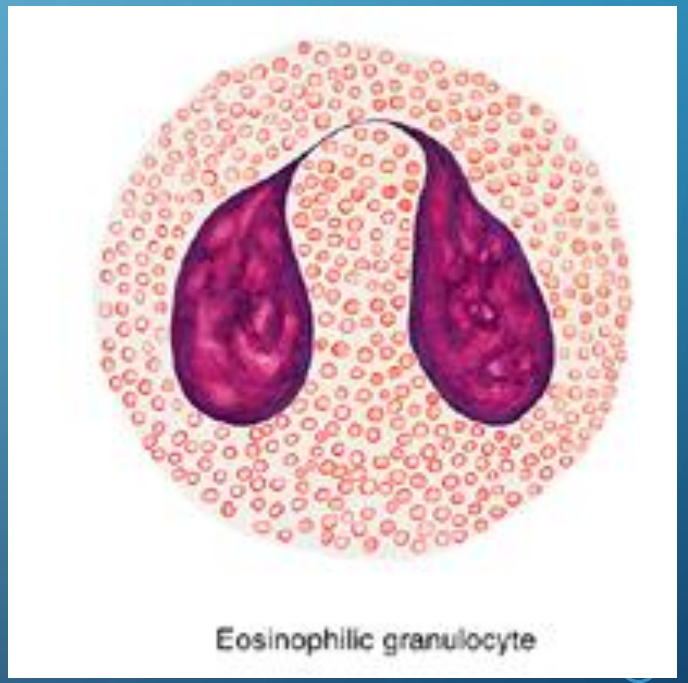


- Once neutrophils perform their function of killing microorganisms they die, resulting in the formation of pus, the accumulation of dead WBC with bacteria and tissue fluid.



EOSINOPHILS:

- they form only 2-4% of total WBC count.
- They have a characteristic bilobed nucleus.
- Their main feature is the presence of many large & elongated granules that are eosinophilic.
- Number of eosinophils increase greatly in many types of parasitic infestations & the protection against the parasitic disease is one of their major functions. They also increase in allergic states.

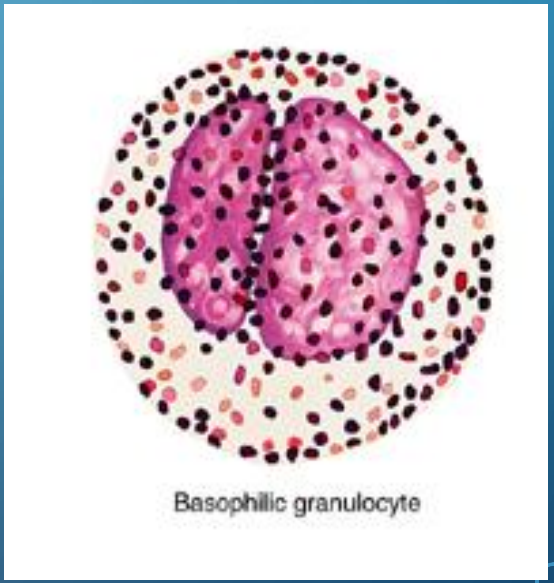


BASOPHILS:

- Constitute less then 1% of the total WBC count,

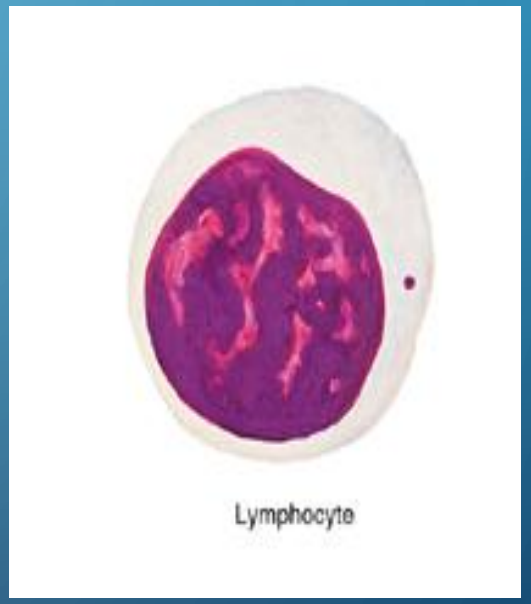
- They have a cytoplasmic granules that are large and intensely basophilic they are irregular in size & shape contain histamine (vasodilator) and heparin (anticoagulant).

- By migrating into connective tissues, basophils appear to transiently supplement the functions of mast cells. Like mast cells, basophils have surface receptors for immunoglobulin E (IgE) and secrete heparin and histamine in response to various antigens and allergens.


Basophilic granulocyte

LYMPHOCYTES:

- Are groups of spherical cells with similar morphological characters,
- they have an ovoid nucleus,
- the cytoplasm of the cell is scanty and can be seen as a thin rim around the nucleus.
- Lymphocytes make up 20-25% of WBCs.



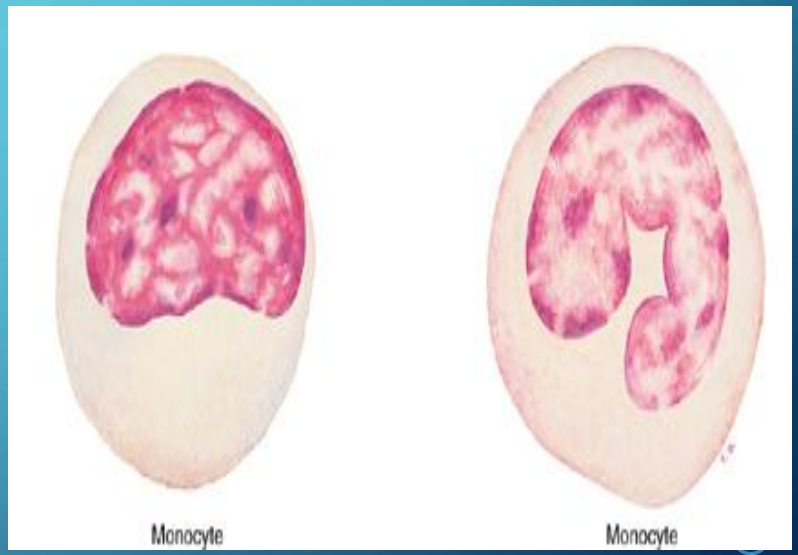
- Major classes include:
- B lymphocytes,
- helper and cytotoxic T lymphocytes (CD4+ and CD8+, respectively), and
- natural killer (NK) cells.
- These and other types of lymphocytes have diverse roles in immune defenses against invading microorganisms and certain parasites or abnormal cells.
- The B cells produce antibodies that are used to attack invading bacteria, viruses, and toxins. The T cells destroy the body's own cells that have themselves been taken over by viruses or become cancerous.

- Activation of B lymphocytes after an immune response to a foreign particle leads to their differentiation into plasma cells.

- Plasma cells are large cells with eccentric rounded nucleus, and they are responsible for active synthesis of immunoglobulins. Plasma cells are seen in small population in lymphoid organs.

MONOCYTES:

- Are spherical cells with oval or kidney shaped nucleus which is often placed eccentrically.
- Their cytoplasm is basophilic.
- Monocytes can live in the blood for 8 hours, after which they move in to the connective tissue, where they may remain for a few months or longer.
- Blood monocytes are the precursor cells of tissue macrophages and other cells of the mononuclear phagocytic system such as kupffer cells in the liver, pulmonary and alveolar macrophages.
- They constitute 3-8% of the blood leukocytes.



Increase in differential WBC count,

Pharmacology Guru
Learning Institute

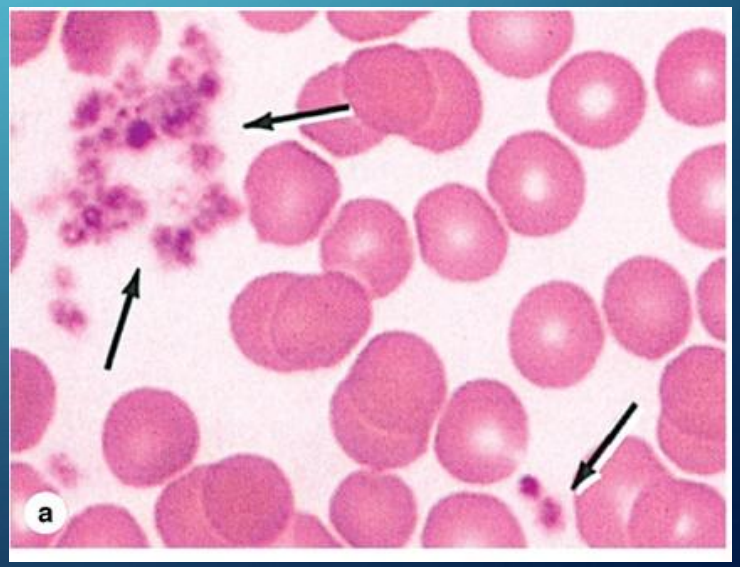
Tell us :

TYPES OF WBC

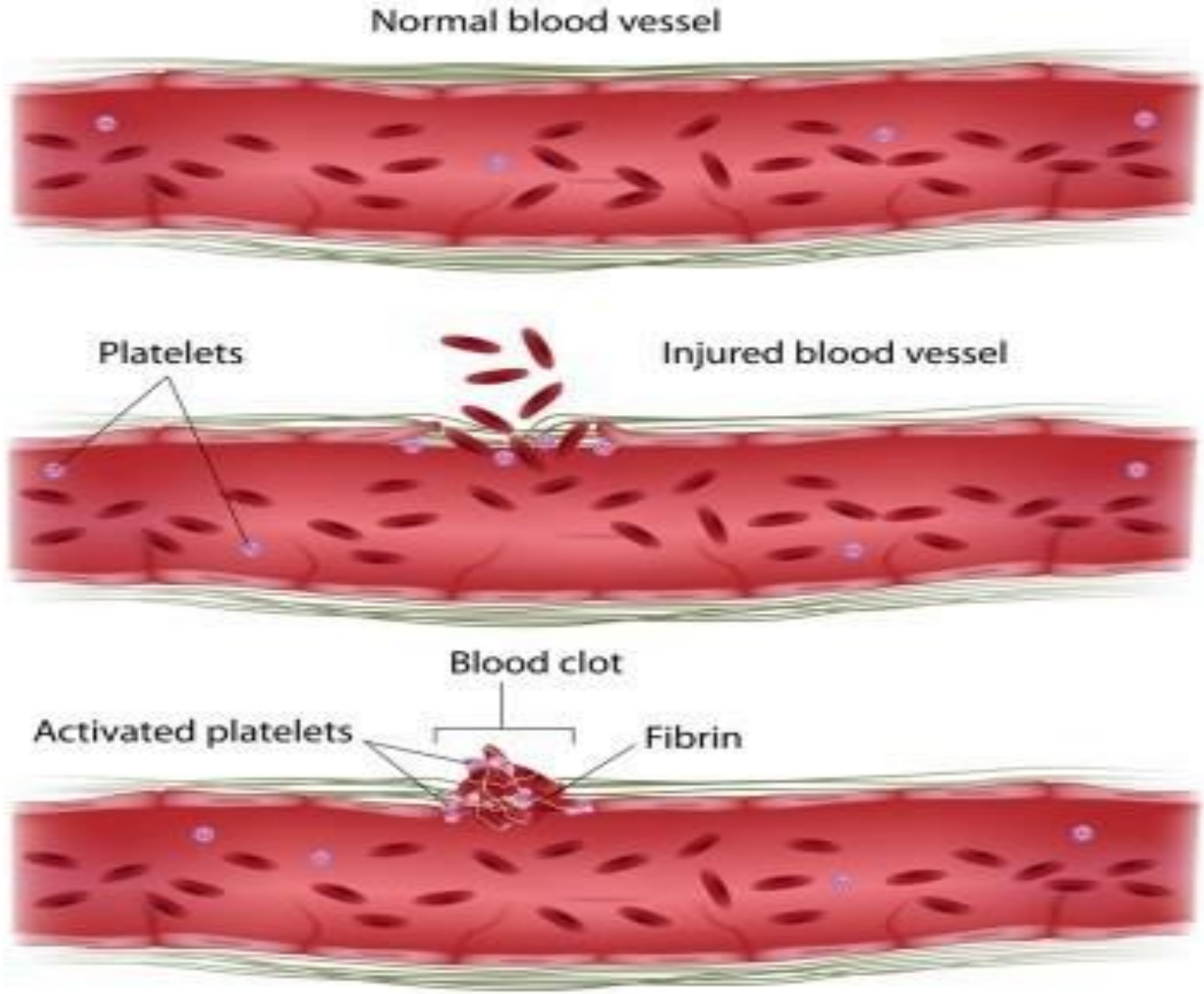
- **Granulocytes**
  - Neutrophil → **Bacterial** infection
  - Eosinophil → **Parasite** infection, **Allergy** & **Asthma**
  - Basophil → **Chronic** Inflammation
- **Agranulocytes**
  - Monocyte → **Inflammation** and Infection
  - Lymphocyte → **Viral** infection

PLATELETS (THROMBOCYTES):

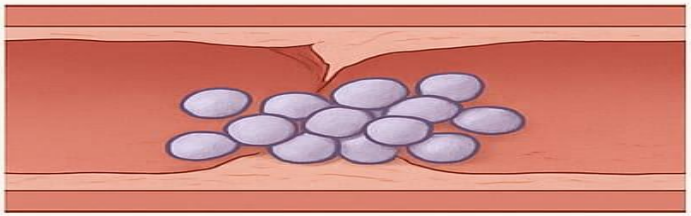
- Are non-nucleated, small, disk like cells formed from fragmentation of a giant cell in the bone marrow called megakaryocytes. Platelets will promote blood clotting & help in repairing gaps in the wall of blood vessels. They have a life span of only 10 days.
- (150-400 $\times 10^3/mm^3$)



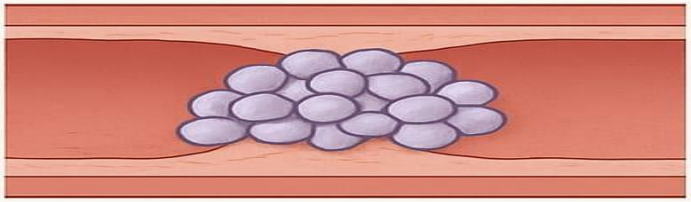
BLOOD CLOTTING:



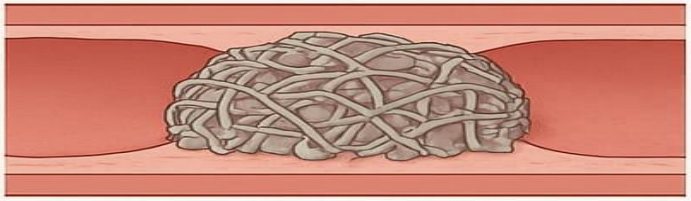
Primary aggregation
Disruptions in the microvascular endothelium, which are very common, allow the late- to form a platelet plug

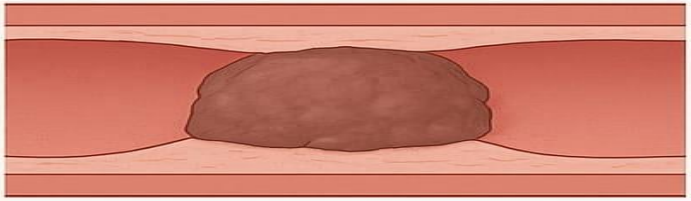


Secondary aggregation
Platelets in the plug increase the size of the plug

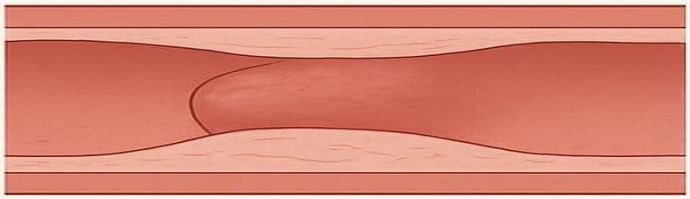


Blood coagulation
During platelet aggregation, fibrinogen from plasma, von Willebrand factor and other proteins released from the damaged endotheljum, and platelet promote the sequential interaction (cascade) of plasma proteins, giving rise to a fibrin polymer that forms a three-dimensional network of fibers trapping RBCs and more platelets to form a blood clot, or thrombus.

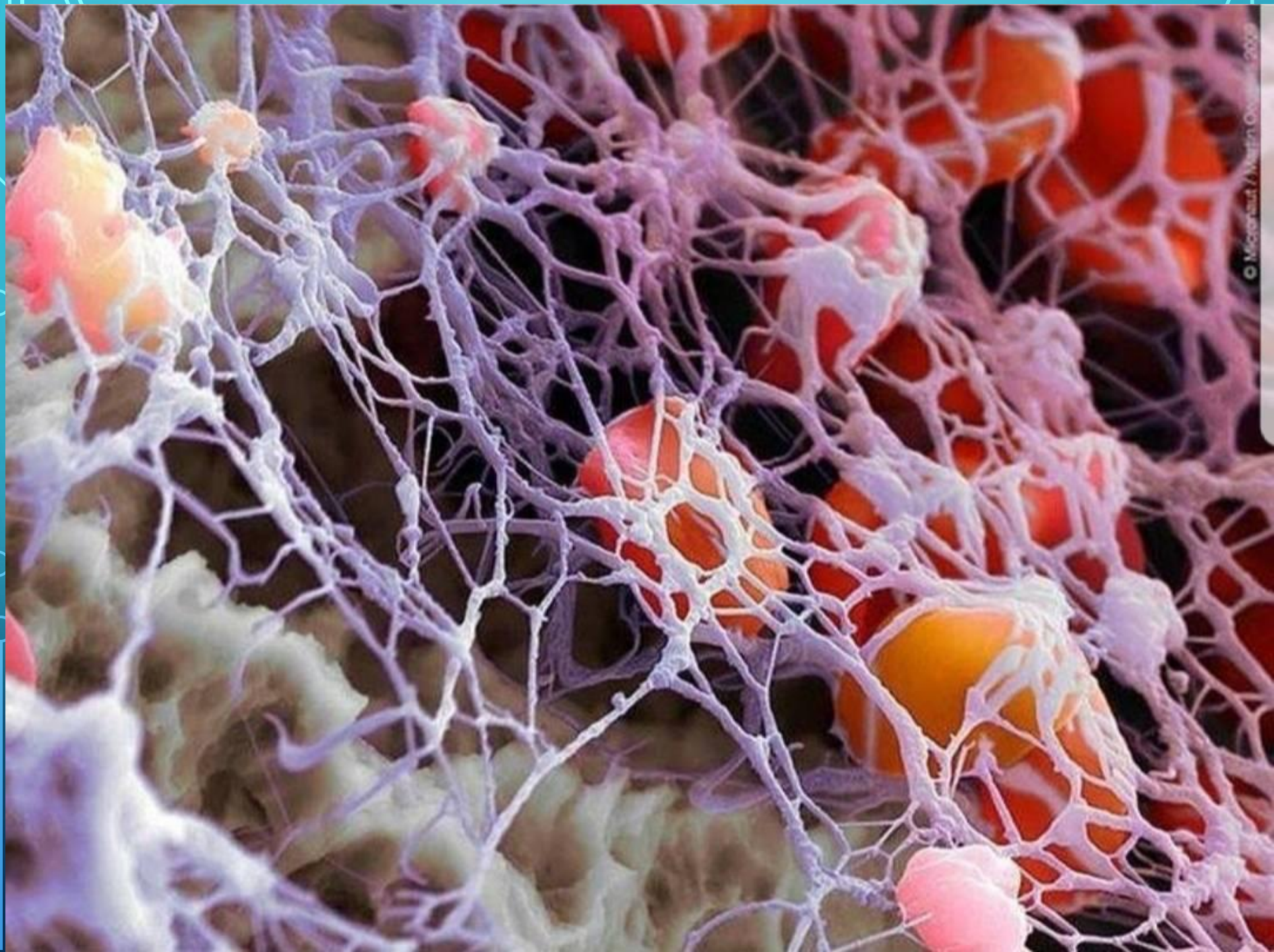




Clot retraction
The clot initially bulges into the blood vessel lumen, but soon contracts slightly



Clot removal
Protected by the clot, the endothelium and surrounding tunic are restored by new tissue, and the clot is then removed, mainly dissolved by the proteolytic enzyme plasmin, which is formed continuously through the local action of plasminogen a-



DISORDERS RELATED TO PLATELETS:

- Thrombocythaemia
- Thrombocytopenia

THANK YOU