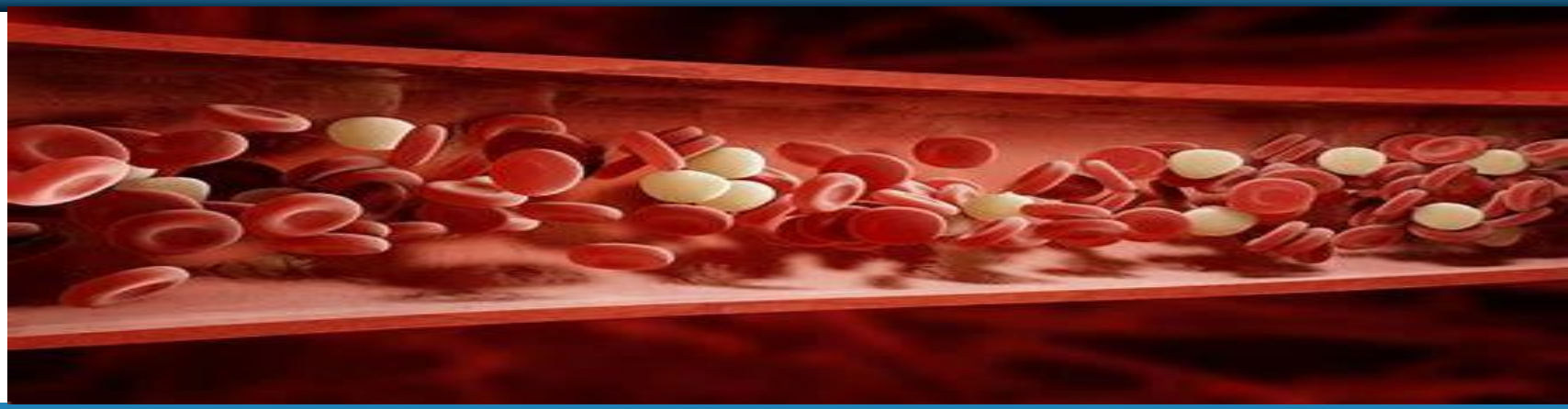
University of Al- Mustaqbal
College Of Nursing
First stage/2nd semester

Lecture 4

Blood physiology



Prepared by :
Dr. Fatima Kamil Salman

Introduction

• **Blood** is a connective tissue in fluid form. It is a denser & more viscous than water.

• It is considered as the '**fluid of life'** because it carries oxygen from lungs to all parts of the body and carbon dioxide from all parts of the body to the lungs.

• It is known as **'fluid of growth'** because it carries nutritive substances from the digestive system and hormones from endocrine gland to all the tissues.

• The blood is also called the **'fluid of health'** because it protects the body against the diseases.

Properties of Whole Blood

- **Blood**: It is a type of liquid connective tissue, a complex mixture of cells, chemicals, and fluid.
- **Color:** Blood is red in color. Arterial blood is scarlet red because it contains more oxygen, and venous blood is purple red because of more carbon dioxide.
- **Volume:** The average volume of blood in a normal adult is 5 L. In a newborn baby, the volume is 450 ml. It increases during growth and reaches 5 L at the time of puberty. In females, it is slightly less and is about 4.5 L. It is about 8% of the body weight in a normal, young, healthy adult, weighing about 70 kg.

Properties of Whole Blood

- **Blood pH**: Blood is slightly alkaline, and its pH under normal conditions is 7.4
- **Viscosity**: Blood is five times more viscous than water. It is mainly due to red blood cells and plasma proteins.
- **Temperature**: 38°C (100.4°F).

Functions of blood

1. Transports:

✓Dissolved gases (e.g. oxygen, carbon dioxide).

✓Waste products of metabolism (e.g., water, urea)

✓Hormones

✓Enzymes

✓Nutrients (e.g. glucose, amino acids, vitamins &minerals, glycerol).

✓Plasma proteins (associated with defense, such as blood clotting and antibodies) .

Functions of blood

2 . Maintains Body Temperature:

Because of the high specific heat of blood, it is responsible for maintaining the thermoregulatory mechanism in the body, i.e., the balance between heat loss and heat gain in the body.

3. Controls pH:

Plasma proteins and hemoglobin act as buffers and help in the regulation of acid-base balance.

4. Removes toxins from the body

5. Regulation of Body Fluid & Electrolytes .

The water content of the blood is freely interchangeable with interstitial fluid. This helps in the regulation of the water content of the body.

Functions of blood

6. Storage Function

Water and some important substances such as proteins, glucose, sodium, and potassium are constantly required by the tissues. Blood serves as a ready-made source for these substances.

7. Defensive Function

Blood plays an important role in the defense of the body. The white blood cells are responsible for this function.

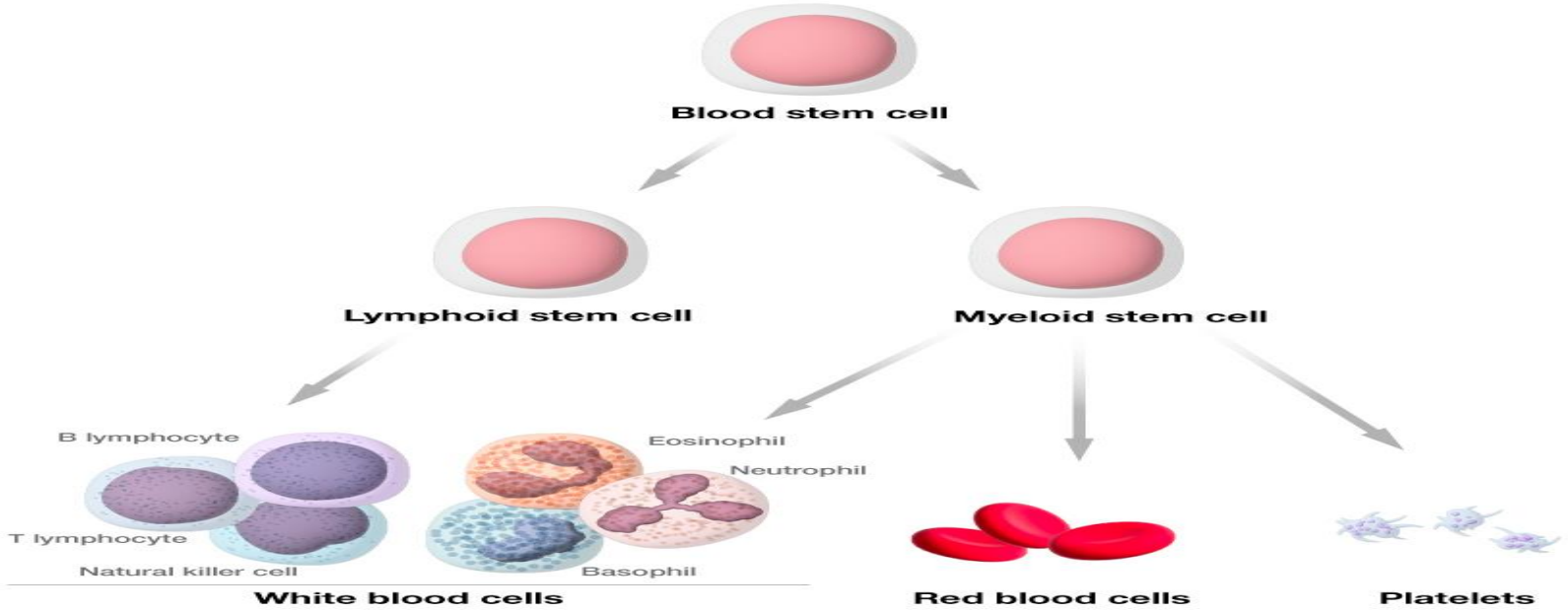
Blood Cells Formation

Hemopoiesis or Hematopoiesis: formation of blood cellular components.

1.Erythropoiesis. Formation of RBC (erythrocytes)

2.Leucopoiesis: Formation of WBC (leucocytes)

3.Thrombopoiesis: Formation of platelets (thrombocytes).



Composition of Blood

Blood consists of about 55% of blood plasma & 45% blood cells. White blood cells and platelets (<1%).

1. Cellular components:

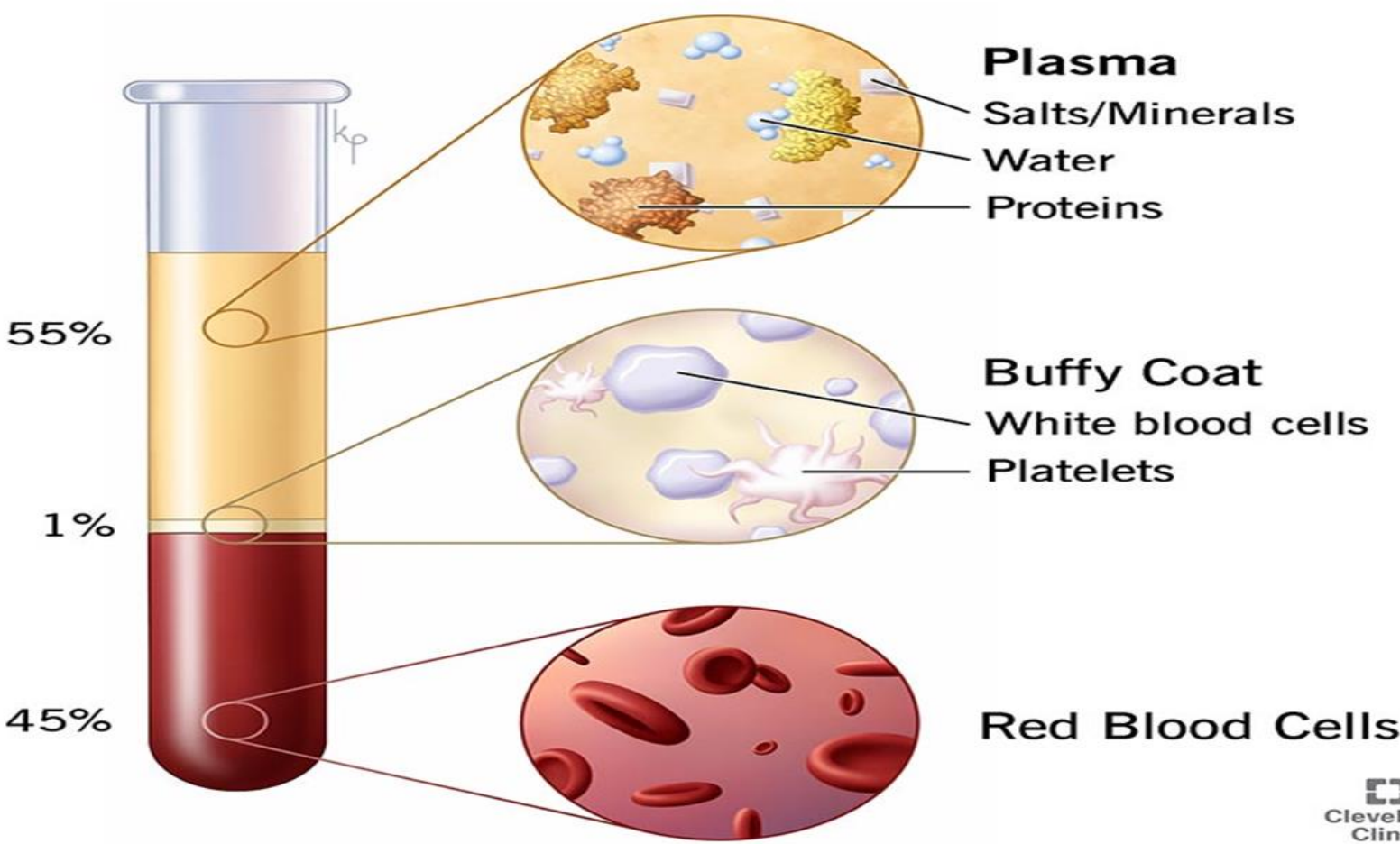
✓Red Blood Cells (Erythrocytes)

✓White Blood Cells (Leucocytes)

✓Platelets (Thrombocytes)

2. Plasma: 95-98% water + ions + plasma proteins e.g. (Albumin, globulin, Fibrinogen)

Same ionic composition as interstitial fluid.


Plasma
Salts/Minerals
Water
Proteins
55%
Buffy Coat
White blood cells
Platelets
1%
45%
Red Blood Cells
Cleveland Clinic
©2021

Composition of Blood

1. Cellular components:

a) **Red blood cells (erythrocytes)**

b) **White blood cells (leukocytes)**

1.Granulocytes

✓Neutrophils .

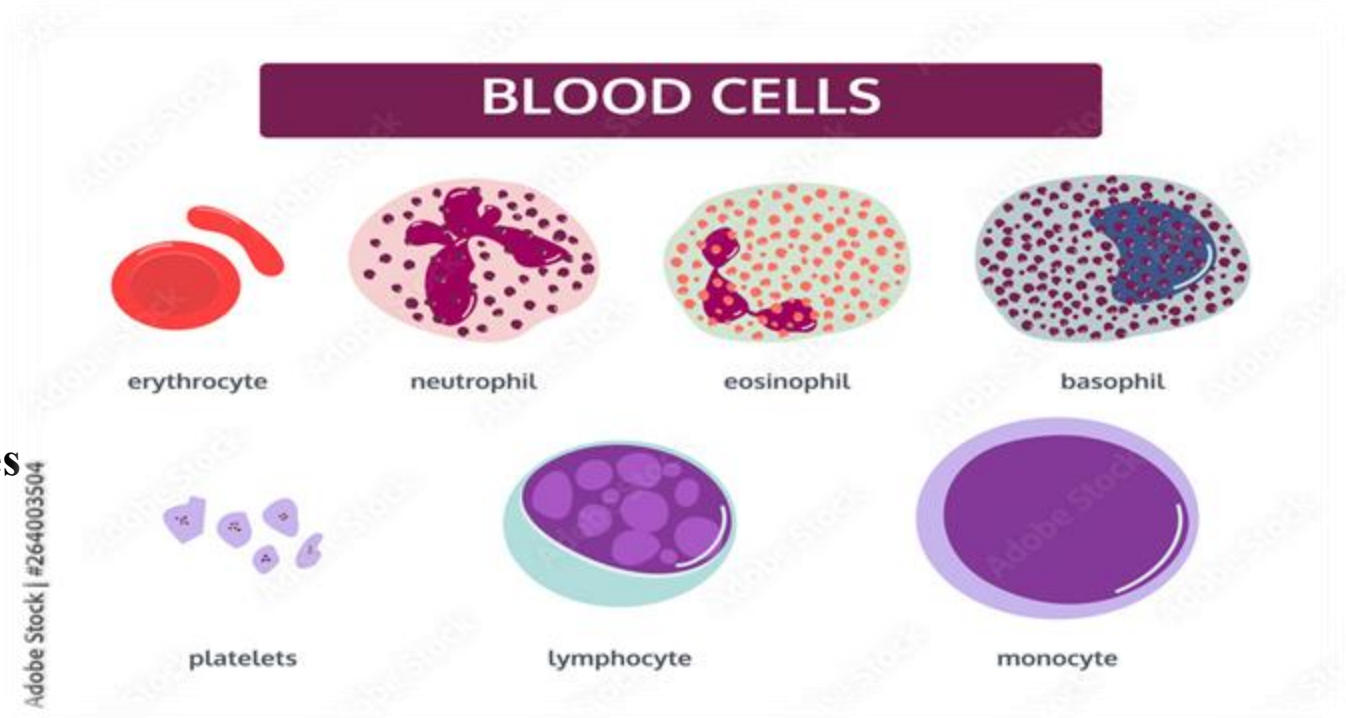
✓Eosinophils.

✓Basophils.

2. Agranulocytes

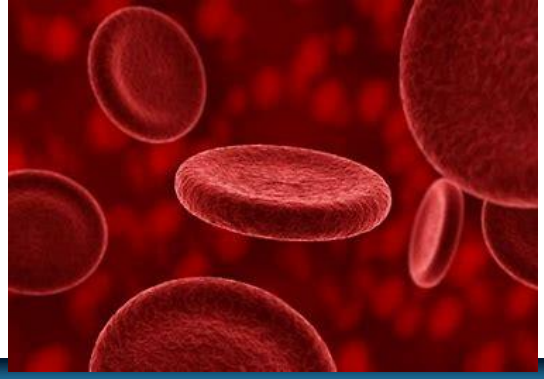
✓Lymphocytes .

✓Monocytes.



c) **Platelets (thrombocytes) .**

a).Erythrocytes or Red Blood Cells (RBCs)



➤ Red blood cells are small, non-nucleated, biconcave disc-shaped cells with a diameter of 7 micrometers.

➤ Its maintained by a network of proteins called spectrin. The protein allows the red blood cells to change shape as they are transported through the blood vessel.

➤ The number of RBCs varies according to age, sex, and physiological conditions of the body.

➤They are red in color due to the presence of hemoglobin which is known as red characteristic pigment.

Erythrocytes or Red Blood Cells (RBCs)

- In fetal life erythrocytes are produced in liver, after birth they are produced in red bone marrow of long bones, compact bones & some irregular bones.
- The life span of RBCs is about 120 days & finally they are destroyed in spleen & liver.
- ➢Normal RBC ranges are:

  Male: 4.7 to 6.1 millioncells per Microliter (cells/mcL)

  Female: 4.2 to 5.4 millioncells/mcL

Functions Red blood cells

1. **Transport of oxygen from the lungs to the tissues:**

Hemoglobin in RBCs combines with oxygen to form oxyhemoglobin. About 97% of oxygen is transported in blood in the form of oxyhemoglobin

2. Transport of carbon dioxide from the tissues to the lungs:

Hemoglobin combines with carbon dioxide to form carbhemoglobin.

About 30% of carbon dioxide is transported in this form.

3. Buffering Action in Blood:

Hemoglobin functions as a good buffer. By this action, it regulates the hydrogen ion concentration and thereby plays a role in the maintenance of acid-base balance.

4. In Blood Group Determination:

RBCs carry the blood group antigens such as A antigen, B antigen, and Rh factor.

b).Leucocytes or White Blood Cells (WBCs)

- Leucocytes (leuco-white, cytes-cells) are the largest blood cells.
- It is a nucleated cell. It is the mobile units of the body's protective system.
- They are formed partially in the bone marrow (granulocytes, monocytes, and a few lymphocytes) and partially in the lymph tissue (lymphocytes).
- The real value of the white blood cells is providing a rapid and potent defense against infectious agents.
- The normal value of leucocytes is 4,000-10,000 cells per cubic mm of blood.

Leucocytes or White Blood Cells (WBCs)

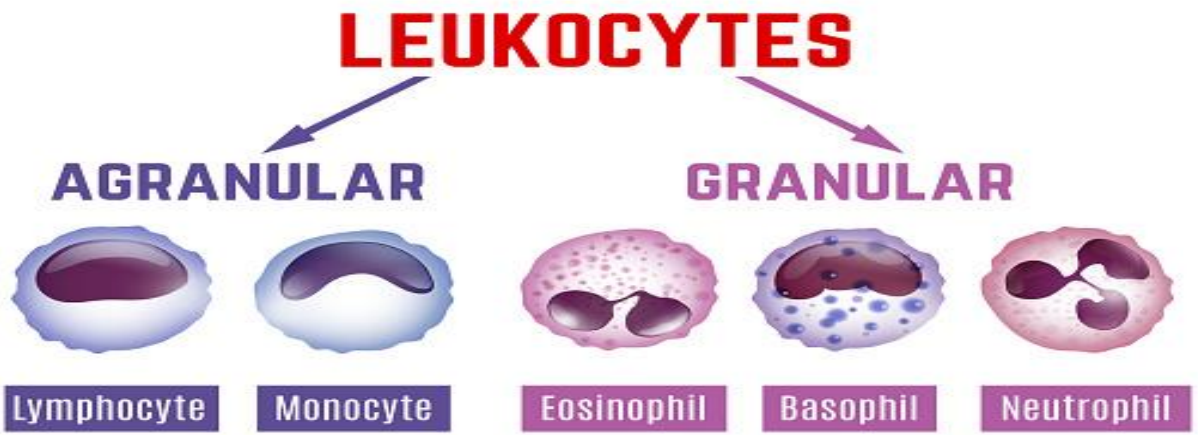
➤ **Leukocytes work together in two ways to prevent disease:**

(1) by actually destroying invading bacteria or viruses by phagocytosis.

(2) by forming antibodies and sensitized lymphocytes, which may destroy or inactivate the invader.

➤ Depending upon the presence of granules in their cytoplasm, they are classified as:

1. Granulocytes
2. Agranulocytes



Leukocyte classification systems

1) Granulocytes

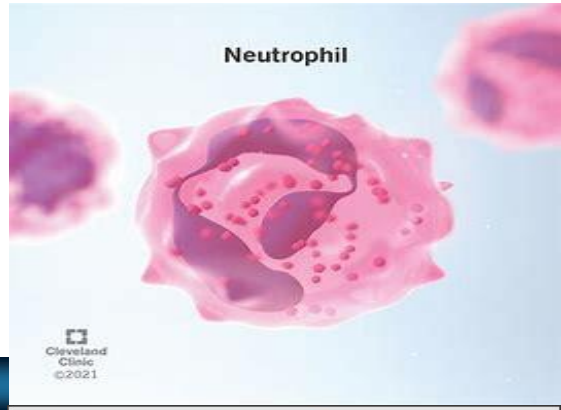
- In this type of WBC, the granules are present in the cytoplasm of the cell.
- They constitute about 75% of total WBC.
- Granulocytes are synthesized into red bone marrow.
- Life Span of the Granulocytes:4 to 8 hours (transit time) in blood circulation and 4 to 15 days in tissues.
- ➤They are further classified as follows...

a) Neutrophils b) Eosinophils c) Basophils

a) Neutrophils

➤These constitute about 70% of total WBC in blood.

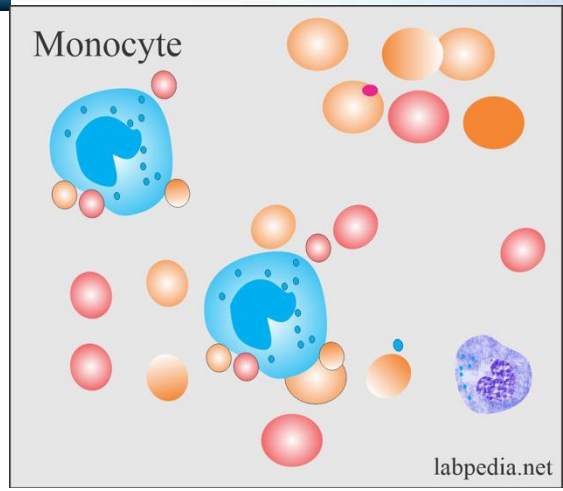
➤The function of neutrophils is to engulf and kill microbes by phagocytosis.



b) Eosinophils(acidophils).

➤ These constitute about 4% of total WBC in blood.

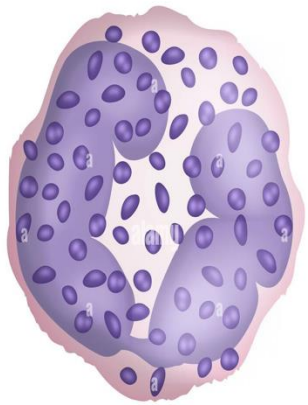
➤ **Function** - fight against the effect of histamine in allergic conditions and phagocytosis.



c).Basophils

These cells constitute about 1% of total WBC in blood.

➤ fight against the effect of histamine, and serotonin in allergic conditions and increase overall inflammatory response.



Basophil

2) Agranulocytes

- This type of WBC Lacking obvious granules in their cytoplasm.
- They constitute about 25% of total WBC.
- They are further classified as follows...

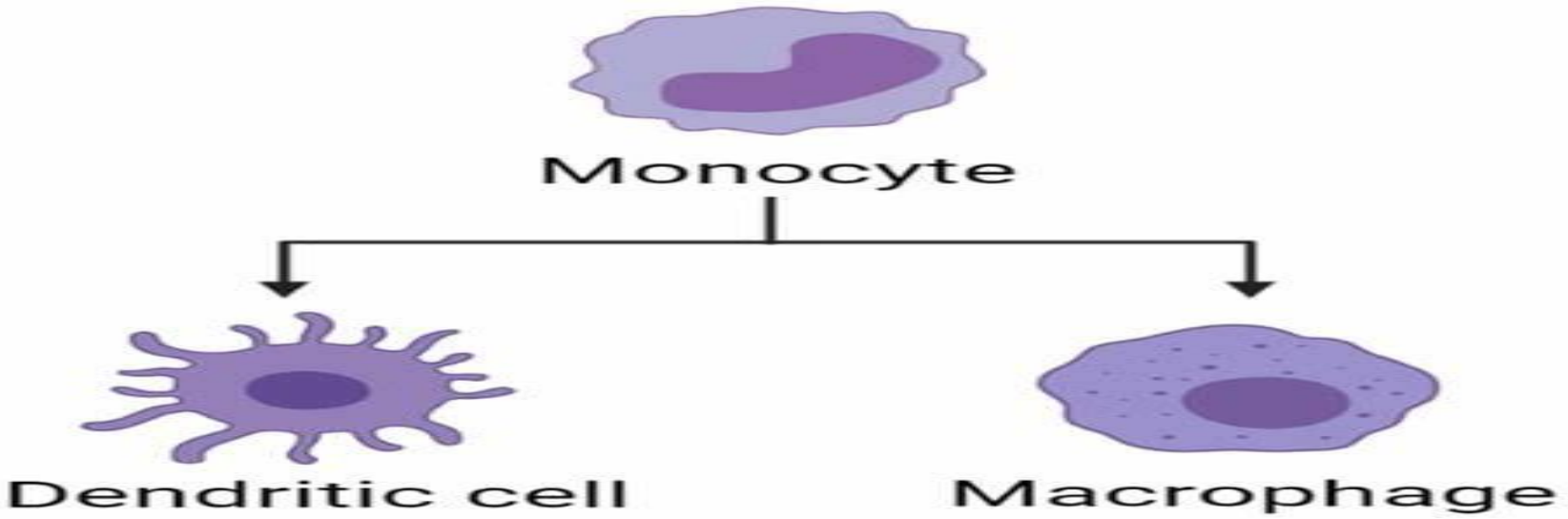
a) Lymphocytes (23%) of circulating WBCs;

- Lymphocytes are smaller than monocytes and have large nuclei.
- Major cell of immune response.
- Lymphocytes are divided into two types: 1. T lymphocytes 2. B lymphocytes
- Life span: weeks to months.

b) Monocytes : (2%) from WBC

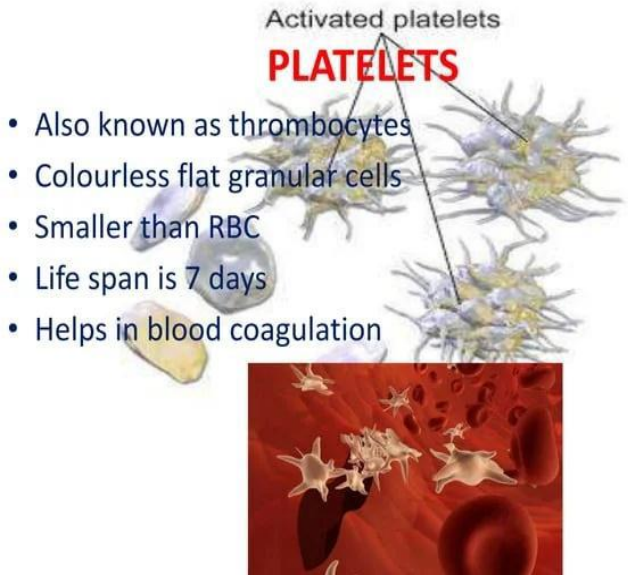
The monocytes are large cells with large nucleus and bigger than lymphocytes. Monocytes are phagocytic in action.

Life span: days to months.



C).Platelets

- Also called thrombocytes are small, colorless cell fragments in blood have no cell nucleus.
- They are derived from the bone marrow, which then enter the circulation.
- On a stained blood smear, platelets appear as dark purple spots, about 20% the diameter of red blood cells, and play an important role in hemostasis.
- **Platelets whose function (along with the coagulation factors)** react to bleeding from blood vessel injury by clumping, thereby initiating a blood clot.
- A normal platelet count in adults ranges from 150,000 to 450,000 platelets per microliter of blood.



2.Plasma

Blood plasma is a pale yellow-colored fluid and its total volume in an adult is approximately 2.5–3 L. and approximately 55% of blood's volume. When the blood cells are removed from the blood, called blood plasma. **Blood Plasma consist of :**

1. Water (92%).
2. Solids (7-8%).

a).Plasma proteins:

– Albumin(60%): the most abundant component. Important in regulation of water movement between tissues and blood.

- Globulins: Immune system or transport molecules
- Fibrinogen: Responsible for formation of blood clots.

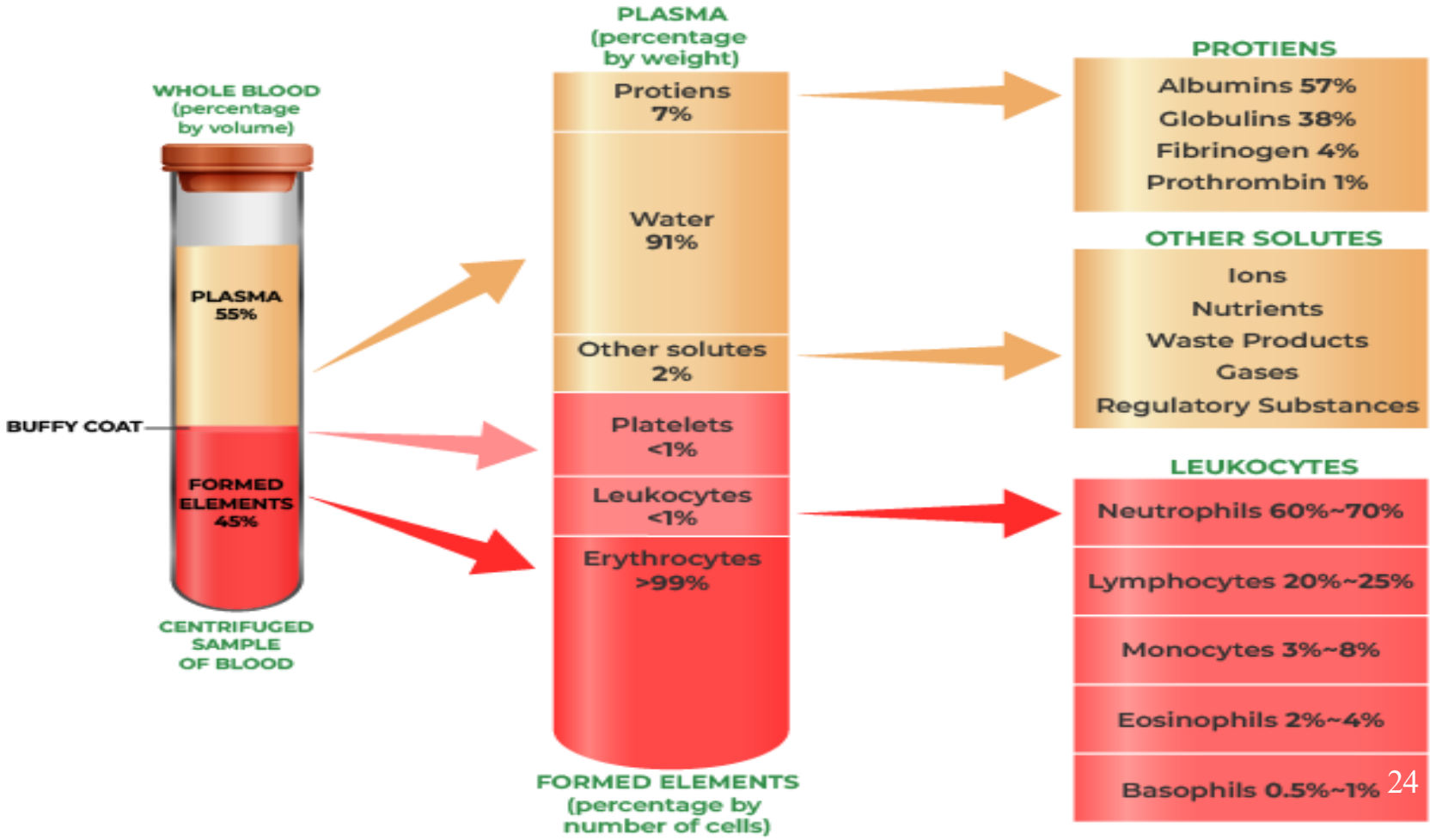
b). Inorganic salts (1%): sodium, potassium, calcium, magnesium

c). Nutrients: Glucose, amino acid, fats, vitamins

d). Waste material: Urea, uric acid, creatinine

f). Enzymes & hormones.

3. Gases: Oxygen, carbon dioxide and nitrogen.


WHOLE BLOOD
(percentage
by volume)
PLASMA
55%
BUFFY COAT
FORMED
ELEMENTS
45%
CENTRIFUGED
SAMPLE
OF BLOOD
PLASMA
(percentage
by weight)
Protiens
7%
Water
91%
Other solutes
2%
Platelets
<1%
Leukocytes
<1%
Erythrocytes
>99%
FORMED ELEMENTS
(percentage by
number of cells)
PROTIENS
Albumins 57%
Globulins 38%
Fibrinogen 4%
Prothrombin 1%
OTHER SOLUTES
Ions
Nutrients
Waste Products
Gases
Regulatory Substances
LEUKOCYTES
Neutrophils 60%~70%
Lymphocytes 20%~25%
Monocytes 3%~8%
Eosinophils 2%~4%
Basophils 0.5%~1%


THANK
YOU