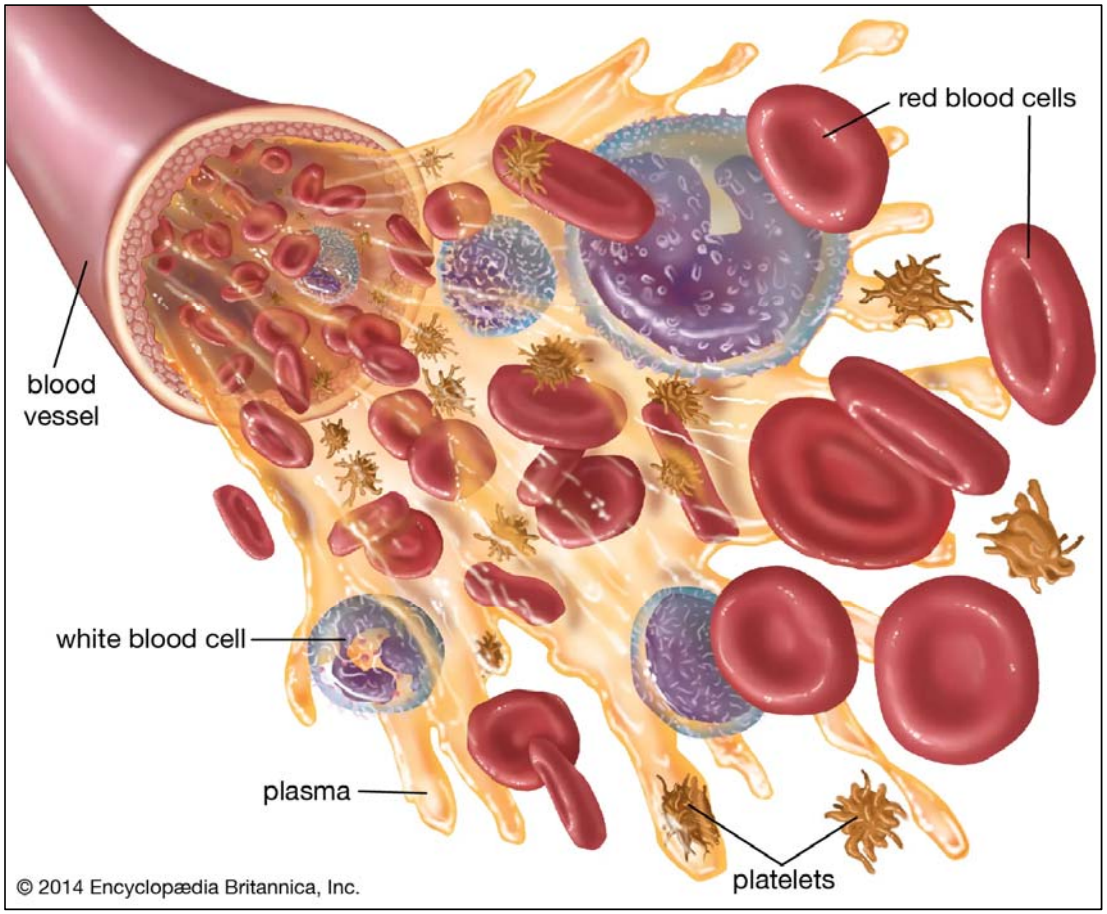
Asst. Lec. Safa Jalil Al-Yassiri

Introduction of physiology

Department of occupational Therapy Techniques

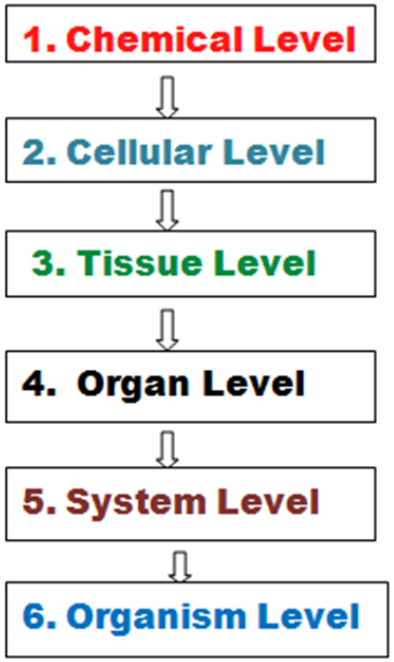


- **Physiology:** is the study of how the parts of the body work, and the ways in which they cooperate together to maintain life and health of the individual (study of body parts function).

- **Pathology:** is the study of abnormalities and how they affect body functions, often causing illness. Building on the normal anatomy and physiology.

- The physiology is important because it provides a thorough understanding of normal body function, enabling more effective treatment of abnormal or disease states.

The human body is organized into structural and functional levels of increasing complexity. Each higher level incorporates the structures and functions of the previous level. We will begin with the simplest level, which is the chemical level, cells, tissues, organs, organ systems and organism level.



1. **Chemicals level:** This very basic level includes **atoms**, the smallest units of matter that participate in chemical reactions, and **molecules**, two or more atoms joined together.

- Certain atoms, such as carbon (C), hydrogen (H), oxygen (O), nitrogen (N), phosphorus (P), calcium (Ca), and sulfur (S), are essential for maintaining life.
- Two familiar molecules found in the body are deoxyribonucleic acid (DNA) and glucose.

2. **Cell level:** The smallest living units of structure and function. There are many different types of human cells, though they all have certain similarities. Each type of cell is made of chemicals and carries out specific chemical reactions. Among the many kinds of cells in the body are muscle cells, nerve cells and epithelial cells.

3. **Tissue level:** A tissue is a group of cells with similar structure and function. There are four groups of tissues: epithelial tissues, connective tissues, muscular tissues and nervous tissues.

4. **Organ level:** are structures that are composed of two or more different types of tissues, they have specific functions and usually have recognizable shapes. Examples of organs are the stomach, skin, bones, heart, liver, lungs, and brain.

5. **Organ system level:** is a group of organs that all contribute to a particular function. Examples are the urinary system, digestive system, and respiratory system. The urinary system, which consists of the kidneys, ureters, urinary bladder, and urethra, these organs all contribute to the formation and elimination of urine.

6. **Organismal level:** All the parts of the human body functioning together constitute the total organism.

The Systems of the Human Body : is a group of organs that work together in the body to perform a complex function, such as pumping blood or processing and utilizing nutrients.

System	Functions	organs
Integumentary	cover, cushion, and protect the deeper tissues and organs of the body and generally provide a boundary between the body's internal environment and the outside world. also important for temperature regulation and excretion of wastes.	The skin and its various appendages (including the hair, nails, glands, and other structures)
Skeletal	Supports the body, protects internal organs and red bone marrow and provides a framework to be moved by muscles	bones, ligaments
Muscular	Moves the skeleton and produces heat	muscles, tendons
Nervous	is a network that makes it possible for different parts of the body to communicate with one another. All body processes, reactions, thoughts, and movements.	is composed of three major parts the sensory input portion (skin, eyes and ears) , the central nervous system (brain and spinal cord), and the motor output portion.
Endocrine	Regulates body functions such as growth and reproduction by means of hormones, Regulates day-to-day metabolism by means of hormones	thyroid gland, pituitary gland, pancreas, pineal, hypothalamus and gonads (ovaries and testes)

Circulatory	transports oxygen and nutrients to all corners of the body. It also carries away carbon dioxide and other waste products	heart, blood and blood vessels (arteries and veins)
Lymphatic	Returns tissue fluid to the bloodstream, destroys pathogens that enter the body and provides immunity.	lymphatic vessels, lymph nodes, lymph ducts and various glands.
Respiratory	The respiratory system is responsible for breathing, which is the controlled movement of air in and out of the body (ventilation). It also moves oxygen and carbon dioxide into and out of the bloodstream.	lungs, pharynx, larynx, trachea, bronchi and diaphragm.
gastrointestinal (GI) system	is sometimes referred to as the gut or the digestive system. It is responsible for breaking down foods into nutrients, which the body needs for energy, growth, and cell repair.	mouth, esophagus, stomach, small intestine, large intestine, rectum and anus. liver, pancreas, and gallbladder are the solid organs of the digestive system
Urinary	Removes waste products from the blood, Regulates volume and pH of blood and tissue fluid.	kidneys, ureters, urinary bladder and urethra
Reproductive	Produces eggs or sperm In women, provides a site for the developing embryo-fetus. Aside from their direct roles in reproduction, the ovaries and testicles also play important roles in the endocrine system, producing estrogen, testosterone, and progesterone.	**Female:** vagina, uterus and ovaries **Male:** epididymis, testes, prostate, As well as the external structures of the scrotum and penis

The blood: blood is a specialized type of connective tissue. The general functions are transportation, regulation, and protection.

- ❖ Transports oxygen, carbon dioxide, nutrients, hormones, heat, and wastes.
- ❖ Regulate fluid–electrolyte balance, acid–base balance, and the body temperature.
- ❖ Protection against pathogens is provided by white blood cells and the blood clotting mechanism prevents excessive loss of blood after injuries.

Blood has distinctive physical characteristics:

1. **The blood volume:** is (5 to 6 liters) in an average-sized adult male and (4 to 5 liters) in an average-sized adult female. The gender difference in volume is due to differences in body size. Blood is about 45% formed elements (red blood cells, white blood cells and platelets) and 55% blood plasma.
2. **Temperature:** of blood is 38°C (100.4°F), about 1°C higher than oral or rectal body temperature.
3. **Color:** The color of blood varies with its oxygen content. When saturated with oxygen, it is bright red. When unsaturated with oxygen, it is dark red.
4. **pH:** the normal pH range of blood is (7.35 to 7.45), which is slightly alkaline. Venous blood normally has a lower pH than does arterial blood because of the presence carbon dioxide.
5. **Viscosity:** this means thickness or resistance to flow. Blood is about three to five times thicker than water. Viscosity is increased by the presence of blood cells and the plasma proteins, and this thickness contributes to normal blood.

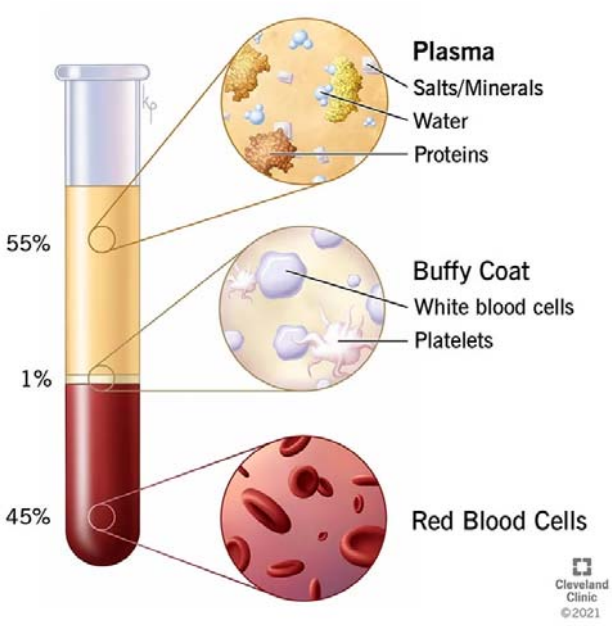
The blood composition: It has two main components: **plasma and cells** (red blood cells, white blood cells and platelets).

1. Plasma:

- Is the liquid part of blood and is approximately (91.5%) water.
- Plasma transports nutrients, wastes, hormones, antibodies, and CO2 as HCO3
- Also in the plasma are the plasma proteins (7%):

- **Fibrinogen:** is clotting factors , synthesized by the liver and circulate until activated to form a clot in a ruptured or damaged blood vessel.

- **Albumin**:
- is the most abundant plasma protein, itis synthesized by the liver, albumin is essential for maintaining the oncotic pressure needed for proper distribution of body fluids between blood vessels and body tissues. This is important to maintain normal blood volume and blood pressure.
- Albumin also helps transport many substances such as drugs, hormones, and fatty acids.



- **Globulins:** globulins are of three types, alpha, beta, and gamma.
  - **Alpha and beta globulins** are synthesized by the liver and act as carriers for molecules such as fats.

  - **Gamma globulins (immunoglobulins)** are antibodies produced by lymphocytes, antibodies initiate the destruction of pathogens and provide us with immunity.

Other Plasma Components (1.5%):

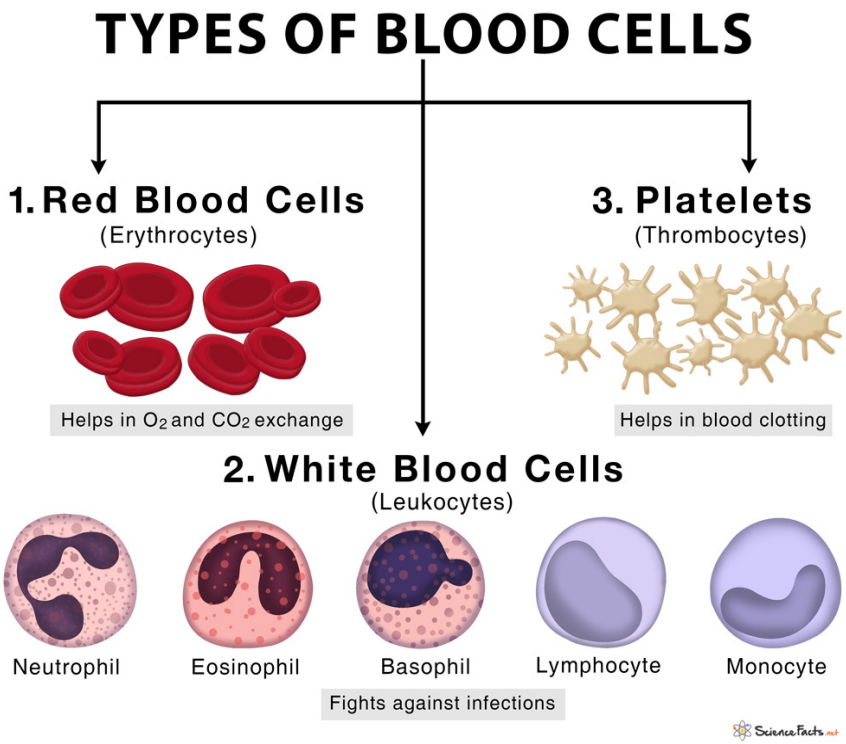
- **Electrolytes:** Sodium is the most abundant ion carried in plasma.

- **Amino acids:** tissues or plasma proteins may be broken down and the amino acids recycled for use in the synthesis of other biological structures.
- **Nitrogenous compounds:** Nitrogenous waste compounds such as urea are produced by the breakdown of various substances in the body, these are carried in the plasma to the kidneys to be excreted.

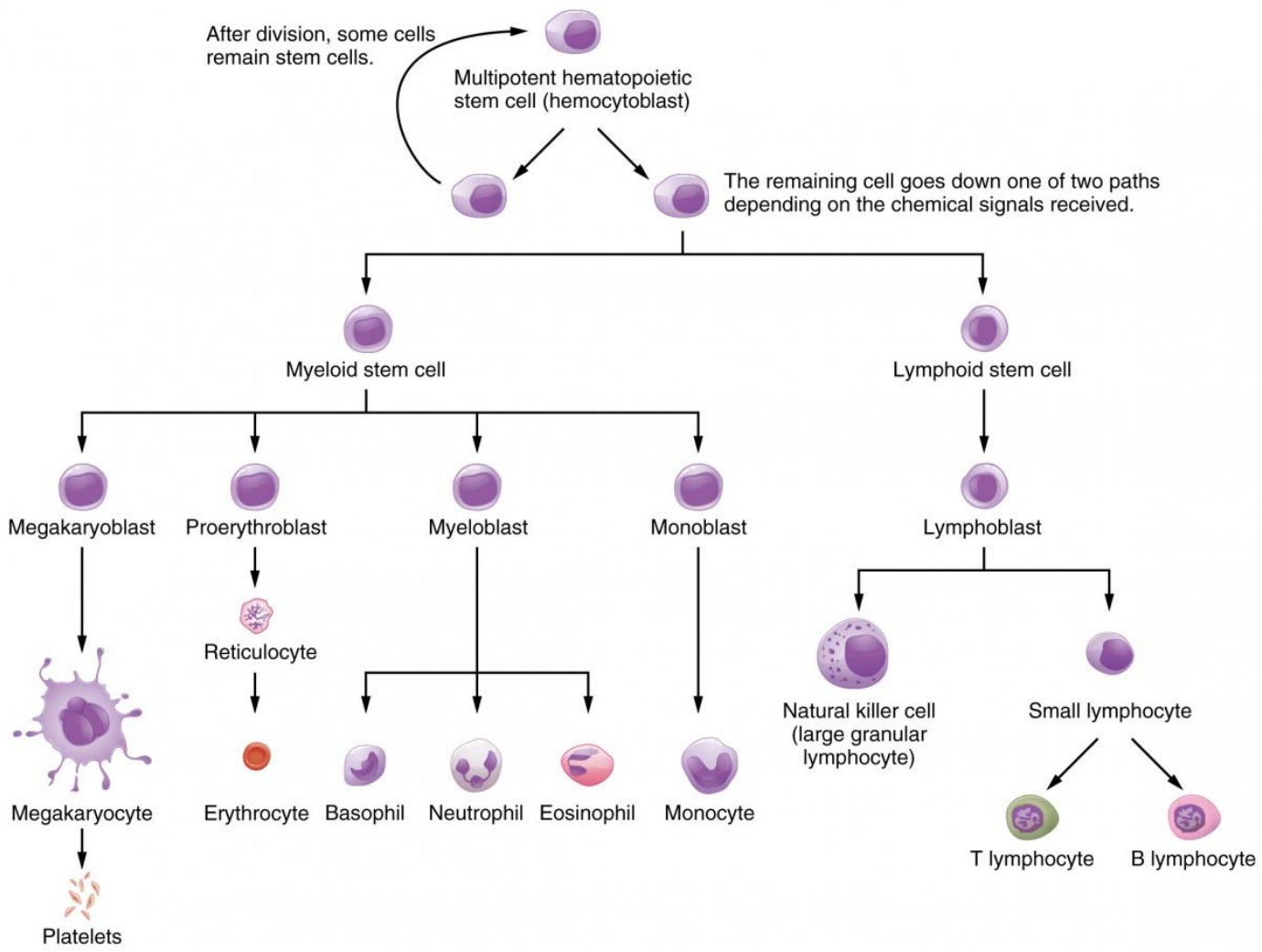
- **Nutrients:** nutrients absorbed from the gut or from other organs of origin are carried in the plasma, such as glucose, fats, amino acids, minerals, and vitamins.

- **Dissolved gases:** plasma also contains dissolved oxygen and carbon dioxide, in small amounts, as well as a significant amount of nitrogen.

2. The blood cells:

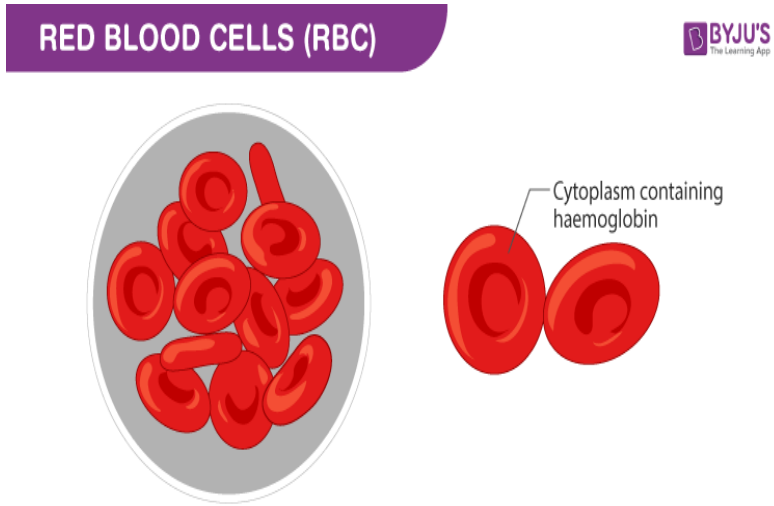


- There are three kinds of blood cells: red blood cells, white blood cells and platelets.
- The process by which the formed elements of blood develop is called hemopoiesis. Blood cells are produced from stem cells in hemopoietic tissue.
- Red bone marrow the primary site of hemopoiesis in the last 3 months before birth, and continues as the source of blood cells after birth and throughout life. It is present chiefly in bones of the axial skeleton, pectoral and pelvic girdles, and the proximal epiphyses of the humerus and femur.
- Lymphocytes mature and divide in lymphatic tissue, found in the spleen, lymph nodes, and thymus gland.
- The stem cells of the red bone marrow may also be called **hemocytoblasts,** and they constantly undergo mitosis to produce all the kinds of blood cells, many of which are RBCs.


After division, some cells remain stem cells.
Multipotent hematopoietic stem cell (hemocytoblast)
The remaining cell goes down one of two paths depending on the chemical signals received.
Myeloid stem cell
Lymphoid stem cell
Megakaryoblast
Proerythroblast
Myeloblast
Monoblast
Lymphoblast
Reticulocyte
Natural killer cell (large granular lymphocyte)
Small lymphocyte
Megakaryocyte
Erythrocyte
Basophil
Neutrophil
Eosinophil
Monocyte
T lymphocyte
B lymphocyte
Platelets

Red blood cells (RBCs):

- Also called erythrocytes.
- Red blood cells (RBCs) are biconcave discs, which means their centers are thinner than their edges. with a diameter of 7–8 µm
- RBCs lack a nucleus and other organelles and can neither reproduce nor carry on extensive metabolic activities.
- Their nuclei disintegrate as the red blood cells mature and are not needed for normal functioning.
- A normal RBC count ranges from 4.5 to 6.0 million cells per microliter.
- RBC counts for men are higher than for women.



Function:

- Red blood cells contain the protein hemoglobin (Hb), which gives them the ability to carry oxygen.

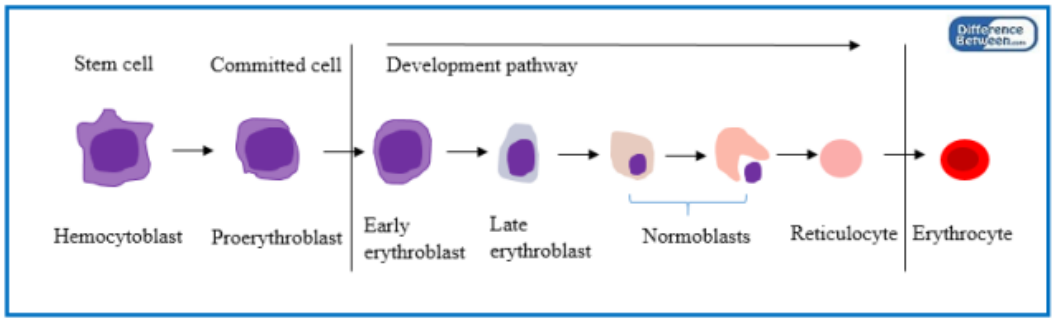
- Each RBC contains about 280 million hemoglobin molecules. A hemoglobin molecule consists of a protein called globin, composed of four polypeptide chains (two alpha and two beta chains); a ring like non-protein pigment called a heme is bound to each of the four chains. At the center of each heme ring is an iron ion (Fe^{2+}) that can combine reversibly with one oxygen molecule, allowing each hemoglobin molecule to bind four oxygen molecules.

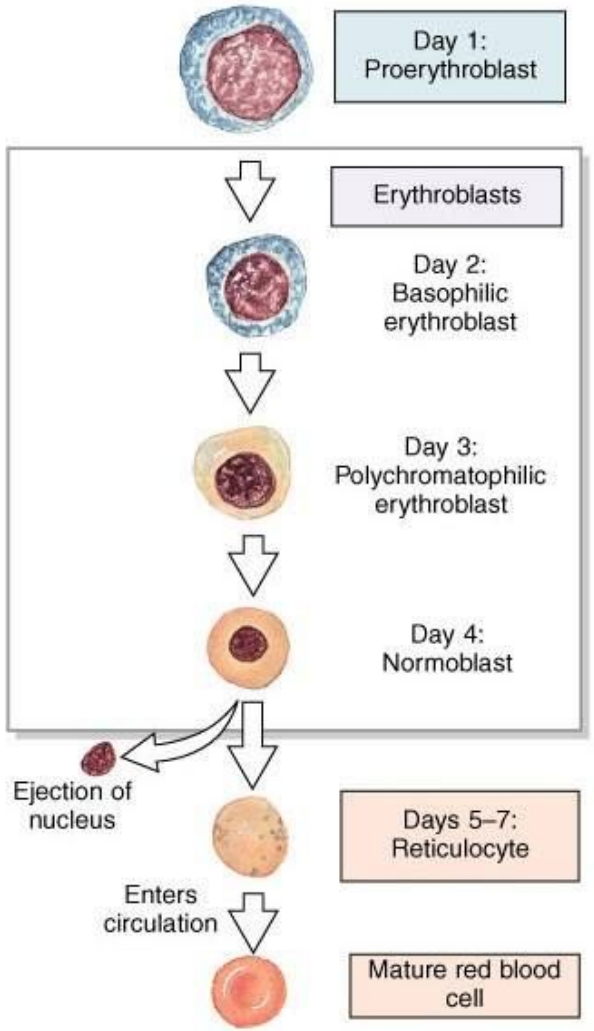
- Hemoglobin also transports about 23% of the total carbon dioxide, a waste product of metabolism. (The remaining carbon dioxide is dissolved in plasma or carried as bicarbonate ions)

Erythrocyte production (Erythropoiesis) :

- The stem cells are unspecialized cells that may develop, or differentiate, in several ways undergo mitosis to produce all the kinds of blood cells, many of which are RBCs. The rate of production is very rapid (estimated at several million new RBCs per second), and a major regulating factor is oxygen.

- **If the body is in a state of hypoxia**, or lack of oxygen, the kidneys produce a hormone called erythropoietin, which stimulates the red bone marrow to increase the rate of RBC production (that is, the rate of stem cell mitosis). This will occur following hemorrhage or if a person stays for a time at a higher altitude. As a result of the action of erythropoietin, more RBCs will be available to carry oxygen and correct the hypoxic state.





RBC Life Cycle:

- Red blood cells live only about 120 days because of the wear and tear their plasma membranes undergo as they squeeze through blood capillaries. The plasma membrane becomes more fragile with age, and the cells are more likely to burst, especially as they squeeze through narrow channels in the spleen. Ruptured red blood cells are removed from circulation and destroyed by fixed phagocytic macrophages in the spleen and liver, and the breakdown products are recycled and used in numerous metabolic processes, including the formation of new red blood cells. **The recycling occurs as follows:**

- Macrophages in the spleen, liver, or red bone marrow phagocytize ruptured and worn-out red blood cells.
- The globin and heme portions of hemoglobin are split apart.
- **Globin** is broken down into amino acids, which can be reused to synthesize other proteins.
- **Iron** is removed from the heme portion into the blood to be returned to the red bone marrow to be used for the synthesis of new hemoglobin if not needed immediately for this purpose, excess iron is stored in the liver.
- When iron is removed from heme, **the non-iron portion of heme** is converted to biliverdin, a green pigment, and then into bilirubin , a yellow-orange pigment.

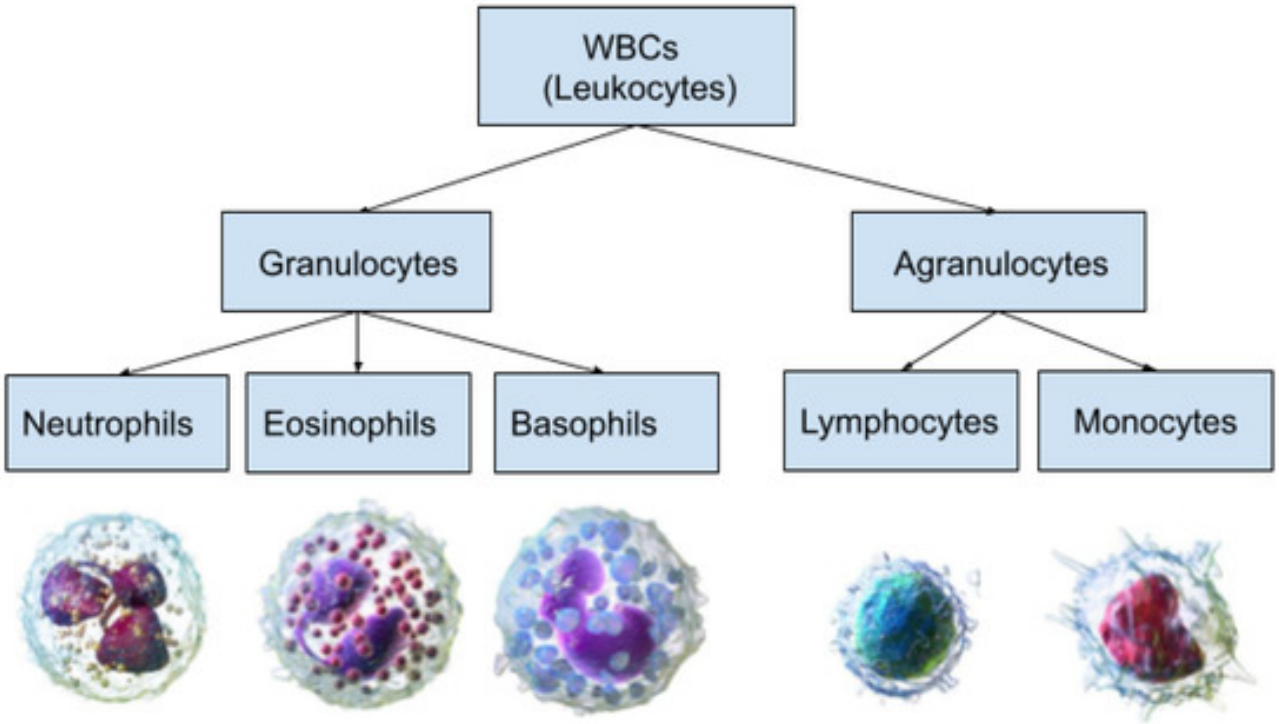
White blood cells:

- White blood cells (WBCs) are also called leukocytes.
- There are five kinds of WBCs; all are larger than RBCs and have nuclei when mature.
- The nucleus may be in one piece or appear as several lobes or segments.
- Special staining for microscopic examination gives each kind of WBC a distinctive appearance.
- A normal WBC count is 5,000 to 10,000 per microliter. Notice that this number is quite small compared to a normal RBC count.
- Many of WBCs are not circulating within blood vessels but are carrying out their functions in tissue fluid or in lymphatic tissue.
- The five kinds of white blood cells, all produced in the red bone marrow (and some lymphocytes in lymphatic tissue).

- **Classification:**
  may be classified in two groups: **granular and agranular**.

❖ **The granular leukocytes:** are the **neutrophils (60-70%), eosinophils (1-4%), and basophils (0.5-1%)**, which usually have nuclei in two or more lobes or segments, and have distinctly colored granules in the cytoplasm when stained. Neutrophils have light blue granules, eosinophils have red granules, and basophils have dark blue granules.

❖ **The agranular leukocytes:** are **lymphocytes (20-30%) and monocytes (3-8%)**, which have nuclei in one piece. Monocytes are usually quite a bit larger than lymphocytes.


WBCs
(Leukocytes)
Granulocytes
Agranulocytes
Neutrophils
Eosinophils
Basophils
Lymphocytes
Monocytes

- **Functions:** which is to protect the body from infectious disease and to provide immunity to certain diseases.

- **Neutrophils and Monocytes:** phagocytize pathogens; monocytes become macrophages, which also phagocytize dead tissue.

- **Eosinophils:** detoxify foreign proteins during allergic reactions and parasitic infections.

- **Basophils:** contain the heparin and histamine.
  - The heparin is an anticoagulant that helps prevent abnormal clotting within blood vessels.
  - Histamine is released as part of the inflammation process, and it makes capillaries more permeable, allowing tissue fluid, proteins, and white blood cells to accumulate in the damaged area.

- **Lymphocytes**: include T cells, B cells and natural killer cells (NK).
  - **T cells** recognize foreign antigens and destroy them.
  - **B cells** become plasma cells, which produce antibodies to foreign antigens.
  - **NK cells** destroy foreign cell membranes.

- A high WBC count, called **leukocytosis**, is often an indication of infection.
- **Leukopenia** is a low WBC count, which may be present in the early stages of diseases such as tuberculosis.

Platelets:

- Platelets also called is **thrombocytes.**
- Some of the stem cells in the red bone marrow differentiate into large cells called **megakaryocytes** , which break up into small pieces that enter circulation. These small, oval, circulating pieces are platelets without nuclei, which may last for 5 to 9 days.
- Thrombopoietin is a hormone produced by the liver that increases the rate of platelet production.
- A normal platelet count is 150,000 to 300,000/microliter (the high end of the range may be extended to 500,000).
- Thrombocytopenia is the term for a low platelet count.

- **Function:** form platelet plug in hemostasis; release chemicals that promote vascular spasm and blood clotting.