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Blood physiology: composition and functions

Balamurugan Madhusree[1], Abdyraimova Meerim Aitmarekovna[2], Orozbek Uulu Tursunbek[3]

[1] 1st year Student; *International Medical Faculty of Osh State University;* Republic of Kyrgyzstan

[2] Professor, Dept of Histology; *International Medical Faculty of Osh State University;* Republic of Kyrgyzstan

[3] Professor, Dept of Histology; *International Medical Faculty of Osh State University;* Republic of Kyrgyzstan

Abstract. The blood is a specialized connective tissue and performs a very important function in the human system to maintain the homeostasis and life support functions in the human body. It is composed of plasma and formed elements. Liquid part (plasma): This is the liquid portion -- about half -- of your blood: It makes up about 55% of its total volume; the blood cells are suspended in the liquid: It contains water, some salts (sodium and potassium, named for the reactivity of the element), and the chemicals your body needs (nutrients such as glucose, and hormones), and also the wastes your body is getting rid of (like carbon dioxide and ammonia). The other 45% are formed elements (red blood cells, white blood cells, and platelets) each having different, specific purposes and functions to perform Red blood cells are involved in the carrying of oxygen by way of vessels.

Keywords: *immune function, blood clotting, Blood physiology, plasma, red blood cells, white blood cells, platelets, oxygen transport, homeostasis, blood composition.*

INTRODUCTION:

Blood is a connective tissue often classified as a fluid that is somewhat controversial regarding the way of life and may vary. Blood continuously flows through the cardiovascular system, delivering oxygen and nutrients to tissues while carrying away waste materials like carbon dioxide and urea. Blood makes up around 7-8% of your total body weight. It is made up of two main parts: plasma and formed elements. The liquid part known as plasma carries proteins, electrolytes, hormones, and waste products. These formed elements have specific roles. Red blood cells are meant for carrying oxygen; white blood cells are meant for immunity, and platelets are

meant for clotting. Mostly red blood cells carry respiratory gases, white blood cells are responsible for immunity and platelets for blood clotting and healing in higher animals. Or you can say very important reason for blood colour red is mainly because of red blood cell. Blood transport oxygen to our tissues and organs whilst buffering pH, distributing body fluid and protecting against infection and disease. The body can easily respond to changes that happen inside the body and outside as well. Moreover, just as the kidney may suffer from conditions that affect its blood supply, other organs likewise suffer pathology as a result of blood disorders, as perhaps best exemplified by human leprosy. It helps in identification, treatment, and preventive health programs.

COMPOSITION OF BLOOD :

Blood is a connective tissue consisting of a liquid (plasma) and formed elements. Plasma is straw-coloured and liquidy while formed elements include blood cells and clotting elements. 1. Plasma. Blood plasma is a liquid component of blood containing water, electrolytes, nutrients, hormones, protein, and waste products. Water makes up between 90 and 92% of plasma and acts as a solvent for transporting different substances within the body. The rest of it (8-10%) is made up of the plasma proteins, electrolytes, hormones, enzymes, nutrients and waste products. Key plasma proteins include. Albumin - Maintains osmotic pressure - and carries hormones and drugs. The globulins help in immunity play and transport. Fibrinogen - Essential for blood clotting. The pH, osmotic equilibrium, and neuro-muscular functions are regulated by electrolytes such as sodium, potassium, calcium, and bicarbonate. Nutrients from the digestive system and hormones from endocrine glands are also carried by plasma. Waste products like urea and creatinine are transported to the kidneys for excretion.

PLASMA COMPONENTS AND BLOOD:

About 55% of blood's volume is made up of plasma, the liquid matrix. It is a straw-colored, pale yellow fluid that is mostly composed of water (90-92%) and serves as a solvent to move different substances throughout the body. Plasma proteins, electrolytes, nutrients, hormones, enzymes, and waste products make up the remaining 8-10% of plasma. The most prevalent of the plasma proteins, albumin is necessary for osmotic pressure maintenance as well as the transportation of fatty acids, hormones, and medications. While fibrinogen is involved in blood coagulation and wound healing, globulins

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play important roles in the immune response and aid in the transportation of lipids and vitamins. The blood's pH, water balance, and nerve and muscle function are all regulated by electrolytes like sodium, potassium, calcium, magnesium, chloride, and bicarbonate.

RED BLOOD CELLS:

The most prevalent of the components that are produced in blood, red blood cells (RBCs), also referred to as erythrocytes, are principally in charge of carrying carbon dioxide and oxygen. They lack a nucleus and other organelles, which gives hemoglobin—the iron-containing protein that binds oxygen—more space, and their biconcave shape increases their surface area for effective gas exchange. About 250 million haemoglobin molecules make up each red blood cell, which allows it to return carbon dioxide for exhalation and transport a significant amount of oxygen from the lungs to tissues. The hormone erythropoietin, which is mostly secreted by the kidneys, controls the process of erythropoiesis, which produces red blood cells in the red bone marrow. The typical lifespan of a red blood cell. They are biconcave in shape, which increases their surface area for efficient gas exchange, and they lack a nucleus and organelles, allowing more room for hemoglobin, the iron-containing protein that binds oxygen. Each red blood cell contains approximately 250 million hemoglobin molecules, enabling it to carry a large amount of oxygen from the lungs to tissues and return carbon dioxide for exhalation. RBCs are produced in the red bone marrow through a process called erythropoiesis, which is regulated by the hormone erythropoietin, primarily secreted by the kidneys. The average lifespan of a red blood cell is about 120 days, after which it is removed and broken down by macrophages in the liver and spleen. The iron from degraded hemoglobin is recycled, while other components are excreted. The red color of blood is due to the abundance of hemoglobin in these cells. A healthy RBC count is essential for maintaining adequate oxygen delivery to the body’s tissues, and abnormalities can result in disorders such as anemia or polycythemia, affecting overall health and metabolic function.

WHITE BLOOD CELLS:

An integral component of the body's immune system, white blood cells, also known as leukocytes, are vital in protecting the body from infections, foreign substances, and aberrant cells. Leukocytes can carry out complex tasks because they

have multiple organelles and a nucleus, unlike red blood cells. They are made in the bone marrow and move through the lymphatic and circulatory systems, continuously scanning for dangers. Granulocytes and agranulocytes are the two primary subtypes of leukocytes. Based on the staining properties of their granules, neutrophils, eosinophils, and basophils are examples of granulocytes. As the first line of defence, neutrophils are the most prevalent and use phagocytosis to engulf and kill bacteria and fungi. While basophils release histamine, eosinophils fight off larger parasites and play a role in allergic reactions.

OXYGEN AND CARBON DIOXIDE TRANSPORT :

The transport of oxygen and carbon dioxide is one of the primary functions of blood and is essential for cellular respiration and for the maintenance of homeostasis. Oxygen enters the lungs, diffuses across the alveolar membrane into blood plasma and then rapidly and reversibly binds to hemoglobin inside red blood cells. The reason that hemoglobin is able to bind oxygen efficiently is due to its very high binding affinity for oxygen — ultimately ~98.5% of oxygen in blood is carried in association with hemoglobin; a very small amount of oxygen is actually dissolved in plasma. After binding, hemoglobin and associated oxygen are transported through the circulatory system to tissues, where oxygen is released for metabolic activities to generate energy. On the contrary, carbon dioxide (the metabolic bi-product of aerobic metabolism) must be transported back from tissues to the lungs to be expelled from the body. Approximately 70% of carbon dioxide is transported in plasma as bicarbonate ions (HCO_3^-) after being formed in red blood cells by the catalytic activity of the enzyme carbonic anhydrase. Another 20-23% of carbon dioxide is transported by binding to hemoglobin as carbaminohemoglobin and the remaining carbon dioxide is dissolved in plasma. This whole blood activity is an effective exchange system that provides intermittent delivery of oxygen to tissues to maintain cellular function and the removal of carbon dioxide to maintain acid-base homeostasis. Issues affecting the blood transport process can result in significant complications such as hypoxia (insufficient oxygen) or hypercapnia (excess carbon dioxide), which can in turn seriously affect organ

BLOOD GROUPS AND TRANSFUSIONS :

Blood plays an immune function, and is vital for defending against infections, toxic substances, and abnormal cells.

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This protective function is primarily performed by white blood cells and their plasma proteins. White blood cells circulate throughout the blood and body tissues; they are key to finding and destroying pathogens. There are many types of leukocytes, and these different types of cells are specialized for different immune functions: neutrophils are first responders to bacterial infections, and can rapidly phagocytose bacteria; eosinophils defend against parasites and secrete mediators involved in allergic responses; and basophils secrete histamines and other mediators in response to inflammatory reactions. Monocytes circulate in the blood and be transformed into macrophages in the tissue, which can phagocytose pathogens and dead cells and activate other immune cells. Lymphocytes, including different types of B cells and T cells, are important for adaptive immune responses. B cells can generate antibodies, and T-cells directly kill infected or cancerous cells. Plasma contains immunoglobulins (antibodies) and complement proteins that help identify or eliminate pathogens, facilitate phagocytosis, and promote inflammation. And cytokines, small signaling proteins that circulate in blood, help regulate immune responses, while also helping cells communicate (most immune cells must be able to communicate with each other). These important cellular and molecular components make blood a very powerful medium to provide immune surveillance, rapid response, and long-term immunity that allows the body to fight off disease and maintain its internal health.

DISORDER OF BLOOD:

Blood diseases are medical conditions that affect one or more components of blood: red blood cells; white blood cells; platelets; and/or plasma. These diseases can impact the circulatory system and the immune system; they can also be hereditary or acquired. One of the most recognized diseases of the red blood cells is anemia. Anemia affects the count or shape of the red blood cells, which decreases the blood's ability to facilitate oxygen delivery to the tissues. Types of anemia include iron-deficiency anemia, sickle cell anemia, and thalassemia. Leukemia is a cancer of the white blood cells. This is disease where abnormal cells continuously multiply and interfere with the immune system. Other blood disorders of the white blood cell inlcude lymgphoma and leukopenia, which decrease the function of the immune system. Thrombocytopenia is a low platelet count. This can lead to excessive bleeding. Hemophilia is a genetic disease where

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certain clotting factors are deficient or lacking, which affects the blood's ability to clot. Various plasma component disorders also affect plasma, such as multiple myeloma, which affects antibody generation and immune response. Early diagnosis and treatment of blood diseases is necessary to reduce symptoms and prevent further complications. Blood disease require blood tests for diagnosis; some blood diseases may include drug therapy, transfusions, and/or bone marrow transplants.

ROLE OF BLOOD IN HOMEOSTASIS:

Blood plays a fundamental role in maintaining homeostasis, the stable internal environment necessary for optimal functioning of the body. It regulates a wide range of physiological processes that ensure balance and stability. One of its key functions is the transport of oxygen and nutrients to tissues and the removal of carbon dioxide and metabolic waste products, which is essential for cellular metabolism. Blood also helps regulate body temperature by distributing heat throughout the body and adjusting flow to the skin for heat loss or conservation. The buffer systems in blood, such as the bicarbonate buffer, maintain acid-base balance by neutralizing excess acids or bases, keeping blood pH within the narrow range of 7.35-7.45. Additionally, blood maintains fluid and electrolyte balance by transporting ions like sodium, potassium, and calcium, which are crucial for nerve and muscle function. Hormones carried by blood help regulate processes such as growth, metabolism, and water balance. The clotting mechanisms of blood prevent excessive bleeding after injury, while white blood cells and antibodies defend against pathogens, supporting immune homeostasis. Overall, blood acts as a dynamic medium, constantly adjusting to internal and external changes to preserve the health and stability of the body.

CONCLUSION :

In conclusion, blood is an indispensable connective tissue that serves so many crucial functions for living organisms. The components of blood—plasma and the formed elements—enable it to transport oxygen, nutrients, hormones, and wastes within the body. Transport of oxygen is accomplished primarily through red blood cells; defense against pathogens/disease is largely performed by white blood cells; and clot formation and repair of broken tissues is accomplished, in varying degrees, by platelets. Plasma also has a plethora of proteins, electrolytes, and various other

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substances critical to metabolic activity, immune defenses, and maintaining homeostasis. Blood makes survival possible in other ways, too, most notably in the regulation of pH, thermoregulation, and as a defense against disease and injury. Complex systems (like clotting pathways and buffering systems) exist to maintain the stability of blood physiology to respond to injuries and physiological challenges to homeostasis. This is why it is critical to understand the many disease and abnormal physiology of blood; early diagnosis and intervention could mean the difference between life and death.

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