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THE MAIN COMPONENTS OF BLOOD: ERYTHROCYTES, LEUKOCYTES, PLATELETS, AND PLASMA

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Abstract

Blood is a vital connective tissue that performs essential functions in the human body, including transportation of oxygen, nutrients, hormones, and waste products. It also plays a critical role in immune defense and hemostasis. Blood consists of plasma and cellular elements—erythrocytes, leukocytes, and platelets—each of which has specific structure and function. Erythrocytes transport oxygen and carbon dioxide, leukocytes protect the body from infections, and platelets participate in coagulation. Plasma serves as a transport medium for nutrients, hormones, and plasma proteins. Understanding the composition and proportion of blood components is essential for clinical diagnostics, medical research, and therapeutic applications.

Keywords

blood, erythrocytes, leukocytes, platelets, plasma, hemostasis, immune system, blood composition

ОСНОВНЫЕ КОМПОНЕНТЫ КРОВИ: ЭРИТРОЦИТЫ, ЛЕЙКОЦИТЫ, ТРОМБОЦИТЫ И ПЛАЗМА

Аннотация

Кровь является важной соединительной тканью, выполняющей основные функции в организме человека, включая транспорт кислорода, питательных веществ, гормонов и продуктов обмена. Она также играет ключевую роль в иммунной защите и гемостазе. Кровь состоит из плазмы и клеточных элементов — эритроцитов, лейкоцитов и тромбоцитов, каждый из которых имеет специфическую структуру и функцию. Эритроциты переносят кислород и углекислый газ, лейкоциты защищают организм от инфекций, а тромбоциты участвуют в свертывании крови. Плазма служит транспортной средой для питательных веществ, гормонов и плазменных белков. Понимание состава и пропорций компонентов крови важно для клинической диагностики, медицинских исследований и терапевтических применений.

Ключевые слова

кровь, эритроциты, лейкоциты, тромбоциты, плазма, гемостаз, иммунная система, состав крови

Blood is a vital connective tissue in the human body, responsible for transporting oxygen, nutrients, hormones, and waste products. It also plays an essential role in maintaining homeostasis, supporting the immune system, and enabling coagulation. Blood consists of cellular elements suspended in a liquid called plasma. The main components—erythrocytes, leukocytes, platelets, and plasma—function together to sustain physiological balance and respond to pathological conditions. Understanding these components is fundamental in hematology, clinical diagnostics, and medical research.

Blood constitutes approximately 7–8% of body weight, with an average volume of 4.5–5.5 liters in adults. Its slightly alkaline pH (7.35–7.45) and slightly higher temperature (~38°C) support optimal enzymatic and cellular function[1]. Blood viscosity is influenced primarily by the proportion of erythrocytes and plasma proteins. Variations in blood composition are key diagnostic indicators for conditions such as anemia, leukemia, and coagulopathies.

Erythrocytes are the most abundant cells in the blood, responsible for transporting oxygen from the lungs to tissues and returning carbon dioxide for exhalation. Human erythrocytes are biconcave, anucleated cells with a diameter of 6–8 µm and an average lifespan of 120 days[2]. The biconcave shape maximizes surface area for gas exchange and allows flexibility to pass through narrow capillaries. Hemoglobin, the oxygen-carrying protein within erythrocytes, binds oxygen via its iron-containing heme groups and releases it in tissues with lower oxygen concentrations. Erythrocyte production, or erythropoiesis, occurs in the bone marrow and is stimulated by erythropoietin, a hormone produced by the kidneys in response to low oxygen levels[3]. Disorders affecting erythrocytes include anemia (reduced RBC count), polycythemia (increased RBC count), and sickle cell disease (abnormal hemoglobin structure).

Leukocytes, though fewer in number than erythrocytes, are essential for immune defense. They are categorized into five types: neutrophils, lymphocytes, monocytes, eosinophils, and basophils.

- Neutrophils: The most abundant WBCs, act as first-line defenders against bacterial infections through phagocytosis.
- Lymphocytes: Include B cells, T cells, and natural killer cells; they regulate adaptive immune responses and produce antibodies.
- Monocytes: Differentiate into macrophages and dendritic cells, which phagocytose pathogens and present antigens.

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- Eosinophils: Combat parasitic infections and participate in allergic reactions.
- Basophils: Release histamine and other mediators during inflammation and hypersensitivity responses.

Leukocyte counts and differential analysis are critical in diagnosing infections, autoimmune disorders, and hematologic malignancies.

Platelets are small, anucleated cell fragments derived from bone marrow megakaryocytes. They play a crucial role in hemostasis by forming platelet plugs at sites of vascular injury and participating in the coagulation cascade[4]. Upon activation, platelets adhere to damaged endothelium, aggregate, and release granule contents to recruit more platelets and amplify clotting. Normal platelet counts range from 150,000 to 450,000 per microliter of blood. Abnormal platelet number or function can result in bleeding disorders (thrombocytopenia) or excessive clot formation (thrombosis).

Plasma, the liquid component of blood, makes up about 55% of blood volume. It consists mostly of water (≈90%) along with electrolytes, proteins, glucose, lipids, hormones, and waste products[5].

- Albumin: Maintains osmotic pressure and transports lipophilic substances.
- Globulins: Include immunoglobulins for immune defense.
- Fibrinogen: Essential for clot formation during coagulation.

Plasma serves as a transport medium for nutrients, hormones, and metabolic waste. It also interacts with cellular components to maintain hemostasis, immunity, and overall homeostasis

The components of blood work together dynamically. For example, during vascular injury, platelets form a plug and activate coagulation factors in plasma, while leukocytes migrate to sites of infection or inflammation, releasing cytokines and growth factors. Erythrocytes, while not immune cells, influence blood viscosity and oxygen delivery, which are critical for the function of other components[6]. Blood composition varies depending on age, sex, diet, health status, and environmental factors. Clinical evaluation of blood includes complete blood count (CBC), hematocrit, hemoglobin levels, platelet count, and plasma protein assessment[7]. Advances in hematology and molecular biology continue to enhance our understanding of blood physiology and pathology, improving diagnostic and therapeutic strategies.

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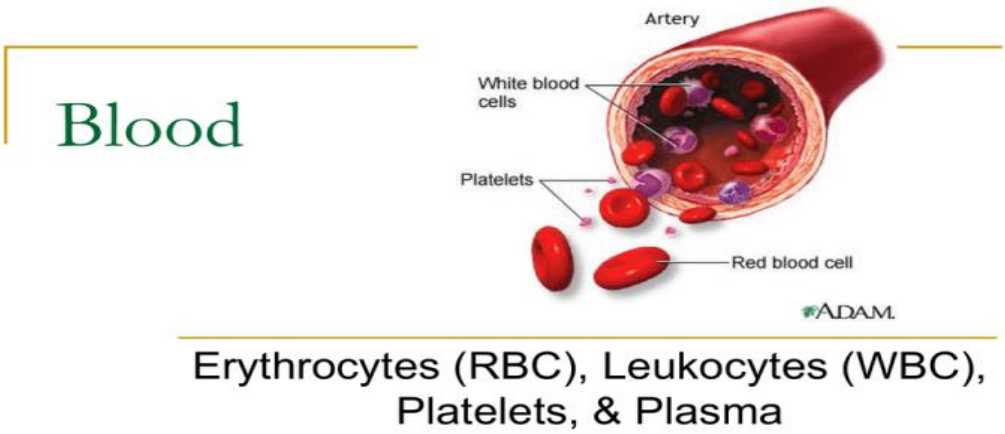
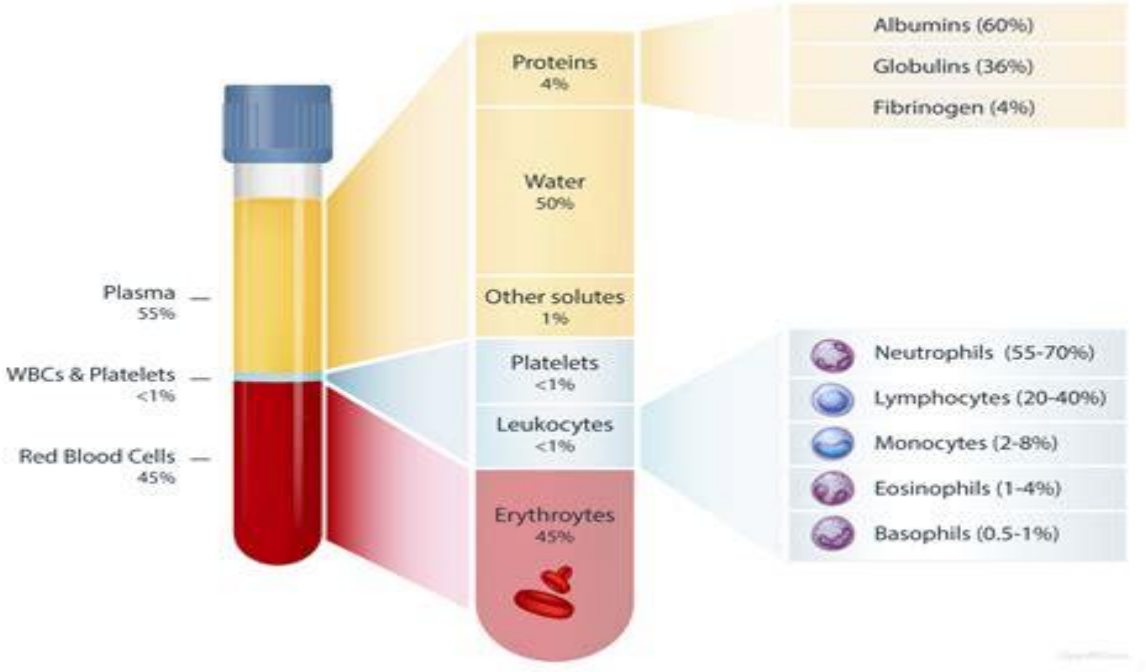


1. Blood Components in Circulation

Description: This diagram shows blood flowing through a vessel.

- Erythrocytes (Red Blood Cells): Biconcave cells responsible for oxygen transport.
- Leukocytes (White Blood Cells): Larger cells involved in immune defense.
- Platelets (Thrombocytes): Small cell fragments that help in blood clotting.
- Plasma: The yellowish fluid that carries nutrients, hormones, and waste products.



2. Blood Composition by Volume

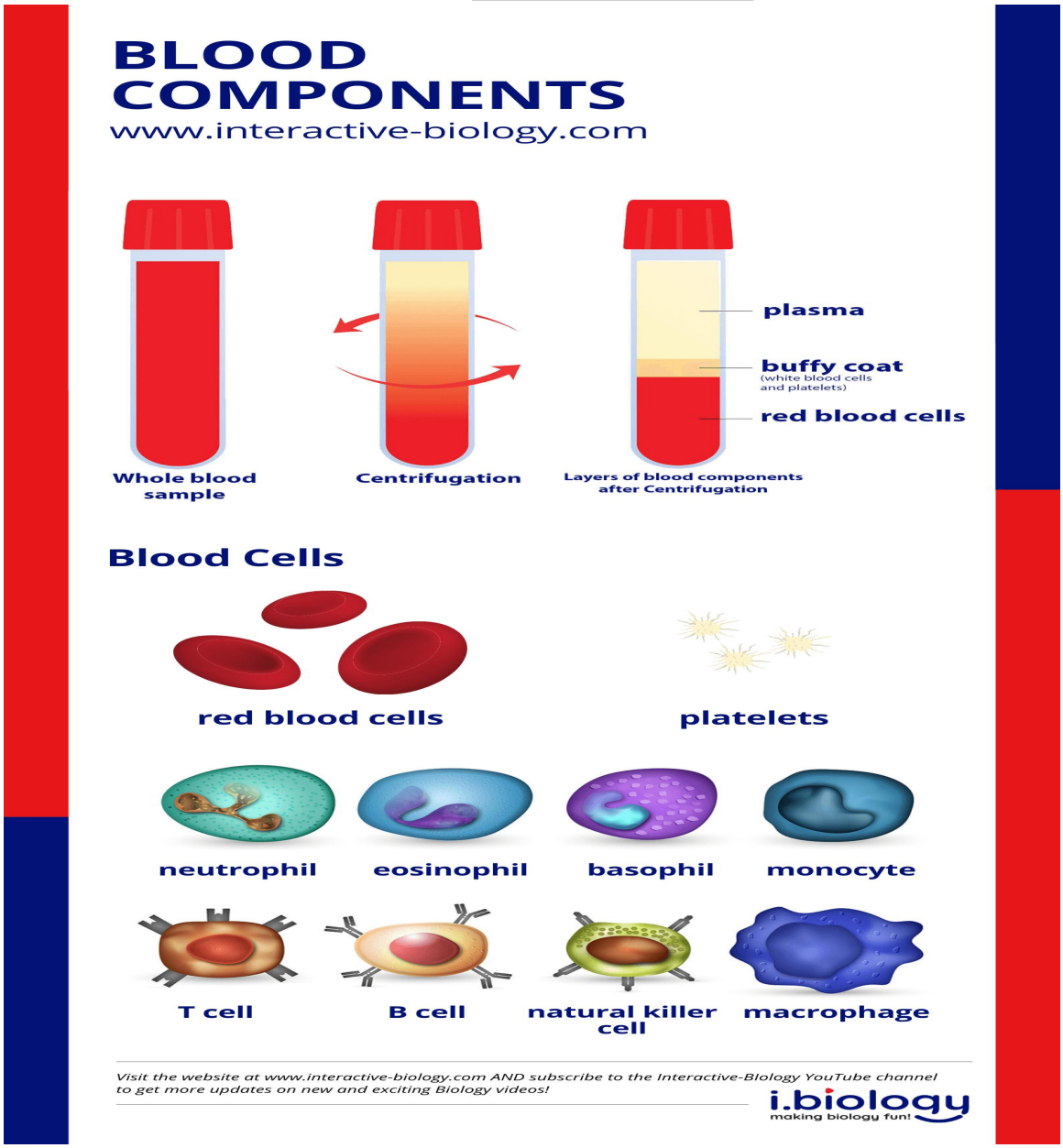
Description: Pie chart or diagram illustrating the proportion of blood components.

- Plasma: ~55% of total blood volume.
- Erythrocytes: ~40–45% (hematocrit).
- Leukocytes & Platelets: ~1% of blood volume, forming the buffy coat.

Blood consists of cellular elements and plasma, with each component contributing differently to total blood volume:

- Plasma: ~55% of total blood volume. Plasma is mostly water (~90%) and carries proteins, electrolytes, hormones, and nutrients.
- Erythrocytes (Red Blood Cells): ~40–45% of blood volume. They transport oxygen from the lungs to tissues and return carbon dioxide to the lungs.
- Leukocytes (White Blood Cells) and Platelets: ~1% of blood volume, forming the buffy coat. Leukocytes protect the body against infections, while platelets are essential for blood clotting.

Although leukocytes and platelets make up a small fraction of blood, they perform crucial protective and hemostatic functions. Plasma and erythrocytes form the majority, ensuring efficient transport of gases, nutrients, and waste products



3. Centrifuged Blood Sample

Description: This image represents a blood sample after centrifugation.

- Plasma: Clear yellow fluid at the top, containing proteins, electrolytes, and nutrients.
- Buffy Coat: Thin white layer in the middle containing leukocytes and platelets.
- Erythrocytes: Red layer at the bottom, densest component, responsible for oxygen transport.

Conclusion

Blood is a complex connective tissue composed of plasma and cellular elements, each playing a critical role in maintaining homeostasis and overall health**. Erythrocytes** transport

oxygen and carbon dioxide, ensuring tissues receive the oxygen necessary for metabolism. Leukocytes provide immune defense, protecting the body from infections and foreign substances. Platelets are essential for hemostasis, enabling rapid blood clot formation in response to vascular injury. Plasma serves as a transport medium for nutrients, hormones, waste products, and plasma proteins, which help regulate osmotic pressure and immune functions.

Understanding the composition and proportion of blood components is fundamental for clinical diagnostics, research in hematology, and therapeutic interventions. Changes in blood composition can indicate a variety of health conditions, from anemia and infections to coagulation disorders. Therefore, a clear knowledge of blood's structure, function, and dynamic interactions among its components is essential for both health professionals and biomedical researchers.

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