COMPOSITION AND CONSTITUENTS OF BLOOD

Term Paper

Submitted

To the

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BY

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INTRODUCTION

Blood is one of the most vital fluids in the human body, responsible for maintaining homeostasis, facilitating nutrient delivery, and ensuring the efficient functioning of various physiological processes. As a complex, specialized tissue, blood plays a crucial role in transporting gases, nutrients, hormones, waste products, and immune cells, making it indispensable for life. The study of blood, particularly its composition and constituents, offers insights into its multifaceted functions in the body. The composition of blood can be divided into two major components: the plasma and the formed elements. Plasma is the liquid portion of blood, accounting for approximately 55% of its total volume, while the formed elements—comprising red blood cells, white blood cells, and platelets—make up the remaining 45%. Together, these constituents enable blood to perform a range of essential functions, including the transport of oxygen and carbon dioxide, regulation of body temperature, immune defense, and coagulation. In this introduction, we will explore the components and constituents of blood in detail, including their roles and physiological significance, with references to scientific literature that highlight their importance in maintaining health and combating disease. *Kuby, J., & Goldsby, R. A. 2007*)

Blood is one of the most important components of life. Almost any animal that possesses a circulatory system has blood. From an evolutionary perspective, blood was speculated to have risen from a type of cell that was responsible for phagocytosis

and nutrition. Billions of years later, blood and the circulatory system have drastically helped the evolution of more complex lifeforms. (*Kuby, J., & Goldsby, R. A. 2007*)

What is Blood?

Blood is a fluid connective tissue that consists of plasma, blood cells and platelets. It circulates throughout our body delivering oxygen and nutrients to various cells and tissues. It makes up 8% of our body weight. An average adult possesses around 5-6 litres of blood. *(Tortora, G. J., & Derrickson, B. H. 2014)*

Types of Blood Cells

We have seen blood consist of cells known as formed elements of blood. These cells have their own functions and roles to play in the body. The blood cells which circulate all around the body are as follows:

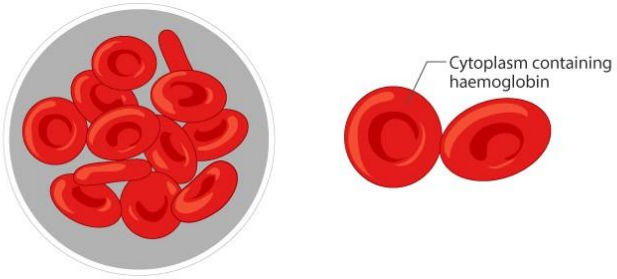
Red blood cells (Erythrocytes)

RBCs are biconcave cells without nucleus in humans; also known as erythrocytes. RBCs contain the iron-rich protein called haemoglobin; give blood its red colour. RBCs are the most copious blood cells produced in bone marrows. Their main function is to transport oxygen from and to various tissues and organs.

White blood cells (Leucocytes)

Leucocytes are colourless blood cells. They are colourless because it is devoid of haemoglobin. They are further classified as granulocytes and agranulocytes. WBCs mainly contribute to immunity and defence mechanism.

Red blood cells (RBC)



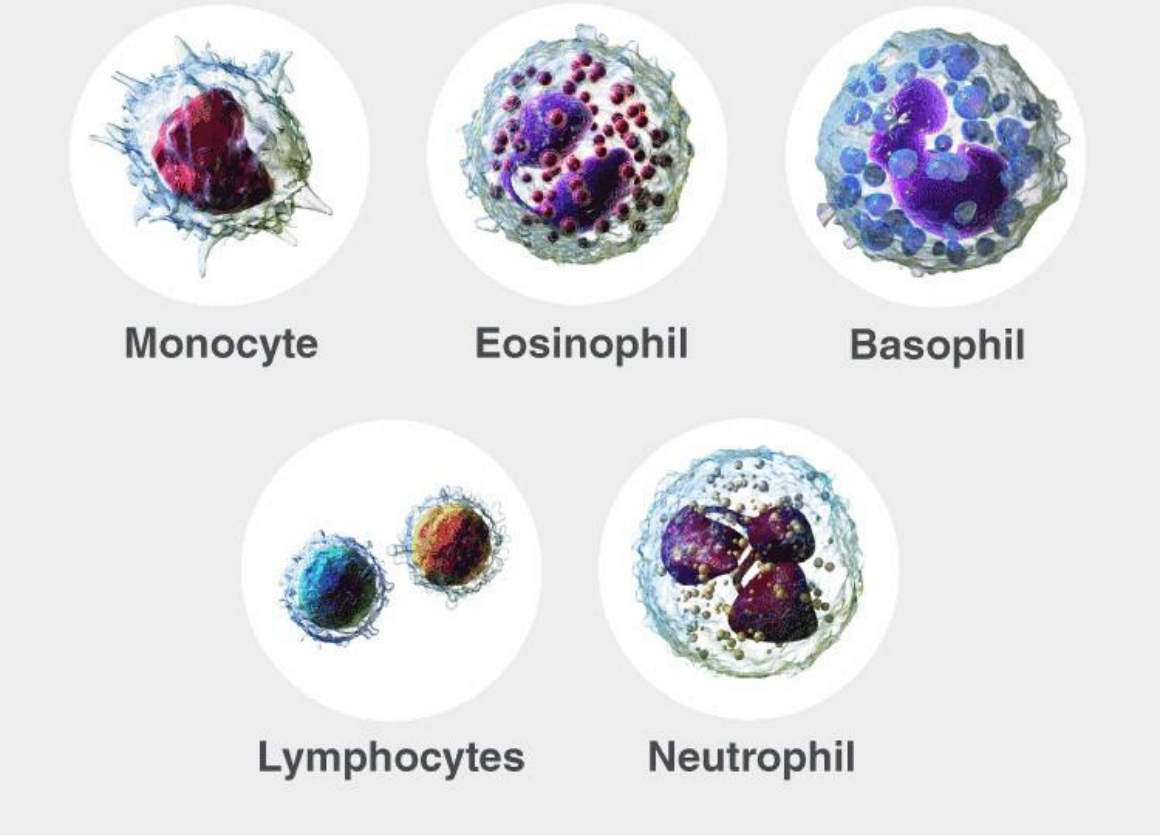
Red Blood Cells are red due to **Hemoglobin**, which is a **transport molecule** and also a **pigment.** As a result, blood is red.

Types of White Blood Cells

There are five different types of White blood cells and are classified mainly based on the presence and absence of granules.

- Granulocytes
- Agranulocytes

White Blood Cells


Monocyte
Eosinophil
Basophil
Lymphocytes
Neutrophil

There are **five types of white blood cells** present in the blood

Granulocytes

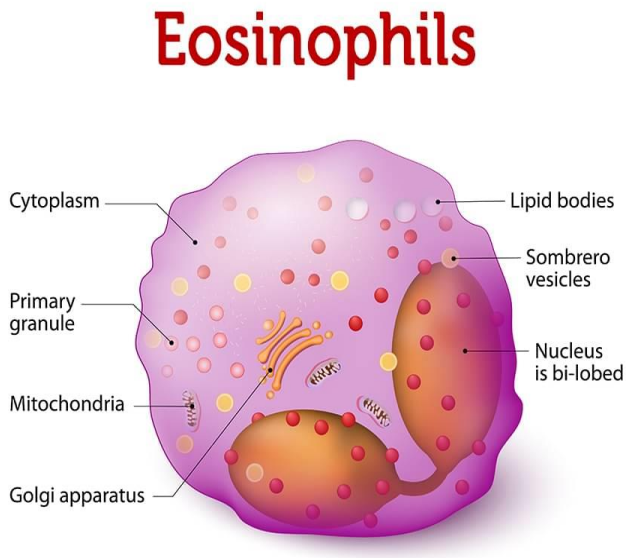
They are leukocytes, with the presence of granules in their cytoplasm. The granulated cells include- eosinophil, basophil, and neutrophil.

Eosinophils

- They are the cells of leukocytes, which are present in the immune system.

  These cells are responsible for combating infections in parasites of vertebrates and for controlling mechanisms associated with allergy and asthma.

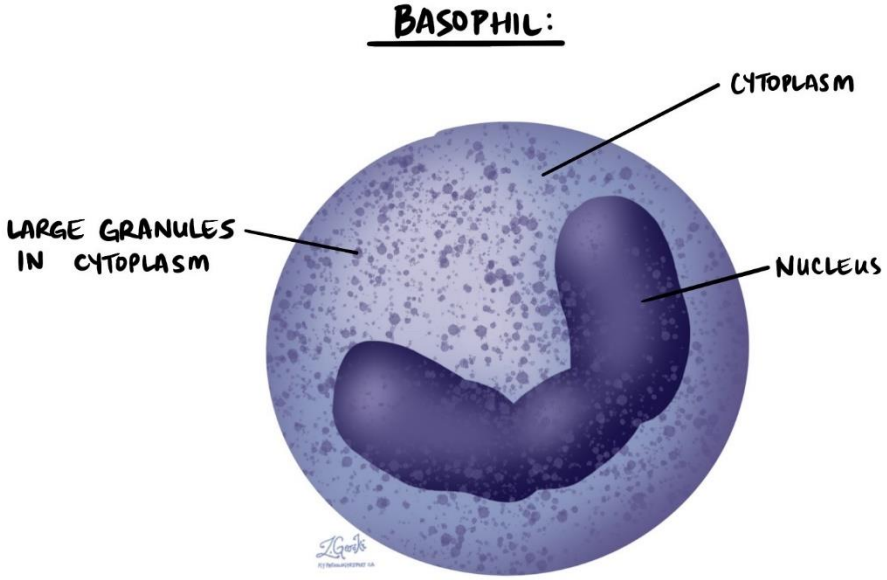
  Eosinophil cells are small granulocyte, which are produced in the bone marrow and makes 2 to 3 per cent of whole WBCs. These cells are present in high concentrations in the digestive tract.



Control mechanisms associated with allergy

Basophils

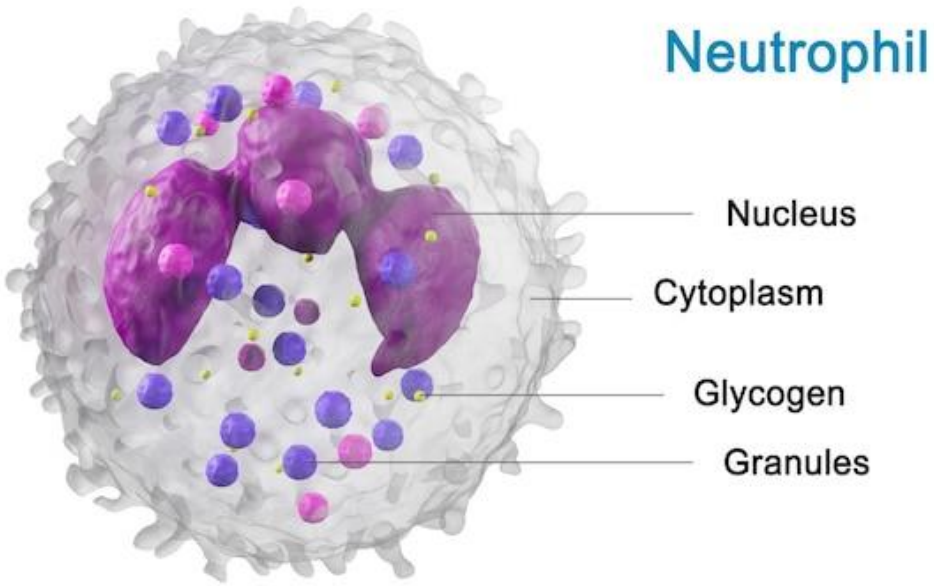
- They are the least common of the granulocytes, ranging from 0.5 to 1 per cent of WBCs.
- They contain large cytoplasmic granules, which play a vital role in mounting a nonspecific immune response to pathogens, and allergic reactions by releasing histamine and dilating the blood vessels.
- These white blood cells have the ability to be stained when exposed to basic dyes, hence referred to as basophil.
- These cells are best known for their role in asthma and their result in inflammation and bronchoconstriction in the airways.
- They secrete serotonin, histamine and heparin.



Neutrophils

- They are normally found in the bloodstream.
- They are predominant cells, which are present in pus.
- Around 60 to 65 per cent of WBCs are neutrophils with a diameter of 10 to 12 micrometres.
- The nucleus is 2 to 5 lobed and the cytoplasm has very fine granules.
- Neutrophil helps in the destruction of bacteria with lysosomes, and it acts as a strong oxidant.
- Neutrophils are stained only using neutral dyes. Hence, they are called so.
- Neutrophils are also the first cells of the immune system to respond to an invader such as a bacteria or a virus.

The lifespan of these WBCs extends for up to eight hours and is produced every day in the bone marrow.



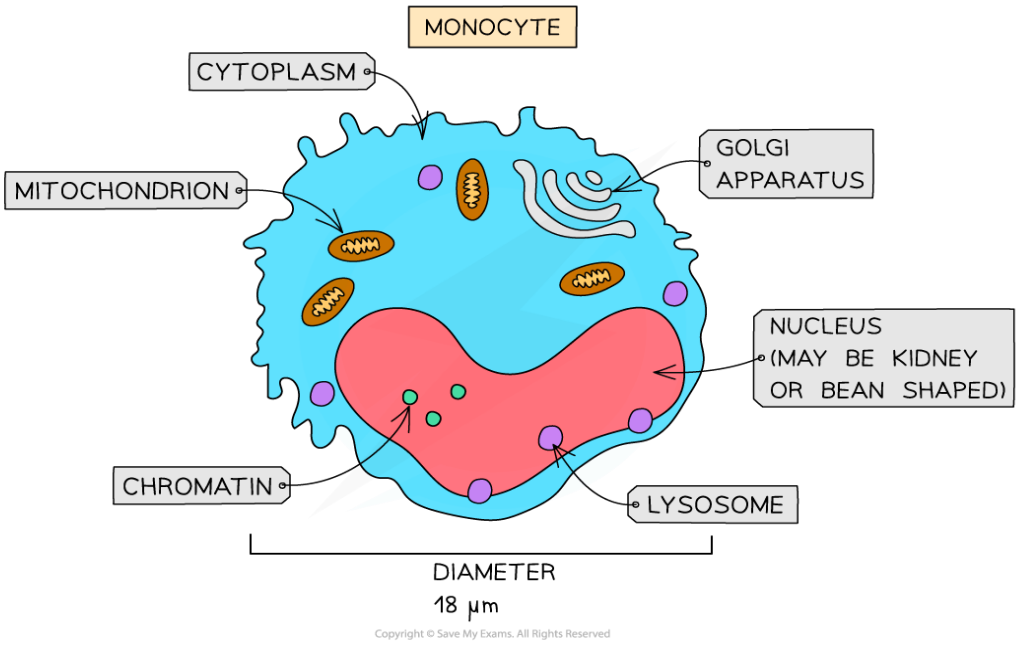
Agranulocytes

They are leukocytes, with the absence of granules in their cytoplasm. Agranulocytes are further classified into monocytes and lymphocytes.

Monocytes

- These cells usually have a large bilobed nucleus, with a diameter of 12 to 20 micrometres.
- The nucleus is generally half-moon shaped or kidney-shaped and it occupies 6 to 8 per cent of WBCs.
- They are the garbage trucks of the immune system.

- The most important functions of monocytes are to migrate into tissues and clean up dead cells, protect against bloodborne pathogens and move very quickly to the sites of infections in the tissues.
- These white blood cells have a single bean-shaped nucleus, hence referred to as Monocytes.



Lymphocytes

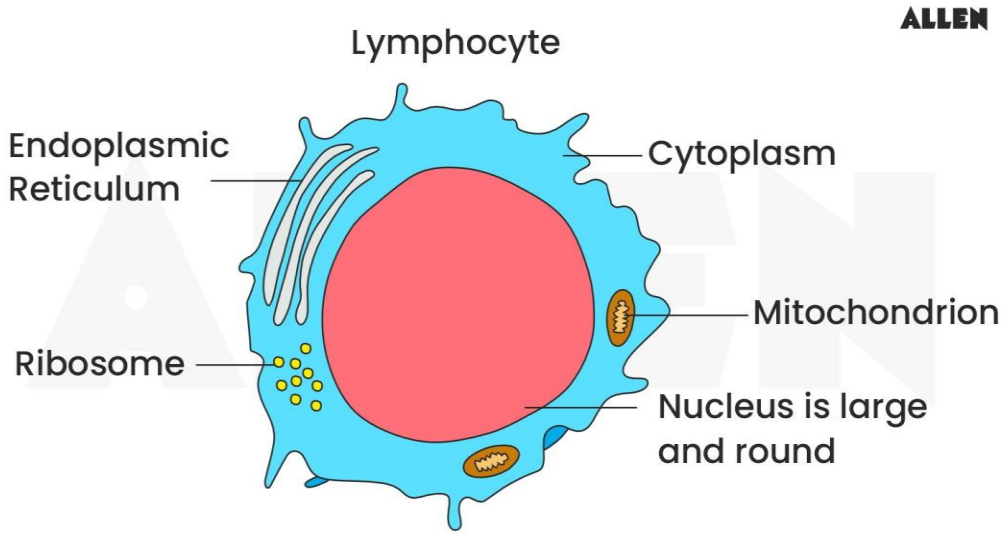
- They play a vital role in producing antibodies.
- Their size ranges from 8 to 10 micrometres.
- They are commonly known as natural killer cells.

- They play an important role in body defence.

  These white blood cells are colourless cells formed in lymphoid tissue, hence referred to as lymphocytes.

  There are two main types of lymphocytes – B lymphocytes and T lymphocytes.

- These cells are very important in the immune systems and are responsible for humoral and cell-mediated immunity.

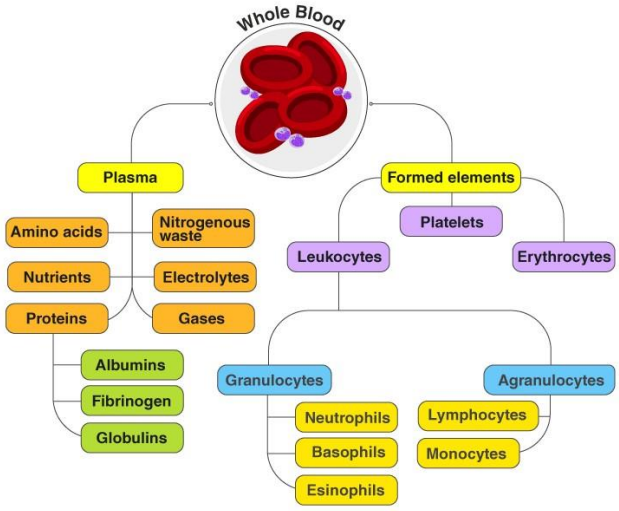


Platelets (Thrombocytes)

- Thrombocytes are specialized blood cells produced from bone marrow.
- Platelets come into play when there is bleeding or haemorrhage.

- They help in clotting and coagulation of blood. Platelets help in coagulation during a cut or wound.

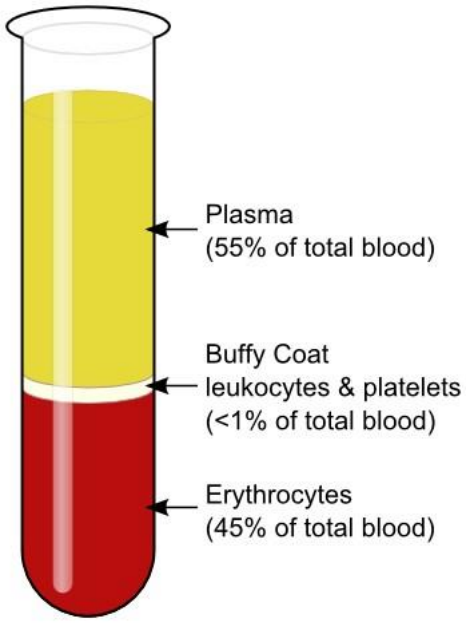
Composition of Blood



Composition of Blood: Plasma, RBCs, WBCs and platelets

Components Of Blood

There are many cellular structures in the composition of blood. When a sample of blood is spun in a centrifuge machine, they separate into the following constituents: Plasma, buffy coat and erythrocytes. Thus blood contains RBC, WBC, platelets and plasma.



Plasma

The liquid state of blood can be contributed to plasma as it makes up ~55% of blood. It is pale yellow in colour and when separated. Blood plasma consists of salts, nutrients, water and enzymes. Blood plasma also contains important proteins and other components necessary for overall health. Hence, blood plasma transfusions are given to patients with liver failure and lifethreatening injuries.

Components of Blood Plasma

Blood plasma has several protein components. Proteins in blood plasma are:

- Serum globulin
- Serum albumin
- Fibrinogen

The serum contains only globulin and albumin. Fibrinogen is absent in serum because it is converted into fibrin during blood clotting.

Red Blood Cells (RBC)

Red blood cells consist of Haemoglobin, a protein. They are produced by the bone marrow to primarily carry oxygen to the body and carbon dioxide away from it.

White Blood Cells (WBC)

White blood cells are responsible for fighting foreign pathogens (such as bacteria, viruses, and fungi) that enter our body. They circulate throughout our body and originate from the bone marrow.

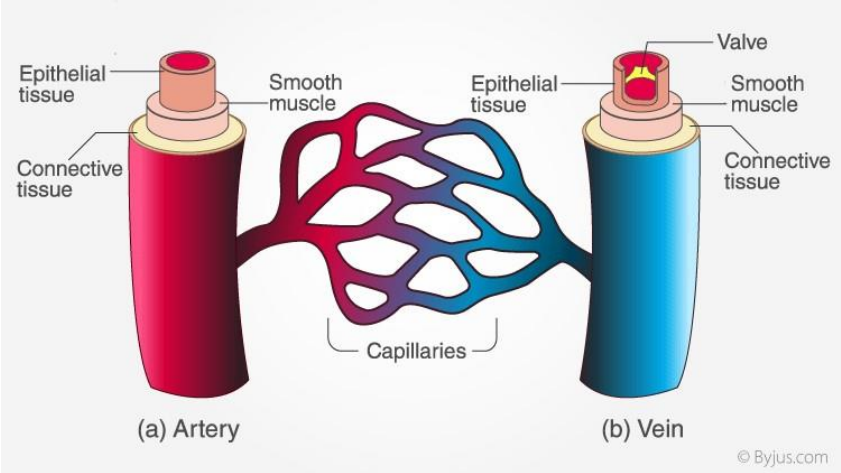
Platelets

Tiny disc-shaped cells that help regulate blood flow when any part of the body is damaged, thereby aiding in fast recovery through clotting of blood.

The above-stated elements form the composition of blood in humans. The only vertebrate without haemoglobin is the crocodile icefish. It derives its oxygen requirement directly from the cold, oxygen-rich water where it lives.

Blood Vessels

There are different types of blood vessels in our body each carrying out specialized functions. **Type of Blood Vessels**



Blood vessels are categorized into arteries, veins and capillaries

Types of Blood Vessels

Three types of blood vessels are:

- Arteries
- Veins
- Capillaries

Arteries

Arteries are strong tubes and muscular in nature. These blood vessels carry oxygen-rich blood from the heart to all the tissues of the body. Aorta is one of the main arteries that arise from the heart and branches further.

Veins

Veins are elastic blood vessels which carry deoxygenated blood from all parts of the body to the heart. An exception is the umbilical and pulmonary veins. The

Pulmonary vein carries oxygenated blood to the heart from the lungs and the umbilical vein carries oxygenated blood from the placenta to the foetus.

Capillaries

On reaching tissues, arteries branch further into extremely thin tubes called capillaries.

Capillaries bring about the exchange of substances between blood and tissues.

Sinusoids

Sinusoids are a special type of wider capillaries present in bone marrow, liver, lymph nodes, spleen and some endocrine glands. They may be continuous, discontinuous or fenestrated.

Layers of Blood Vessels

Both arteries and veins consist of three layers.

- **Tunica Intima**: It is one of the innermost and thinnest layers of arteries and veins. It comprises endothelial cells. They are in direct contact with the flow of blood.
- **Tunica Media**: It is the middle layer of an artery or vein. Tunica media is made up of smooth muscle cells.
- **Tunica Externa:** It surrounds tunica media. It is made up of collagen and is also supported by the elastic lamina in arteries.

Blood Plasma: The Liquid Component

Blood plasma is the yellowish, straw-colored liquid that constitutes about 55% of total blood volume. It is predominantly water (around 90%), but it also contains

various proteins, hormones, nutrients, waste products, and electrolytes. Plasma serves as the medium through which formed elements are transported throughout the circulatory system.

Plasma Proteins

Plasma proteins are the most significant dissolved components in plasma, making up approximately 7-9% of its volume. These proteins perform a variety of functions, such as maintaining osmotic pressure, transporting substances, and contributing to immune defense. The three main types of plasma proteins are:

1. **Albumins**: The most abundant plasma proteins, albumins account for about 60% of the total plasma proteins. They play a critical role in maintaining the colloidal osmotic pressure of the blood, which helps in regulating the balance of fluids between blood vessels and tissues. Albumins also function as transport proteins, carrying substances such as fatty acids, hormones, and medications through the bloodstream (*Silver et al., 2020*).

2. **Globulins**: This group of proteins includes alpha, beta, and gamma globulins, each serving different functions. Alpha and beta globulins primarily serve as transporters of lipids, hormones, and metal ions, while gamma globulins are the antibodies, or immunoglobulins, that are crucial for immune defense. Immunoglobulins specifically help in identifying and neutralizing foreign invaders like bacteria and viruses. (*Geyer et al., 2019*)

3. **Fibrinogen**: Fibrinogen is a key protein involved in blood coagulation. Upon activation during injury or trauma, fibrinogen is converted into fibrin, which forms a clot that helps to prevent excessive blood loss (*Moreno et al., 2018*).

Electrolytes and Nutrients

Blood plasma also contains various electrolytes, including sodium, potassium, calcium, chloride, bicarbonate, and magnesium. These ions are critical for maintaining the proper pH balance and electrical conductivity within the blood. Additionally, plasma transports glucose, amino acids, fatty acids, vitamins, and minerals, providing essential nutrients to cells and tissues throughout the body.

Waste products, such as urea, creatinine, and carbon dioxide, are carried in plasma to be excreted by the kidneys, lungs, and other organs. Hormones released by endocrine glands are also transported via plasma to regulate metabolic functions. (*Lee et al., 2017*).

Formed Elements of Blood

The formed elements of blood are the cellular components, which are produced in the bone marrow and make up about 45% of blood volume. The formed elements are categorized into three major types: red blood cells (erythrocytes), white blood cells (leukocytes), and platelets (thrombocytes).

Red Blood Cells (Erythrocytes)

Red blood cells are by far the most numerous of the formed elements, comprising nearly 99% of all blood cells. These cells are responsible for oxygen transport from the lungs to tissues and carbon dioxide removal from tissues to the lungs for exhalation. Erythrocytes have a unique biconcave shape, which increases their surface area and facilitates gas exchange.

The primary component of red blood cells is hemoglobin, a protein that binds to oxygen molecules in the lungs and releases them in tissues where oxygen levels are low Hemoglobin also binds to carbon dioxide in tissues and transports it back to the

lungs for exhalation. Each red blood cell contains approximately 270 million molecules of hemoglobin, making it highly efficient at gas transport. (*Hershfield et al., 2021*).

The lifespan of red blood cells is around 120 days, after which they are broken down by macrophages in the spleen, liver, and bone marrow. The iron from hemoglobin is recycled to form new red blood cells, and the remaining components are excreted as waste.

White Blood Cells (Leukocytes)

White blood cells are an essential component of the immune system, responsible for defending the body against infections, foreign substances, and cancer cells. Unlike red blood cells, white blood cells have a nucleus and can move out of blood vessels to reach sites of infection or injury.

There are five major types of white blood cells, each with specific functions in the immune response:

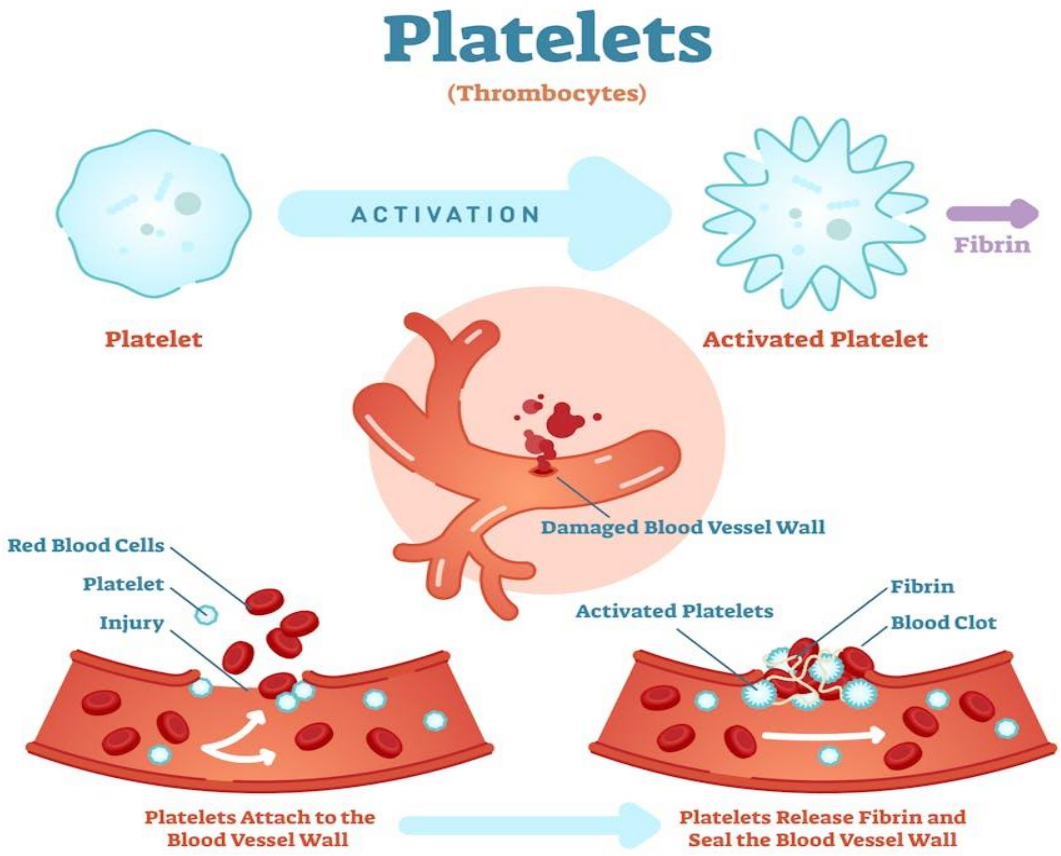
1. **Neutrophils**: These are the most abundant type of white blood cells and are involved in the initial defense against bacterial infections. They are capable of phagocytosis, in which they engulf and destroy pathogens (*van der Meer et al., 2020*).
2. **Lymphocytes**: Lymphocytes include T-cells, B-cells, and natural killer cells. T-cells help in directly killing infected cells or assisting other immune cells, while B-cells produce antibodies. Natural killer cells are involved in identifying and destroying cancerous or infected cells.

3. **Monocytes**: These cells transform into macrophages once they leave the bloodstream and enter tissues. Macrophages play a critical role in phagocytosis and antigen presentation, stimulating the immune response.
4. **Eosinophils**: Eosinophils are involved in combating parasitic infections and modulating allergic reactions.
5. **Basophils**: Basophils release histamine and other substances that are involved in inflammatory and allergic responses.

White blood cells, though fewer in number compared to red blood cells, are critical for immune surveillance and combating disease.

Platelets (Thrombocytes)

Platelets are small, non-nucleated cell fragments derived from megakaryocytes in the bone marrow. They play a crucial role in blood clotting, or hemostasis. When blood vessels are damaged, platelets adhere to the injury site and release various substances that promote the formation of a clot.



Platelets work in conjunction with fibrinogen, which is converted into fibrin to form a mesh that traps red blood cells and other components, thus sealing the wound (*Wiley et al., 2021*).

Platelets are also involved in wound healing and tissue repair. Their lifespan is relatively short, around 7-10 days, after which they are removed by the spleen.

Blood Is a highly complex and dynamic fluid that consists of various components, each with distinct and essential functions in maintaining the body's overall health and functioning. The plasma serves as the liquid medium for transporting nutrients, waste products, and hormones, while the formed elements—red blood cells, white blood cells, and platelets—are critical for oxygen transport, immune defense, and

coagulation. Understanding the composition and constituents of blood provides insight into its indispensable role in sustaining life.

The dynamic nature of blood's constituents underscores the importance of maintaining a balance in their quantities and functions for optimal health. Imbalances in blood composition can lead to a range of diseases and disorders, highlighting the importance of blood in the body's homeostasis. Ongoing research in hematology continues to enhance our understanding of blood's components, with implications for improving diagnostic and therapeutic approaches to various medical conditions.

REVIEW OF LITERATURE

Composition and Constituents of Blood

Blood is a vital fluid circulating in the human body, composed of a variety of elements that serve critical functions essential for maintaining homeostasis and promoting life. The study of blood has long been a major area of research in various scientific fields, from hematology to immunology and molecular biology. The composition of blood, including its cellular elements—red blood cells (RBCs), white blood cells (WBCs), platelets, and plasma—has been explored extensively. Over time, significant discoveries have been made regarding the structure, function, and regulation of these components, as well as their role in both normal physiology and pathological conditions.

This review aims to provide an in-depth summary of the scientific literature on blood composition and its constituent elements, focusing on their structure, function, and interactions, along with the disorders associated with abnormalities in blood

composition. Each major blood constituent is explored, starting from the plasma to the blood cells and their various roles in immune response, oxygen transport, hemostasis, and disease.

History of Blood Research

Blood has intrigued scholars for centuries, and its study has evolved dramatically over time. Some of the earliest understandings of blood came from ancient civilizations such as the Egyptians and Greeks, who recognized its vital role in sustaining life. However, it wasn't until the 17th century that significant advancements in blood research were made. William Harvey's discovery of the circulation of blood in the body (Harvey, 1628) was groundbreaking, providing a foundational understanding of blood movement and leading to further investigation into the components of blood.

The advent of microscopy in the 19th century, pioneered by scientists like Antonie van Leeuwenhoek and Robert Hooke, allowed for the first visualization of blood cells. These early studies revealed the presence of cellular components within blood, setting the stage for modern hematology. The 20th century saw the development of techniques such as blood typing and advances in molecular biology, which provided a more intricate understanding of the genetic and functional diversity of blood cells.

Composition of Blood

Blood is made up of several components, each with specific functions. The two primary components of blood are plasma and formed elements, which include red

blood cells, white blood cells, and platelets. Understanding the balance between these elements is crucial in appreciating the full scope of blood's role in the body.

Plasma: Composition and Function

Plasma is the liquid portion of blood, constituting approximately 55% of its total volume. It is predominantly composed of water (around 90%), with dissolved proteins, nutrients, electrolytes, and waste products suspended within. Plasma proteins play pivotal roles in maintaining osmotic pressure, immune function, and blood coagulation.

- **Albumin**: The most abundant plasma protein, albumin helps maintain blood volume by contributing to osmotic pressure. It also functions as a transport protein for fatty acids, hormones, and drugs (Davis & Gahl, 2015).
- **Globulins**: This group of proteins includes antibodies (immunoglobulins), which play a central role in immune defense. Alpha, beta, and gamma globulins serve in immune response and transport.
- **Fibrinogen**: Essential for blood clotting, fibrinogen is converted into fibrin during the coagulation cascade, helping to form a blood clot after vascular injury (Bick, 2008).

Plasma also carries electrolytes such as sodium, potassium, calcium, and bicarbonate, which are crucial for maintaining fluid balance, acid-base homeostasis, and the functioning of various enzymes and receptors.

Red Blood Cells (Erythrocytes)

Red blood cells (RBCs) are the most abundant blood cells and are critical for the transport of oxygen from the lungs to tissues and carbon dioxide back to the lungs

for exhalation. RBCs are unique in their biconcave shape, which maximizes their surface area for gas exchange and allows them to deform as they pass through narrow capillaries (Rao & Canfield, 2005).

- **Hemoglobin**: The major component of RBCs, hemoglobin, binds to oxygen in the lungs and releases it in the tissues. Hemoglobin's structure allows it to undergo conformational changes based on oxygen concentration, facilitating efficient oxygen loading and unloading (Perutz, 1989).
- **Erythropoiesis**: The production of RBCs, known as erythropoiesis, occurs in the bone marrow. This process is regulated by erythropoietin, a hormone primarily produced by the kidneys in response to low oxygen levels (Jacobsen, 2014).

Red blood cells have a lifespan of about 120 days, after which they are removed from circulation and broken down by macrophages in the spleen and liver. Disorders of RBCs, such as anemia and sickle cell disease, are often characterized by abnormal RBC production, structure, or function, leading to impaired oxygen delivery (Kato et al., 2018).

White Blood Cells (Leukocytes)

White blood cells (WBCs) are primarily involved in immune defense and the body's response to infections, foreign substances, and abnormal cell growth. WBCs are divided into two broad categories: granulocytes and agranulocytes.

- **Granulocytes**: These include neutrophils, eosinophils, and basophils, which contain granules filled with enzymes and antimicrobial agents. Neutrophils are the most abundant and are often the first responders to infection (Simon et al., 2013).

- **Agranulocytes**: Lymphocytes and monocytes fall into this category. Lymphocytes are essential for adaptive immunity, with B cells producing antibodies and T cells orchestrating cellular immune responses. Monocytes differentiate into macrophages, which engulf and digest pathogens and debris (Miller et al., 2015).

Leukocytes are critical for the body's defense mechanisms, but when these cells proliferate abnormally, as in leukemia, they can lead to severe disease (Fialkow, 1987).

Platelets (Thrombocytes)

Platelets are small, anucleate cell fragments derived from megakaryocytes in the bone marrow. These cells are essential for blood clotting and wound healing. Platelets adhere to sites of injury and release granules containing clotting factors, which promote the formation of a blood clot.

- **Coagulation Cascade**: The clotting process involves a series of steps where platelets aggregate and release substances that activate fibrinogen into fibrin, leading to the formation of a stable blood clot (Jackson, 2013).
- **Platelet Disorders**: Thrombocytopenia (low platelet count) can lead to excessive bleeding, while thrombocytosis (high platelet count) can increase the risk of thrombosis, both of which are significant clinical concerns (Nester & Ward, 2017).

Blood Groups and Hematological Variability

Blood typing is one of the most important applications of hematology. The ABO blood group system, discovered by Karl Landsteiner in 1900, classifies blood into four major groups: A, B, AB, and O, based on the presence or absence of antigens on the surface of red blood cells.

- **ABO System**: The ABO blood type determines the compatibility for blood transfusions, as incompatible transfusions can lead to severe immune reactions. Individuals with type O blood are universal donors, while those with type AB are universal recipients (Prowse et al., 1999).
- **Rh Factor**: In addition to the ABO system, the Rh factor is another antigen that classifies blood as either Rh-positive or Rh-negative. This is particularly important during pregnancy, as Rh incompatibility can lead to hemolytic disease of the newborn (Dutta & Mitra, 2019).

The variability in blood groups across different populations is also of clinical significance, influencing disease susceptibility, transfusion practices, and organ transplantation compatibility.

Abnormalities in Blood Composition

Disorders in the composition of blood can lead to various clinical manifestations and conditions. These abnormalities often affect one or more blood components, leading to pathologies that require medical intervention.

Anemia

Anemia is one of the most common blood disorders, characterized by a reduction in the number of red blood cells or hemoglobin, which impairs the ability of blood to

carry oxygen to tissues. Anemia can result from a variety of causes, including nutritional deficiencies (e.g., iron-deficiency anemia), chronic diseases (e.g., anemia of chronic inflammation), and genetic disorders (e.g., sickle cell anemia) (Cappellini et al., 2020).

Leukemia and Lymphoma

Leukemia is a type of cancer that affects the blood and bone marrow, leading to an overproduction of abnormal white blood cells. Lymphoma, another hematologic malignancy, affects the lymphatic system and can spread to the blood. Both conditions are life-threatening but have become treatable through advances in chemotherapy and stem cell transplantation (DeVita et al., 2017).

Hemophilia and Coagulation Disorders

Hemophilia is a genetic disorder that impairs the blood's ability to clot, leading to excessive bleeding. It is often due to deficiencies in clotting factors such as factor VIII (Hemophilia A) or factor IX (Hemophilia B). Coagulation disorders can also lead to excessive clot formation, causing thrombosis and increasing the risk of stroke, heart attack, and deep vein thrombosis (Heit et al., 2015).

The composition and constituents of blood are integral to maintaining life and health. Advances in research have provided detailed insights into the roles of plasma, red blood cells, white blood cells, and platelets, and their interactions in critical physiological processes. However, disorders related to abnormalities in blood composition continue to present challenges in clinical practice. Understanding these elements and their functions remains crucial in the diagnosis and treatment of hematological and systemic diseases.

This review highlights the complexity of blood composition, the necessity for its precise regulation, and the potential clinical implications of blood-related disorders. Future research into blood components may offer new therapeutic approaches and improve outcomes for patients with hematological diseases.

CONCLUSION

The composition and constituents of blood are integral to maintaining life and health. Advances in research have provided detailed insights into the roles of plasma, red blood cells, white blood cells, and platelets, and their interactions in critical physiological processes. However, disorders related to abnormalities in blood composition continue to present challenges in clinical practice. Understanding these elements and their functions remains crucial in the diagnosis and treatment of hematological and systemic diseases.

This review highlights the complexity of blood composition, the necessity for its precise regulation, and the potential clinical implications of blood-related disorders. Future research into blood components may offer new therapeutic approaches and improve outcomes for patients with hematological diseases.

Blood is a vital fluid in the human body that plays a crucial role in maintaining homeostasis and supporting various physiological functions. Its composition is complex, comprising several key components that work together to ensure proper bodily function. Understanding the constituents of blood is essential in fields such as medicine, biology, and health sciences.

The main components of blood are plasma, red blood cells (RBCs), white blood cells (WBCs), and platelets. Each of these elements has unique functions that contribute to the overall functioning of the body. Plasma, the liquid portion of blood, makes up

about 55% of blood's volume. It is primarily water but also contains essential proteins like albumin, globulins, and fibrinogen, electrolytes, hormones, nutrients, and waste products. Plasma serves as the medium for transporting substances throughout the body, including gases, nutrients, waste products, and hormones, ensuring that organs and tissues receive the necessary substances to function.

Red blood cells, the most abundant cellular component of blood, are primarily responsible for oxygen transport. They contain hemoglobin, a protein that binds to oxygen in the lungs and releases it in tissues that require oxygen. The biconcave shape of RBCs enhances their surface area, allowing for optimal gas exchange and facilitating their movement through the narrowest capillaries. The lifespan of red blood cells is around 120 days, after which they are removed by the spleen.

White blood cells, though fewer in number compared to RBCs, are essential for immune function. They protect the body against infections, foreign invaders, and abnormal cells. There are several types of white blood cells, each with a specific role, such as neutrophils (which fight bacterial infections), lymphocytes (which are involved in the adaptive immune response), and monocytes (which become macrophages and help in tissue repair). The balance and activity of WBCs are crucial for maintaining the immune system's effectiveness.

Platelets, or thrombocytes, are crucial for blood clotting. They help prevent excessive bleeding by forming clots at the site of an injury, thereby initiating the repair process. Platelets work together with clotting factors present in plasma to form a stable clot, which is essential in stopping hemorrhaging and promoting tissue healing.

The composition of blood is not only essential for carrying out its physiological roles but also plays a significant role in diagnosing diseases and conditions. Abnormalities

in any of the blood components can indicate a variety of health issues. For example, anemia results from a deficiency of RBCs or hemoglobin, while leukopenia refers to a low white blood cell count, often indicating an immune system disorder or infection. Platelet dysfunction can lead to bleeding disorders such as hemophilia.

In conclusion, the constituents of blood, including plasma, red blood cells, white blood cells, and platelets, work in a coordinated manner to maintain the body's internal environment. They contribute to the transport of gases, nutrients, and waste products, provide immune defense, and support clotting mechanisms to prevent excessive blood loss. A thorough understanding of blood's composition is crucial for recognizing the underlying causes of various medical conditions and for developing appropriate treatments. As blood continues to be a focus of research, advancements in hematology and related fields hold promise for better diagnostic and therapeutic strategies in the future.

SUMMARY/ABSTRACT

Blood is a vital fluid in the human body, playing an essential role in transporting oxygen, nutrients, and waste products, as well as in immune defense and temperature regulation. The composition of blood is complex, consisting of both cellular and non-cellular components, each performing specialized functions to maintain homeostasis and overall health. (*Guyton, A.C., & Hall, J.E. 2015)*

The primary constituents of blood include plasma, red blood cells (RBCs), white blood cells (WBCs), and platelets, all of which work together to ensure the proper functioning of the circulatory system.

1. **Plasma:** Plasma is the liquid component of blood, making up about 55% of its total volume. It is a yellowish fluid that consists mainly of water (approximately 90%), along with a variety of dissolved substances such as proteins, electrolytes, hormones, and waste products. Plasma proteins, such as albumins, globulins, and fibrinogen, perform essential functions. Albumins help maintain osmotic pressure, while globulins are involved in immune responses. Fibrinogen is crucial for blood clotting. Other components of plasma include glucose, amino acids, vitamins, and dissolved gases, all contributing to the overall metabolic and immune functions of the body. (*Tortora, G.J., & Derrickson, B. 2017*)

2. **Red Blood Cells (RBCs):** RBCs, or erythrocytes, make up the majority of blood cells, comprising around 40-45% of blood volume (hematocrit). These cells are specialized in transporting oxygen from the lungs to tissues and carbon dioxide from tissues to the lungs. RBCs are highly flexible and contain hemoglobin, a protein that binds oxygen in the lungs and releases it in tissues where oxygen levels are lower. The lifespan of an RBC is about 120 days, after which it is broken down by the spleen and liver. The production of RBCs occurs in the bone marrow through a process called erythropoiesis.

3. **White Blood Cells (WBCs):** WBCs, or leukocytes, are part of the immune system, responsible for protecting the body against infections, foreign invaders, and abnormal cells. They are fewer in number compared to RBCs, typically constituting less than 1% of blood volume. WBCs are classified into

several types, including neutrophils, lymphocytes, monocytes, eosinophils, and basophils, each with a specific function. Neutrophils are key in fighting bacterial infections, while lymphocytes are involved in adaptive immunity. Monocytes act as phagocytes that engulf pathogens, and eosinophils and basophils participate in allergic reactions and responses to parasitic infections.

4. **Platelets:** Platelets, or thrombocytes, are small cell fragments that play a critical role in blood clotting. They help prevent excessive bleeding by aggregating at sites of injury and forming a plug that initiates the clotting cascade. Platelets are produced in the bone marrow from large precursor cells called megakaryocytes. Though they lack a nucleus, their presence and function are crucial for wound healing and preventing blood loss.
(*Marieb, E.N., & Hoehn, K. 2019).*

Abstract:

Blood is a vital fluid that plays an essential role in the transportation of nutrients, gases, hormones, and waste products throughout the body. It is a specialized connective tissue composed of several key components, each with distinct functions critical to maintaining homeostasis and overall health. The primary constituents of blood include plasma, red blood cells (RBCs), white blood cells (WBCs), and platelets.

Plasma, which constitutes approximately 55% of blood volume, is a pale yellow liquid that primarily consists of water (about 90%), proteins (such as albumin, globulins, and fibrinogen), electrolytes, nutrients, gases, and waste products. The proteins in plasma are crucial for maintaining osmotic pressure, immune function, and blood clotting. Red blood cells (erythrocytes), making up about 45% of blood, are specialized in the transportation of oxygen from the lungs to the tissues and

carbon dioxide from the tissues to the lungs, facilitated by hemoglobin. White blood cells (leukocytes) are involved in the immune response, defending the body against infections and foreign invaders. Platelets (thrombocytes), though the smallest of blood cells, play a pivotal role in blood clotting and wound healing.

Each of these components performs indispensable roles that contribute to the physiological processes required for life. Plasma supports fluid balance and nutrient transport, while the cellular components ensure oxygen delivery, immune defense, and tissue repair. Disruption in the composition or function of any blood component can lead to a variety of disorders, such as anemia, leukemia, or hemophilia.

This abstract outlines the fundamental composition of blood and highlights the essential roles of its constituents in sustaining bodily functions. Understanding the properties and functions of blood is crucial for diagnosing and treating various hematological conditions.

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