**III. Blood Tissue**

**III.1. Introduction**

Blood is a specialized connective tissue composed of cellular elements (formed elements) within a liquid matrix (plasma).

**III.2. Composition of Blood**

When blood is subjected to centrifugation, it separates into two main components: plasma and formed elements (which settle at the bottom of the centrifuge). Blood is composed of 55% plasma and 45% formed elements. The human body contains an average of 4.8 liters of blood.

**III.2.1. Plasma**

Plasma is the liquid component of blood, with water making up 90% of its total weight. Plasma contains three main types of proteins: albumin, fibrinogen, and globulins.

* **Albumin** is the most abundant plasma protein, synthesized by the liver. It helps maintain the blood’s colloid osmotic pressure.
* **Fibrinogen** is an essential component for blood clotting.
* **Globulins** (alpha, beta, and gamma) include various proteins involved in hormone transport. Gamma globulins are immunoglobulins (antibodies) synthesized by cells in lymphatic tissues.

Plasma also contains hormones, nutrients (carbohydrates, lipids), and mineral salts.

**III.2.2. Formed Elements of Blood**

**A. Red Blood Cells (Erythrocytes)**

Commonly known as red blood cells, erythrocytes have a biconcave disc shape. This shape provides flexibility, allowing them to transport oxygen and carbon dioxide efficiently and pass through the narrowest capillaries. Their red color comes from hemoglobin, a pigment composed of proteins and iron.

Erythrocytes lack a nucleus. Their cytoplasm, rich in hemoglobin, contains no organelles but has specific enzymes necessary for maintaining cell integrity throughout their lifespan (about 120 days). The cytoplasmic membrane consists of a lipid bilayer containing various globular proteins. Blood group antigens are located on the surface of red blood cells.

**B. White Blood Cells (Leukocytes)**

White blood cells, also called leukocytes, are divided into **granular leukocytes (or polymorphonuclear leukocytes)** and **hyaline leukocytes (or mononuclear leukocytes),** which include lymphocytes and monocytes. These cells play a crucial role in defending the body against foreign invaders such as pathogens or abnormal cells.

**B.1. Granular Leukocytes**

These cells are categorized into three types: **neutrophils, eosinophils, and basophils.** Granulocytes are characterized by a **multi-lobed nucleus**.

**B.1.1. Neutrophils (Polymorphonuclear Neutrophils)**

Neutrophils are the most abundant type of granulocytes. Their nucleus consists of **two to four lobes** connected by narrow bridges. Neutrophils are the first line of defense against bacterial infections. They migrate to infection sites, where they **phagocytize and digest bacteria**, helping to eliminate pathogens from the body.

**B.1.2. Eosinophils (Polymorphonuclear Eosinophils)**

Eosinophils are characterized by **large, specific granules** in their cytoplasm and a **bilobed nucleus** with finer chromatin than neutrophils. After leaving the bone marrow, these cells circulate in the blood for only a few hours before migrating to connective tissues, particularly in the **respiratory and gastrointestinal epithelium**, where they remain for **8 to 10 days**.

Eosinophils play a key role in **allergic reactions** and **defense against parasitic infections**.

**B.1.3. Basophils (Polymorphonuclear Basophils)**

Basophils are the **rarest type of granulocytes**, making up **less than 1% of leukocytes**. Their **U- or J-shaped nucleus** gives them a bilobed appearance in histological sections. Their cytoplasm contains **large but fewer granules** compared to eosinophils.

Basophils are **highly mobile** and accumulate at **inflammation sites**. They play a role in **allergic reactions** by binding to **IgE antibodies** and releasing **histamine and heparin**, which contribute to the immune response.

**B.2. Hyaline or Mononuclear Leukocytes**

These white blood cells **lack specific granules** and have a **regular, non-lobed nucleus**. They are classified into two main types: **lymphocytes and monocytes**.

**B.2.1. Lymphocytes**

Lymphocytes are **small cells** with a **large, spherical nucleus** that has very dense chromatin. The cytoplasm appears as a **thin rim surrounding the nucleus**. Lymphocytes make up **20 to 30% of blood leukocytes** and play a crucial role in the **immune defense** of the body.

Functionally, lymphocytes are divided into three main categories:

* **B lymphocytes (B cells)**
* **T lymphocytes (T cells)**
* **Natural Killer (NK) cells**

**B.2.2. Monocytes**

Monocytes are **large white blood cells**, making up **2 to 10% of leukocytes**. They circulate in the bloodstream for **3 to 4 days** before migrating into tissues, where they differentiate into **macrophages** in peripheral tissues and organs.

Monocytes are characterized by a **large, eccentrically placed nucleus**, which is **oval or kidney-shaped**. They play a key role in the **immune response**, particularly in **phagocytosis** and the removal of pathogens and cellular debris.

**B.2.2. Monocytes (continued)**

The cytoplasm of monocytes contains **all classic organelles in moderate amounts**, particularly **some lysosomes**.

Monocytes have **limited function in circulating blood** but respond to **chemotactic signals** from damaged tissues, microorganisms, and inflammation. They migrate into tissues and differentiate into **macrophages**, which play a critical role in **phagocytosis**. With their **hydrolytic enzymes**, macrophages break down **foreign bodies and damaged tissues**.

**C. Platelets (Thrombocytes)**

Platelets, or **thrombocytes**, are the **second most abundant** blood component after red blood cells. They are **not considered cells** but rather **cytoplasmic fragments** derived from **megakaryocytes**, large precursor cells in the bone marrow.

Platelets are **small (2–5 μm in diameter)** and **lack a nucleus**. Their primary function is to **monitor the vascular system** and **detect damage to the endothelial lining** of blood vessels. When endothelial damage occurs, platelets **adhere to the injury site** and initiate a **complex biochemical process** leading to **blood clot formation** to prevent excessive bleeding.

