HEMATOLOGY & HEMOSTASIS ACADEMY

Section 2

OVERVIEW OF BLOOD

LEARNING OBJECTIVES

When you complete this section, you will be able to:

1. **Indicate the four major functions of blood**
2. **Recognize the components of blood**
3. **Identify the chief characteristics of red blood cells, white blood cells, and platelets**
4. **Recognize normal values for the cellular elements in blood**
5. **Recognize a general description of blood cell formation**
6. **Indicate the role of the spleen**

FUNCTIONS OF BLOOD

Blood is essential to all cell life. It distributes oxygen, nutrients, electrolytes, hormones, and enzymes throughout the body. **Table 1** shows four major functions of blood.

Four major functions of blood

TRANSPORTS	FROM:	TO:
Oxygen (O_2)	Lungs	All cells
Carbon dioxide (CO_2)	Cells	Lungs
Nutrients	Digestive organs	All cells
Waste products	All cells	Organs of excretion
Hormones	Endocrine glands	Target organs
Regulates fluid and electrolyte balance between cells and interstitial fluid, and of body and cell temperature		
Protects against toxins produced by bacteria		
Prevents fluid loss through the clotting mechanism		

Table 1. Primary functions of blood.

Components of Blood

Blood consists of plasma and formed elements. Plasma, which makes up about 55% of blood, is the straw-colored clear liquid in which cellular elements and dissolved substances (solutes) are suspended. (Serum is the fluid portion of the blood that remains after fibrin and the formed elements have been removed with centrifugation.) Plasma is approximately 92% water and 8% a mixture of both organic and inorganic substances. **Table 2** shows the components of plasma and their functions.

COMPONENTS OF PLASMA AND THEIR FUNCTIONS
WATER (92%): Carries formed elements and dissolved substances; absorbs heat
Major proteins. Albumin controls water movement across membranes; affects blood viscosity (thickness), pressure, and volume; transports substances such as drugs. Globulin forms antibodies to fight bacteria and viruses. Fibrinogen forms fibrin and, with platelets, coagulates blood
Nonprotein nitrogen. Products of metabolism: urea, uric add, creatine, creatinine, ammonium salts; toxic if not removed; carried in blood to organs of excretion
Products of digestion. Amino acids, glucose, fatty adds – all needed by cells for energy, repair, and reproduction
Regulatory substances. Enzymes for cellular chemical reactions; hormones to regulate growth and development
Electrolytes. Sodium (Na+), potassium (K+), calcium (Ca++), magnesium (Mg+), chloride (Cl–), phosphate (PO4–), sulfate (SO4–), bicarbonate (HCO3–), and inorganic salts

Table 2. Components of plasma.

BLOOD CELLS AND PLATELETS

The blood has three types of formed elements: erythrocytes (red blood cells), leukocytes (white blood cells), and platelets or thrombocytes (**Figure1**).

Most blood samples are measured in microliters (µL); to give you a reference, a drop of blood is roughly 30 µL.

Erythrocytes. Also called red blood cells (RBCs), erythrocytes are the body's most numerous blood cells. Average normal values indicating numbers of RBCs in the blood may be recorded as 4.60 x 10^6/µL (4.60 million/µL) for women and 5.20 x 10^6/µL (5.20 million/µL) for men.

To transport oxygen and carbon dioxide through the circulation, each RBC contains approximately 280 million hemoglobin molecules. Each hemoglobin molecule contains four iron atoms. As RBCs pass through the lungs, iron atoms combine with oxygen molecules. RBCs travel the circulatory system until, at the tissues, iron atoms release oxygen into interstitial fluid and hemoglobin molecules take up carbon dioxide. Back at the lungs, RBCs release carbon dioxide and take up oxygen again.

Leukocytes. The body normally contains 4,500-11,000 white blood cells (WBCs) per µL of blood. This value may be reported as 4.5-11.0 x 10^3/µL or k/µL (k = thousand). Unlike RBCs, WBCs occur in many different types. Most WBCs are filled with tiny grains and are called granulocytes (gran = grain). The normal range for granulocytes is 1.8-8.5 x 10^3/µL of blood.
Granulocytes include:

- **Neutrophils:** 50%-70% of total WBCs or ≈1.8-7.7 x 103/µL
- **Eosinophils:** up to 5% of total WBCs or ≈0-0.450 x 103/µL
- **Basophils:** up to 2% of total WBCs or ≈0-0.2 x 103/µL

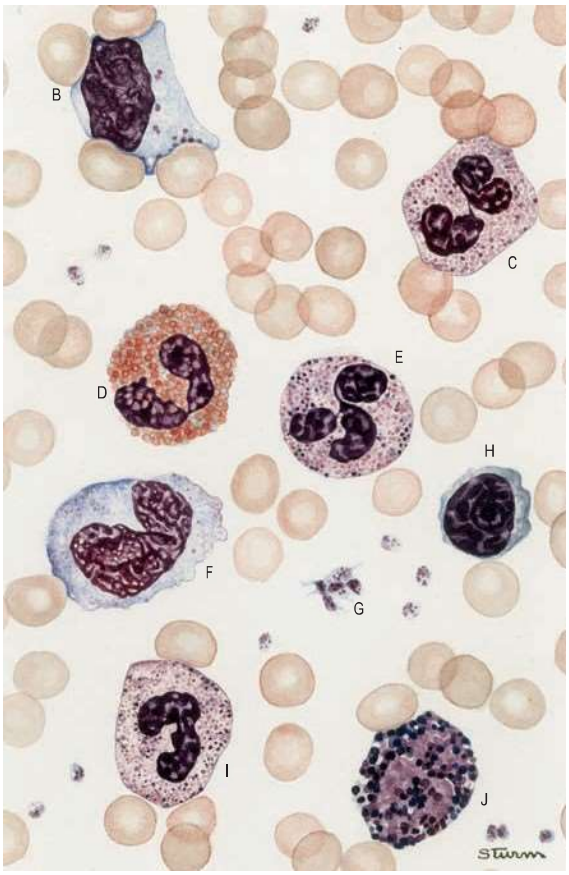

Figure 1. The blood has three types of formed elements: erythrocytes (red blood cells), leukocytes (white blood cells), and platelets or thrombocytes. Blood cells and platelets. A = erythrocytes, B-F = leukocytes, G = platelets (thrombocytes), H-J = leukocytes.

Lymphocytes and monocytes are non-granular WBCs. The normal range for lymphocytes and monocytes are:

- **Lymphocytes:** 20%-47% of total WBCs or about 1.0-4.8 x 103/µL
- **Monocytes:** 3%-10% of total WBCs or about 0.0-0.8 x 103/µL

WBCs fight infection; some surround and destroy debris and foreign invaders while others produce antigen/antibody reactions [an antigen is any substance (foreign or part of the body) which causes production of an antibody; an antibody is a protein which neutralizes antigens].

NICE TO KNOW

- The average adult circulation contains 5 liters of blood (roughly 5.28 quarts).
- Blood completes the entire systemic circuit – from left heart through the body to right heart – in 90 seconds.
- Every cubic millimeter of blood contains 5 million RBCs.
- RBCs survive about 4 months; neutrophils survive about 6 hours.

Platelets. Also called thrombocytes, platelets are cell fragments that travel in the bloodstream. The normal range for platelets is 140-440 x $10^3/\mu L$ of blood.

Platelets help prevent blood and fluid loss by clumping together to begin the coagulation process. A blood clot is formed when sticky platelets become covered with fibrin – a plasma protein that holds the blood clot together.

Each of the formed elements of blood will be covered in more detail in the following sections.

HEMATOPOIESIS: THE FORMATION OF BLOOD CELLS

All blood cells begin as undifferentiated stem cells capable of reproducing themselves. Generations of cells eventually differentiate into cell lines that will mature to produce erythrocytes, leukocytes, and platelets. Stem cells in bone marrow continuously proliferate – usually at a steady state to maintain a constant population of mature blood cells. A disruption in this process can lead to serious illnesses.

As a group, immature cells are large. As they age and mature, they become smaller and change in their reaction to the dyes used to stain them for identification.

Role of the Spleen. Located beneath the diaphragm and behind the stomach, the spleen is an intricate filter that receives 5% of the total blood volume each minute. In the embryo, the spleen is a blood-forming center; it loses this function as the fetus matures.

In the spleen, RBCs and WBCs are "inspected" by specialized WBCs. Old or damaged cells are removed; salvageable cells may be "pitted", that is, unwanted particles are removed without destroying the cells.

Because it is not essential to life, the spleen may be removed (splenectomy) without serious effects.