

The Blood and Lymphatic System

Blood

Is the fluid that circulates through the vessels, bringing oxygen and nourishment to all cells and carrying away carbon dioxide and other waste products. The blood also distributes body heat and carries special substances, such as antibodies and hormones. Certain blood cells are a major component of the immune system, which protects against disease.

Whole blood is about 45% solid and 55% liquid. The **solid portion** is referred to as formed elements. The liquid portion, or plasma (55%). Plasma is about 90% water. The remaining 10% contains nutrients, electrolytes (dissolved salts), gases, albumin (a protein), clotting factors, antibodies, wastes, enzymes, and hormones.

Elements of Blood

The formed elements in blood consist of red blood cells (RBCs), also called **erythrocytes**; **platelets**, also called **thrombocytes**; and white blood cells (WBCs), also called **leukocytes**.

Each element has an important role, ranging from the

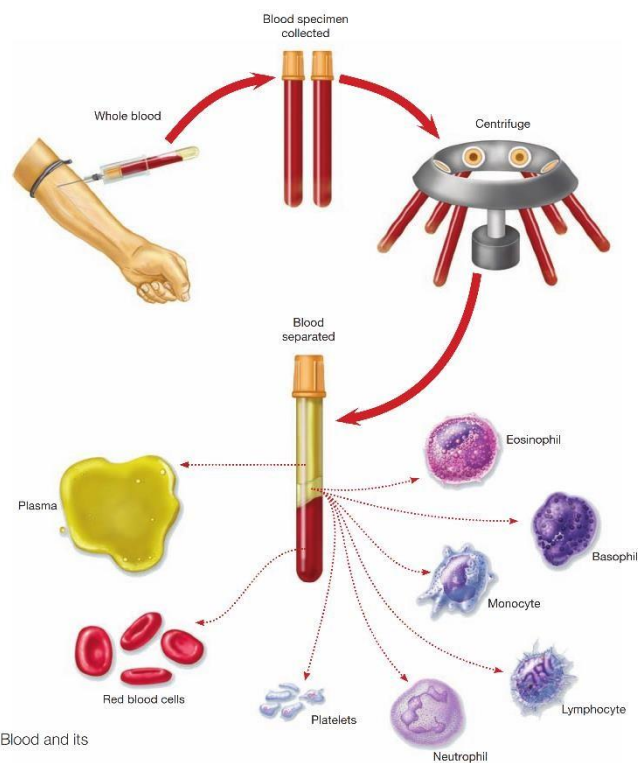


Figure 10.1 Blood and its components.

transportation of oxygen to body cells to defense of the body against harmful organisms. The following list identifies the structure and function of each element:

1. Erythrocytes

Erythrocytes are commonly called red blood cells (RBCs). Mature RBCs are flexible biconcave disks that lack nuclei. They transport oxygen (most of which is bound to hemoglobin contained in the cell) and carbon dioxide. There are approximately 5 million erythrocytes per cubic millimeter of blood, and they have a lifespan of 80–120 days. Erythrocytes are formed in the red bone marrow.

2. Leukocytes

All WBCs show prominent nuclei when stained. They total about 5,000 to 10,000/ μL , but their number may increase during infection. There are five types of leukocytes that vary in their relative percentages and their functions.

A. Granulocytes, or granular leukocytes, have visible granules in the cytoplasm when stained. A granulocyte has a segmented nucleus. There are three types of granulocytes, named for the kind of stain (dye) the granules take up:

- ■ **Neutrophils** stain weakly with both acidic and basic dyes.
- ■ **Eosinophils** stain strongly with acidic dyes.
- ■ **Basophils** stain strongly with basic dyes.

B. Agranulocytes do not show visible granules when stained. An agranulocyte's nucleus is large and either round or curved. There are two types of agranulocytes:

- **Lymphocytes** are the smaller agranulocytes.
- **Monocytes** are the largest of all the WBCs.

3. Platelets

The blood platelets (thrombocytes) are not complete cells, but fragments of large cells named megakaryocytes, which form in bone marrow. They number from 200,000 to 400,000/ μ L of blood. Platelets are important in hemostasis, the prevention of blood loss, which includes the process of blood clotting, or coagulation.

When a vessel is injured, platelets stick together to form a plug at the site. Substances released from the platelets and from damaged tissue then interact with clotting factors in the plasma to produce a wound-sealing clot. Clotting factors are inactive in the blood until an injury occurs. To protect against unwanted clot

formation, 12 factors must interact before blood coagulates. The final reaction is the conversion of fibrinogen to threads of fibrin that trap blood cells and plasma to produce the clot. The plasma that remains after blood coagulates is serum.

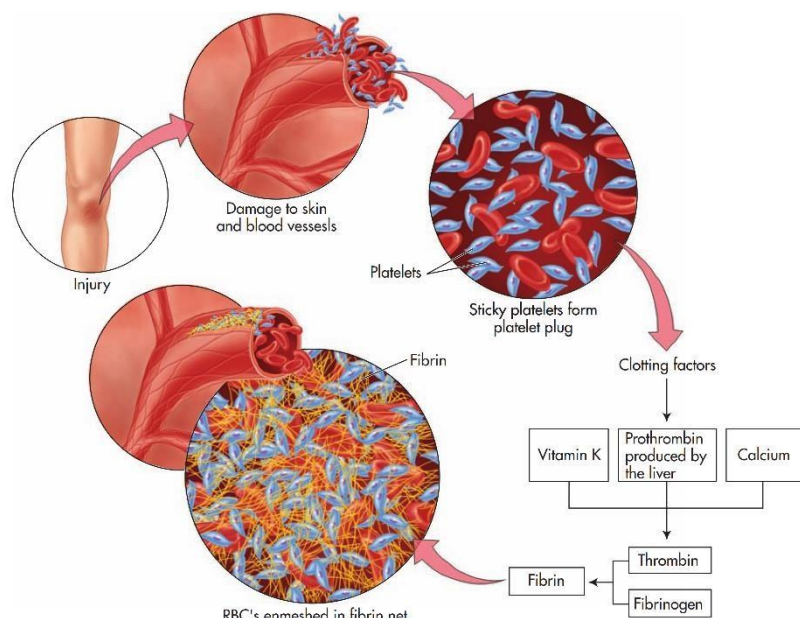


Figure 10.3 The clotting process (coagulation).

Blood Types

Genetically inherited proteins on the surface of RBCs determine blood type. More than 20 groups of these proteins have now been identified, but the most familiar are the ABO and Rh blood groups.

The ABO system includes types A, B, AB, and O. The Rh types are Rh positive (Rh+) and Rh negative (Rh-). Blood is typed by mixing samples separately with

different prepared antisera. Red cells in the sample will agglutinate (clump) with the antiserum that corresponds to the blood type.

For a blood transfusion to be safe and successful, ABO and Rh blood groups of the donor and the recipient must be compatible. If they are not, the red blood cells from the donated blood can agglutinate and cause clogging of blood vessels and slow and/or stop the circulation of blood to various parts of the body.

The agglutinated red blood cells can also hemolyze (dissolve or be destroyed) and their contents leak out in the body. This can be very dangerous, even lifethreatening, to the patient.

Before blood can be administered to a patient, a type and crossmatch must be performed. This means mixing the donor cells with the recipient's serum and watching for agglutination. If none occurs, the blood is considered compatible. Even though the blood is checked for compatibility, blood transfusion reactions can still occur and usually involve fever and chills. These reactions typically begin during the first 15 minutes of the transfusion.

Clinical Aspects of Blood

1. Anemia

Anemia is defined as an abnormally low amount of hemoglobin in the blood. Anemia may result from too few RBCs or from cells that are too small (microcytic) or have too little hemoglobin (hypochromic). Key tests in diagnosing anemia are blood counts, mean corpuscular volume (MCV), and mean corpuscular hemoglobin concentration (MCHC).

The general symptoms of anemia include fatigue, shortness of breath, heart palpitations, pallor, and irritability. There are many different types of anemia, some of which are caused by faulty production of red cells and others by loss or destruction of red cells.

Hemolysis is destruction of red blood cells. **Haemorrhage** is the discharge of blood.

2. Coagulation Disorders

The most common cause of coagulation problems is a deficiency in the number of circulating platelets, a condition termed thrombocytopenia. Possible causes include aplastic anemia, infections, bone marrow cancer, and agents that destroy bone marrow, such as x-rays or certain drugs. This disorder results in bleeding into the skin and mucous membranes.

Hemophilia is a hereditary deficiency of a specific clotting factor. It is a genetically sex-linked disease that is passed from mother to son. There is bleeding into the tissues, especially into the joints (hemarthrosis). Hemophilia must be treated with transfusions of the necessary clotting factors, which are now produced in purified form from blood products or by genetic engineering.

3. Neoplasms

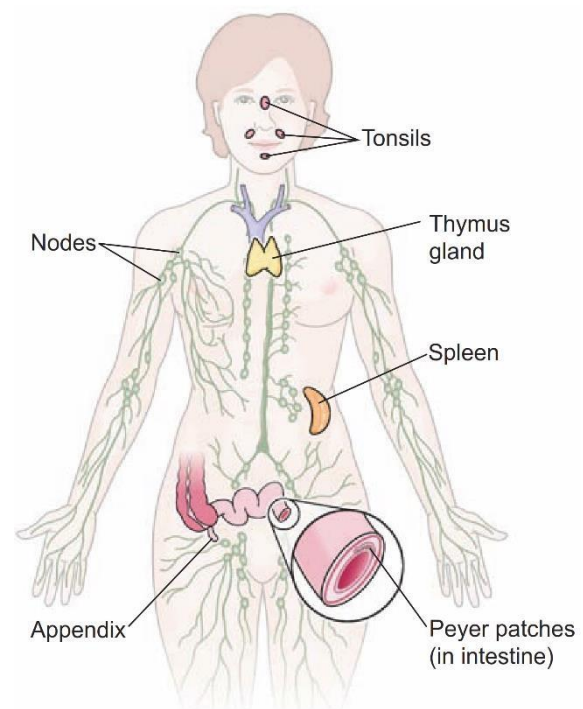
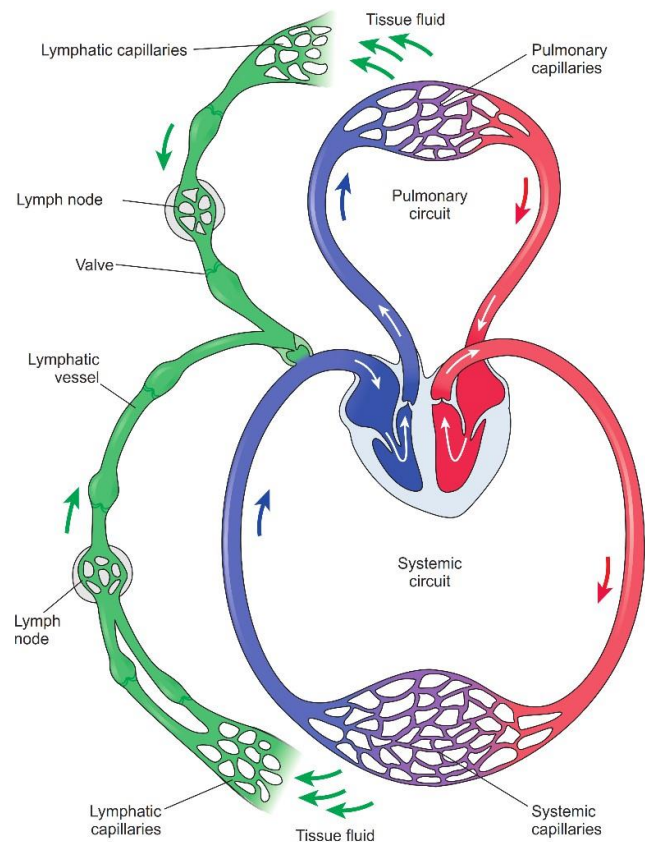
Leukemia is a neoplasm of WBCs. The rapidly dividing but incompetent white cells accumulate in the tissues and crowd out the other blood cells. The symptoms of leukemia include anemia, fatigue, easy bleeding, splenomegaly, and sometimes hepatomegaly (enlargement of the liver). The causes of leukemia are unknown but may include exposure to radiation or harmful chemicals, hereditary factors, and perhaps viral infection.

The Lymphatic System

The lymphatic system is a network of organs, tissues, and vessels spread throughout the body. Medically speaking, immunity refers to the body's capacity to resist disease. The lymphatic system distributes a fluid, called **lymph** [from the Latin word **lympha** (water, clear water)], on a one-way path, whereas the cardiovascular system circulates blood within a closed system. Nevertheless, lymph is similar to blood in that it contains special cells called **lymphocytes** [lymph/o (lymph); cyte (cell)], which are a type of white blood cell that fights disease and infection. A major function of the lymphatic system is to protect the body from infection.

Structure and Function

The lymphatic system consists of lymph vessels, lymph, special **lymphoid** tissues called lymph nodes, and lymph organs (tonsils, spleen, thymus gland, and the



appendix). All of these structures play an important role in the body's immune responses.

Disorders and Treatments

A primary function of the lymphatic system is to filter out harmful organisms. When bacteria spreads into the lymphatic system or when an injury to the body is not treated effectively, however, an infection can result in **lymphadenitis** [lymph/o (lymph or lymphatic system); aden/o (gland); -itis (inflammation)]. Lymph tissue swelling, called **lymphedema** [lymph/o (lymph or lymphatic system); from the Greek word *oidema* (a swelling tumor)], can result from infection or obstruction of the lymph vessels. **Lymphadenopathy** [lymph/o (lymph or lymphatic system); aden/o (gland); -pathy (disease)] that produces enlarged lymph nodes is an indicator of possible infection.