

Arteries

Arteries and arterioles contain a well-developed layer of smooth muscle (the media) and are sometimes called *resistance* vessels. Their efficiency depends on their patency and ability to constrict or dilate in response to various stimuli. The degree of constriction or dilation (vasomotor tone) determines peripheral vascular resistance, which is a major determinant of blood pressure.

Veins

Veins and venules have a thin media and valves that assist blood flow against gravity. They are sometimes called *capacitance* vessels, because blood may accumulate in various parts of the venous system. Their efficiency depends on patency, competency of valves, and the pumping action of muscles around veins.

Capillaries

Capillaries, the smallest blood vessels, connect the arterial and venous portions of the circulation. They consist of a single layer of connected endothelial cells and a few smooth muscle cells. Gases, nutrients, cells, and waste products are exchanged between blood and extracellular fluid across capillary walls. The endothelial lining acts as a semipermeable membrane to regulate the exchange of plasma solutes with extracellular fluid. Lipid-soluble materials diffuse directly through the capillary cell membrane; water and water-soluble materials enter and leave the capillary through the junctions or gaps between endothelial cells.

Lymphatics

Lymphatic vessels, which are composed mainly of endothelium, parallel the veins and empty into the venous system. They drain tissue fluid that has filtered through the endothelium of capillaries and venules from the plasma. They then carry lymphocytes, large molecules of protein and fat, microorganisms, and other materials to regional lymph nodes.

BLOOD

Blood functions to nourish and oxygenate body cells, protect the body from invading microorganisms, and initiate hemostasis when a blood vessel is injured. Specific functions and components are listed in the following sections.

Functions

- Transports oxygen to cells and carbon dioxide from cells to lungs for removal from the body
- Transports absorbed food products from the gastrointestinal tract to tissues; at the same time, carries meta-

bolic wastes from tissues to the kidneys, skin, and lungs for excretion

- Transports hormones from endocrine glands to other parts of the body
- Transports leukocytes and antibodies to sites of injury, infection, and inflammation
- Assists in regulation of body temperature by transferring heat produced by cell metabolism to the skin, where it can be released
- Transports platelets to injured areas for hemostasis

Components

- *Plasma* comprises approximately 55% of the total blood volume, and it is more than 90% water. Other ingredients are
 - Serum albumin, which helps maintain blood volume by exerting colloid osmotic pressure
 - Fibrinogen, which is necessary for hemostasis
 - Gamma globulin, which is necessary for defense against microorganisms
 - Less than 1% antibodies, nutrients, metabolic wastes, respiratory gases, enzymes, and inorganic salts
- *Solid particles* or cells comprise approximately 45% of total blood volume. Cells include erythrocytes (red blood cells or RBCs); leukocytes (white blood cells or WBCs); and thrombocytes (platelets). The bone marrow produces all RBCs, 60% to 70% of WBCs, and all platelets. Lymphatic tissues (spleen and lymph nodes) produce 20% to 30% of the WBCs, and reticuloendothelial tissues (spleen, liver, lymph nodes) produce 4% to 8% of WBCs. Cell characteristics include the following:
 - Erythrocytes function primarily to transport oxygen. Almost all oxygen (95% to 97%) is transported in combination with hemoglobin; very little is dissolved in blood. The lifespan of a normal RBC is approximately 120 days.
 - Leukocytes function primarily as a defense mechanism against microorganisms. They leave the bloodstream to enter injured tissues and phagocytize the injurious agent. They also produce antibodies. The lifespan of a normal WBC is a few hours.
 - Platelets are fragments of large cells, called megakaryocytes, found in the bone marrow. Platelets are essential for blood coagulation. For example, when a blood vessel is injured, platelets adhere to each other and the edges of the injury to form a cluster of activated platelets (ie, a platelet thrombus or “plug”) that sticks to the vessel wall and prevents leakage of blood. In addition, the clustered platelets release substances (eg, adenosine diphosphate, thromboxane A₂, von Willebrand factor) that promote recruitment and aggregation of new platelets.

Platelets have no nucleus and cannot replicate. If not used, they circulate for approximately a week before being removed by phagocytic cells of the spleen.