

CARDIOVASCULAR SYSTEM

The cardiovascular system consists of the heart, arteries, veins, networks of capillaries, and the blood itself. It has the job of transporting oxygen, nutrients, hormones, antibodies, and soluble waste products from place to place within the body.

Color titles A through F and the related structures. Use colors that do not obscure the detail of the heart cavities.

The human *heart* is an organ with four chambers whose walls are formed of cardiac muscle cells and supporting fibrous tissue. The right side of the heart receives deoxygenated blood from the two great veins, the superior vena cava and the inferior vena cava, which collect blood returning from all over the body. These vessels discharge blood into a thin-walled muscular chamber called the *right atrium*. The atrium contracts to force the blood through the right atrioventricular valve into the much thicker-walled *right ventricle*. A fraction of a second later, the right ventricle contracts and pumps the blood through the right semilunar valve into the *pulmonary trunk*, which divides into right and left pulmonary arteries, carrying the blood to the lungs for oxygenation. Valves are a part of the fibrous skeleton of the heart and serve to prevent reflux of blood into the chamber from which it was pumped.

The left heart consists of similar chambers with similar names. The *left atrium* receives oxygenated blood from the lungs via four pulmonary veins. It pumps the blood through the left atrioventricular valve into the *left ventricle*, which then contracts to pump the blood through the left semilunar valve (not shown) into a single, large artery called the aorta.

The contractions of cardiac muscle are coordinated by a system of specialized muscle cells called the cardiac conduction system (not shown). Cardiac muscle will contract rhythmically in the absence of any nerve input, but nerves to the heart regulate the rate to adjust to the needs of the rest of the body.

Color titles G through L and related structures in the figure at the left and the cross sections through the artery and vein.

Arteries are vessels that convey blood from the heart to the body tissues. *Veins* are vessels that conduct blood to the heart from body tissues. The structure of these blood

vessels is directly related to the pressures imposed on them. Arteries have three layers: an inner layer composed of simple squamous epithelial cells, called *endothelium* (*endo-*, "inside"), a middle layer consisting of variable numbers of concentric layers of *smooth muscle* cells and their fibrous envelopes, and an outer layer of *fibrous connective tissue*. Sandwiched between each two layers is a *lamina* of variable thickness containing *elastic* connective tissue fibers. In the aorta and its major branches, which receive blood from the heart in surges and at high pressure, muscle fibers are almost entirely absent and the middle and outer layers are predominantly elastic fibers. In medium-sized arteries, where the pressure is less, the muscle layers predominate, allowing regulation of blood flow to a given region by contracting (causing vasoconstriction) or relaxing (vasodilation).

Capillaries (not shown) are simple endothelial tubes supported by a small amount of fibrous tissue, connected to arteries at one end and to veins at the other end. Capillary walls are thin enough to allow ready diffusion of materials between the blood and nearby tissue cells.

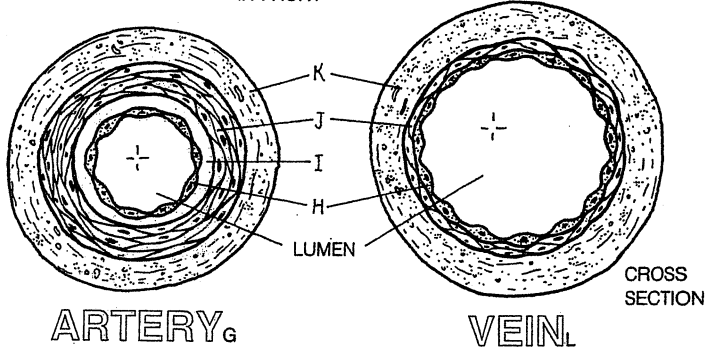
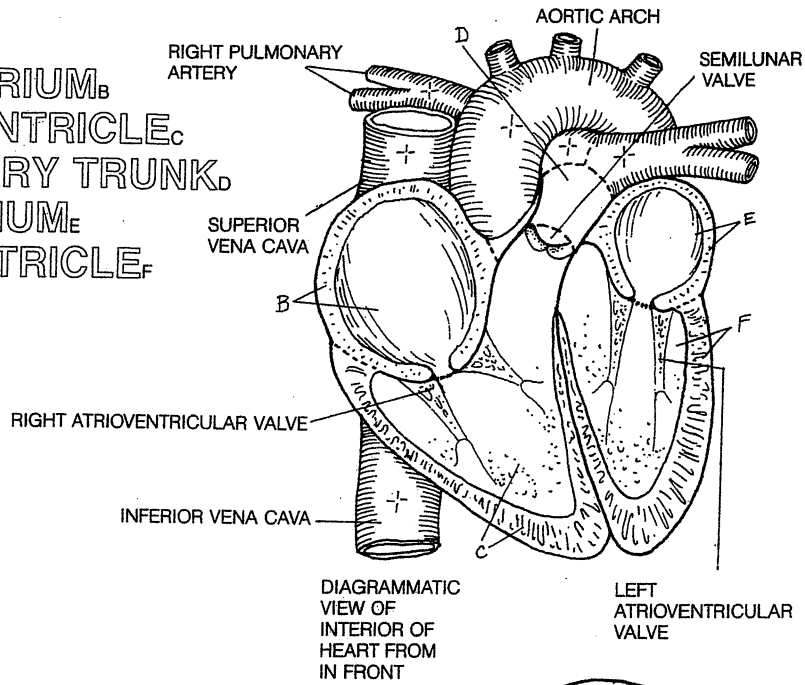
Veins collect blood from the capillaries under very low pressure; many veins, especially those of the limbs, have endothelial valves to prevent reverse flow of the blood. Veins have an inner layer of *endothelium* as arteries do, but their middle layer is largely devoid of *smooth muscle* and the outer layer is thickest, characterized by layers of *fibrous connective tissue*.

Color the heading Formed Elements of Blood, titles M through P, and the related structures at the bottom of the plate.

Blood consists of red, oxygen-carrying cells called *erythrocytes*, a much smaller number of white blood cells called *leukocytes* (two of which are shown here), tiny masses of cytoplasmic particles called *platelets*, and the fluid part called *plasma*. Erythrocytes are unusual in that they have no nuclei, having lost them in the bone marrow during development. About one-third of their volume is hemoglobin, which is responsible for 85 percent of the oxygen-carrying capacity of the blood and gives blood its red color. White blood cells are associated with body defense. Some are scavenger cells, some are antibody producers, and others are associated with allergic hypersensitivity reactions. Platelets initiate blood-clotting reactions.

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HEART_A
 RIGHT ATRIUM_B
 RIGHT VENTRICLE_C
 PULMONARY TRUNK_D
 LEFT ATRIUM_E
 LEFT VENTRICLE_F



ENDOTHELIUM/ELASTIC LAMINA
 SMOOTH MUSCLE/
 FIBROUS CONNECTIVE TISSUE_K

FORMED ELEMENTS
 OF BLOOD*
 ERYTHROCYTE_M
 LEUKOCYTE_N
 PLATELETS.

PLASMA.

