

## **Human Circulatory System**

The human circulatory system functions to transport blood and oxygen from the lungs to the various tissues of the body. The heart pumps the blood throughout the body, which carries all the vital materials which help our bodies function and removes the waste products that we do not need. For example, the brain requires oxygen and glucose, which, if not received continuously, will cause it to lose consciousness. Muscles need oxygen, glucose and amino acids, as well as the proper ratio of sodium, calcium and potassium salts in order to contract normally. The glands need sufficient supplies of raw materials from which to manufacture the specific secretions. If the heart ever ceases to pump blood the body begins to shut down and after a very short period of time will die. On average, your body has about 5 liters of blood continually traveling through it by way of the circulatory system. The heart, the lungs, and the blood vessels work together to form the circle part of the circulatory system. The pumping of the heart forces the blood on its journey. The lymphatic system is an extension of the human circulatory system that includes cell-mediated and antibody-mediated immune systems. The components of the human circulatory system include the heart, blood, red and white blood cells, platelets, and the lymphatic system.

### **Heart**

The heart is one of the most important organs in the entire human body. It is really nothing more than a pump, composed of muscle which pumps blood throughout the body, beating approximately 72 times per minute of our lives. It contains four chambers: two atria and two ventricles. Oxygen-poor

blood enters the right atrium through a major vein called the vena cava. The blood passes through the tricuspid valve into the right ventricle. Next, the blood is pumped through the pulmonary artery to the lungs for gas exchange. Oxygen-rich blood returns to the left atrium via the pulmonary vein. The oxygen-rich blood flows through the bicuspid (mitral) valve into the left ventricle, from which it is pumped through a major artery, the aorta. Two valves called semi lunar valves are found in the pulmonary artery and aorta.

The ventricles contract about 70 times per minute, which represents a person's pulse rate. Blood pressure, in contrast, is the pressure exerted against the walls of the arteries. Blood pressure is measured by noting the height to which a column of mercury can be pushed by the blood pressing against the arterial walls. A normal blood pressure is a height of 120 millimeters of mercury during heart contraction (*systole*), and a height of 80 millimeters of mercury during heart relaxation (*diastole*). Normal blood pressure is usually expressed as "120 over 80."

Coronary arteries supply the heart muscle with blood. The heart is controlled by nerves that originate on the right side in the upper region of the atrium at the sinoatrial node. This node is called the pacemaker. It generates nerve impulses that spread to the atrioventricular node where the impulses are amplified and spread to other regions of the heart by nerves called Purkinje fibers.

## **Blood**

Blood is the medium of transport in the body. The fluid portion of the blood, the plasma, is a straw-colored liquid composed primarily of water. All the important nutrients, the hormones, and the clotting proteins as well as the

waste products are transported in the plasma. Red blood cells and white blood cells are also suspended in the plasma. Plasma from which the clotting proteins have been removed is serum.

## **Red blood cells**

Red blood cells are erythrocytes. These are disk-shaped cells produced in the bone marrow. Red blood cells have no nucleus, and their cytoplasm is filled with hemoglobin.

Hemoglobin is a red-pigmented protein that binds loosely to oxygen atoms and carbon dioxide molecules. It is the mechanism of transport of these substances. (Much carbon dioxide is also transported as bicarbonate ions.) Hemoglobin also binds to carbon monoxide. Unfortunately, this binding is irreversible, so it often leads to carbon-monoxide poisoning.

A red blood cell circulates for about 120 days and is then destroyed in the spleen, an organ located near the stomach and composed primarily of lymph node tissue. When the red blood cell is destroyed, its iron component is preserved for reuse in the liver. The remainder of the hemoglobin converts to bilirubin. This amber substance is the chief pigment in human bile, which is produced in the liver.

Red blood cells commonly have immune-stimulating polysaccharides called antigens on the surface of their cells. Individuals having the A antigen have blood type A (as well as anti-B antibodies); individuals having the B antigen have blood type B (as well as anti-A antibodies); individuals having the A and B antigens have blood type AB (but no anti-A or anti-B

antibodies); and individuals having no antigens have blood type O (as well as anti-A and anti-B antibodies).

## **White blood cells**

White blood cells are referred to as leukocytes. They are generally larger than red blood cells and have clearly defined nuclei. They are also produced in the bone marrow and have various functions in the body. Certain white blood cells called lymphocytes are essential components of the immune system. Other cells called neutrophils and monocytes function primarily as phagocytes; that is, they attack and engulf invading microorganisms. About 30 percent of the white blood cells are lymphocytes, about 60 percent are neutrophils, and about 8 percent are monocytes. The remaining white blood cells are eosinophils and basophils. Their functions are uncertain; however, basophils are believed to function in allergic responses.

## **Platelets**

Platelets are small disk-shaped blood fragments produced in the bone marrow. They lack nuclei and are much smaller than erythrocytes. Also known technically as thrombocytes, they serve as the starting material for blood clotting. The platelets adhere to damaged blood vessel walls, and thromboplastin is liberated from the injured tissue. Thromboplastin, in turn, activates other clotting factors in the blood. Along with calcium ions and other factors, thromboplastin converts the blood protein prothrombin into thrombin. Thrombin then catalyzes the conversion of its blood protein fibrinogen into a protein called fibrin, which forms a patchwork mesh at the injury site. As blood cells are trapped in the mesh, a blood clot forms.

## **Lymphatic system**

The lymphatic system is an extension of the circulatory system consisting of a fluid known as lymph, capillaries called lymphatic vessels, and structures called lymph nodes. Lymph is a watery fluid derived from plasma that has seeped out of the blood system capillaries and mingled with the cells. Rather than returning to the heart through the blood veins, this lymph enters a series of one-way lymphatic vessels that return the fluid to the circulatory system. Along the way, the ducts pass through hundreds of tiny, capsule like bodies called lymph nodes. Located in the neck, armpits, and groin, the lymph nodes contain cells that filter the lymph and phagocytize foreign particles.

The spleen is composed primarily of lymph node tissue. Lying close to the stomach, the spleen is also the site where red blood cells are destroyed. The spleen serves as a reserve blood supply for the body.

The lymph nodes are also the primary sites of the white blood cells called lymphocytes. The body has two kinds of lymphocytes: B-lymphocytes and T-lymphocytes. Both of these cells can be stimulated by microorganisms or other foreign materials called antigens in the blood. Antigens are picked up by phagocytes and lymph and delivered to the lymph nodes. Here, the lymphocytes are stimulated through a process called the immune response.

Certain antigens, primarily those of fungi and protozoa, stimulate the T-lymphocytes. After stimulation, these lymphocytes leave the lymph nodes, enter the circulation, and proceed to the site where the antigens of microorganisms were detected. The T-lymphocytes interact with the

microorganisms cell to cell and destroy them. This process is called cell-mediated immunity.

B-lymphocytes are stimulated primarily by bacteria, viruses, and dissolved materials. On stimulation, the B-lymphocytes revert to large antibody-producing cells called plasma cells. The plasma cells synthesize proteins called antibodies, which are released into the circulation. The antibodies flow to the antigen site and destroy the microorganisms by chemically reacting with them in a highly specific manner. The reaction encourages phagocytosis, neutralizes many microbial toxins, eliminates the ability of microorganisms to move, and causes them to bind together in large masses. This process is called antibody-mediated immunity. After the microorganisms have been removed, the antibodies remain in the bloodstream and provide lifelong protection to the body. Thus, the body becomes immune to specific disease microorganisms.

## **Glossary of Human circulatory System**

**Anterior:** adjective referring to front end of an animal or organism.

**Aorta:** the main systemic artery of the body, emerging directly from the left ventricle.

**Arteriole:** a small arterial branch that delivers blood directly to a capillary bed.

**Artery:** a muscular blood vessel that carries blood away from the heart.

**Arthropod:** Phylum which is bilaterally symmetric segmented animal with tough, chitinous exoskeleton. Phylum contains crustaceans, insects, spiders, centipedes and millipedes.

**Atrium:** one of the chambers of the heart that receives blood directly from a vein.

**Circulatory system:** the system of the body responsible for internal transport. Composed of the heart, blood vessels, lymphatic vessels, lymph, and the blood.

**Closed circulatory system:** a type of circulatory system where the blood is contained within a system of vessels and the heart.

**Coronary artery:** one of the arteries that supply blood to the heart.

**Coronary vein:** one of the veins that receive blood from the heart muscle and empty directly into the right atrium.

**Deoxygenated blood:** blood that is low in oxygen concentration.

**Dorsal:** adjective referring to the top or upper surface of an organism.

**Heart:** the muscular organ composed of cardiac muscle that is responsible for pumping blood throughout the body.

**Heart attack:** a condition occurring when a section of the heart is deprived of oxygenated blood and dies.

**Interstitial fluid:** the fluid filling the microscopic spaces between cells of the body.

**Mollusca:** phylum of bilaterally symmetrical invertebrates. Primarily marine invertebrates, but also includes land snails and slugs.

**Open circulatory system:** a type of circulatory system where the blood is not contained within a system of vessels and the heart. Blood empties from vessels into sinuses and then returns through other vessels to a "heart".

**Peristalsis:** wave-like muscular contractions in the walls of tubular organs, e.g. the alimentary canal. Peristalsis serves to push material contained within the organ along its length.

**Posterior:** adjective referring to the hind end of an animal.

**Pulmonary artery:** one of the arteries carrying deoxygenated blood from the heart to the lungs.

**Septum:** the wall dividing the two ventricles.

**Sinus:** a cavity into which blood flows and baths the internal organs in organisms with an open circulatory system.

**Spiracle:** opening which leads to a trachea in an insect, arachnid, isopod, centipede or millipede.

**Vein:** one of the blood vessels that carries blood to the heart.

**Ventral:** adjective referring to the lower surface of an animal or organism.

**Ventricle:** one of the muscular chambers of the heart that is responsible for pumping blood from the heart into the arteries.

**Venule :** a small venous branch that carries blood from a capillary bed to a vein.