

Introduction to the Circulatory System

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The circulatory system is a network that carries blood throughout the body. All animals except the simplest kinds have some type of circulatory system. The human circulatory system supplies the cells of the body with the food and oxygen needed to survive. At the same time, it carries carbon dioxide and other wastes away from the cells. The circulatory system also helps regulate body temperature and carries substances that protect the body from disease. In addition, the system transports chemical substances called hormones, which help regulate the activities of various parts of the body.

The Heart

The heart is a hollow, muscular organ that pumps blood. It consists of two pumps that lie side by side. These pumps relax when taking in blood and contract as they send out blood. The left side of the heart is a stronger pump than the right side. The stronger pump receives blood from the lungs and sends it to cells throughout the body. The weaker pump receives blood from the cells throughout the body and sends the blood to the lungs.

The Blood Vessels

The blood vessels form a complicated system of connecting tubes throughout the body. The three major types of blood vessels include: Arteries that carry blood from the heart, veins that return blood to the heart and capillaries that are extremely tiny vessels that connect the arteries and the veins. The exchange of nutrients and oxygen usually occurs in the capillaries.

The blood consists chiefly of liquid called *plasma* and three types of solid particles known as *formed elements*. Plasma is made mostly of water, but it also contains proteins, minerals and other substances. The three types of formed elements are red blood cells, white blood cells and platelets. *Red blood cells* carry oxygen and carbon dioxide throughout the body. *White blood cells* help protect the body from disease. *Platelets* release substances that enable blood to clot. Platelets thus aid in preventing the loss of blood from injured vessels.

Circulatory System Functions

The circulatory system performs many vital functions. The circulatory system is important in nutrition, in the removal of wastes and poisons, and in several other body processes. It also plays an important role in respiration by delivering oxygen to cells and removing carbon dioxide from them. During this process, the blood follows two routes, called the systemic circulation and the pulmonary circulation.

From the left side of the heart, blood full of oxygen is pumped into the systemic circulation. This blood leaves the heart through the aorta, the main artery of the body. A number of major arteries branch off the aorta, and in turn, branch into smaller and smaller vessels, finally emptying into the tiny capillaries. There, oxygen leaves the blood and enters the tissues through the thin capillary walls. In a similar way, carbon dioxide leaves the tissues and enters the blood. The blood, now carrying carbon dioxide, leaves the capillaries and flows through larger and larger veins. Eventually, the blood enters the right side of the heart through two large veins — the superior vena cava, which carries blood from the head and arms, and the inferior vena cava, which carries blood from the trunk and legs.

The circulatory system carries digested food substances to the cells of the body. These nutrients enter the bloodstream by passing through the walls of the small intestine into the capillaries. The blood then carries most of the nutrients to the liver. The circulatory system also helps dispose of waste products and poisons that would harm the body if they accumulated. These substances include carbon dioxide, salts and ammonia, a by-product of cells' use of protein.

Circulatory System Disorders

The circulatory system can be damaged by disease or injury. A common illness of the system is arteriosclerosis, as seen by the accumulation of fatty deposits in the arteries. Such deposits stiffen and thicken the walls of the arteries. As a result, the flow of blood is restricted. In some cases, blood clots develop in vessels affected by arteriosclerosis. Such clots may lead to a heart attack or a stroke, a condition in which the brain does not receive enough blood.

Another disease, hypertension, commonly called high blood pressure, is often associated with arteriosclerosis. Hypertension makes the heart work harder and may lead to such complications as a heart attack, a stroke or kidney failure.

Coronary heart disease, which is a disease of the blood vessels supplying the heart muscle, is the second leading cause of death for people aged 15-59 years. More than 300 risk factors are associated with coronary heart disease and stroke. The major established risk factors include: tobacco use, alcohol use, high blood pressure, high cholesterol, physical inactivity, poor nutrition and obesity. Some risk factors can be changed; these are called modifiable risk factors. Some cannot and are called non-modifiable risk factors. And, some are in the middle and are called somewhat modifiable risk factors.

Treatment for arteriosclerosis and hypertension include rest, exercise and diet changes. Doctors may prescribe various medications to lower the blood pressure, strengthen the heart, or prevent infection and blood clots. In extreme cases, a surgeon may remove clots or replace one or more diseased blood vessels.

Other circulatory system disorders result from damage or defects in the heart or blood vessels. For example, rheumatic fever may harm or destroy the valves that control the flow of blood through the heart. Incomplete development of the heart or its blood vessels before birth may produce defects called congenital heart disorders. Some damage and defects can be corrected by surgery.

Engineers and the Circulatory System

Biomedical, mechanical and electrical engineers work together alongside doctors to design engineering solutions to problems affecting the human body and the circulatory system. Engineers use their knowledge of fluid flow and biomechanics to create devices that can alleviate problems, while doctors combine their knowledge of the human body and patient care to make sure any solutions are feasible and functional. Together, they have been able to design and implement various devices, including heart pumps, artificial hearts, replacement valves and diagnostic tools. Biomedical engineers apply their understanding of basic biological and medical science to solving real-world problems.