

CIRCULATORY SYSTEM TYPES OF CIRCULATION, THEIR FUNCTIONS, AND DISEASE

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ABSTRACT.

The circulatory system consists of blood, the heart and blood, and lymphatic vessels. Blood Is formed from stem cells in the bone marrow. The heart pumps blood through its four Chambers with the help of valves, which prevent backflow. A conducting system, composed of modified cardiac muscle cells, regulates the nature and frequency of the heartbeat. The Structure of the walls of large arteries provides the resiliency to modify the pressures of Blood leaving the heart so that blood flow is more even. Smooth muscle in the walls of Smaller arteries are also important in regulating blood pressure and the regional distribution of blood. Exchange of gasses and metabolites occurs in capillary beds throughout the body. A network of veins collects blood and returns it to the heart. Most of the blood volume resides in the veins. Lymphatic vessels collect tissue fluids and white blood cells and return them to the circulation through two major ducts. Homeostasis within the circulatory system is regulated by sensors in the carotid body and carotid sinus.

INTRODUCTION

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.

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 for 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. Antigens are present on the surface of erythrocytes, and can react with antibodies causing agglutination of the red blood cells. This is the basis of the ABO blood groupingsystem. Individuals inherit two alleles, one from each parent, that code for a specific blood group. Blood groups can be homozygous, where the alleles are the same, or heterozygous where alleles are different. Specific blood groups have antibodies that are sensitive to the alleles absent from their erythrocytes. For example, blood group A will carry the A antigen and the anti-B antibodies. These are divided in groups: monocytes,

lymphocytes, neutrophils, basophils and eosinophils. These groups are distinguishable from each other by cell size, shape of nucleus and cytoplasm composition. These groups can themselves be grouped into 2 groups: granulocytes and agranulocytes. This classification is based on the presence or lack of granules in the cytoplasm of the cell. Collectively, white blood cells form part of the immune response.

Granulocytes

Neutrophils, eosinophils and basophils fall into this category of white blood cells. Leukocytes are classified into this group based on the presence of vesicles, called granules, in their cytoplasm. Granulocytes are largely involved in inflammatory and allergic responses.

Leukocytes(White Blood Cells)

Neutrophils: are the most abundant white blood cells, accounting for about 40-75% of all leukocytes. The number of neutrophils varies, and increases in response to acute bacterial infections. They have an irregular, segmented nucleus. They mainly function in the defence of the body against microorganisms, and can ingest foreign substances by phagocytosis. They are also involved in inflammation. Neutrophils have a short life span, spending 4-7 hours in circulation and a few days in connective tissue.

Eosinophils: are similar to neutrophils, but are far fewer in number. Their nucleus is prominently bilobed, and the granules in the cytoplasm are large. Their motility mirrors that of other leukocytes, and they migrate from the circulation into the tissues.

VASCULAR DISEASES

Arteriosclerosis is the thickening of the walls of arteries, reducing function. Atherosclerosis is a specific form of arteriosclerosis, where plaque builds up on the endothelium of arteries, causing them to narrow and reducing oxygen delivery to the tissues.

Coronary artery disease occurs in the arteries supplying the heart itself, with narrowing of the coronary arteries causing reduced oxygen delivery to the heart tissue. This can result in a condition called angina, which is essentially spasming of the coronary arteries due to reduced blood flow. Myocardial Infarction (heart attack) is also caused by the narrowing of the coronary arteries due to atherosclerosis. A myocardial infarction occurs when the artery becomes completely occluded due to dislodged plaque or development of a

thrombus (blood clot). Cerebrovascular disease affects the arteries supplying the brain. One of the most common presentations is ischemic stroke, which is also caused by atherosclerosis. Ischemic stroke results in a reduced blood flow to brain regions, leading to impaired brain function. It can be caused by the development of a thrombus or the passing of an embolus (blockage causing substance) from another region of the body to the cerebral circulation.

Peripheral artery disease is reduced blood flow to the limbs due to atherosclerosis. An aneurysm is a localised weakening in the wall of a blood vessel. It can result in bulging of the vessel wall. Thrombus formation and embolisation can also occur. Aneurysms can rupture, leading to significant blood loss depending on where they occur. Particularly lethal sites of aneurysm formation are in the abdominal aorta, the circle of Willis in cerebral

circulation, and in the renal vessels. Varices occur where blood vessels become enlarged and twisted. They can occur at multiple sites in the body. One of the most prominent sites of varices is in the veins of legs, termed varicose veins. Other common sites of varices are at sites of portocaval anastomoses, such as esophageal varices, umbilical varices (caput medusae) and anorectal varices (hemorrhoids or piles).

CARDIAC DISEASES

Cardiovascular diseases can also solely affect the heart. Cardiomyopathy is a collection of diseases that affects the heart muscle. The muscle can become enlarged (hypertrophic) and rigid, causing decreased heart function, arrhythmias (irregular heart rate), and Sometimes even heart failure. The valves of the heart can also be affected by disease.

There are two main types: valve incompetence, in which the valve is unable to function sufficiently; and valve stenosis, where the orifice between the valve narrows as the valve is unable to open fully. Mitral valve disease affects the mitral valve that lies between the left atrium and ventricle. It is normally caused by a combination of valve incompetence and stenosis. Aortic valve disease affects the aortic valve, and is largely caused by stenosis of the valve with contribution from regurgitation, which is backflow through the valve.

Inflammation of the heart tissues can also occur. It includes inflammation of the inner endocardium (endocarditis) and the middle muscular layer (myocarditis). Pericarditis is the inflammation of the pericardium, which comprises the outer layer of the heart itself and the pericardial sac which encloses the heart in the thoracic cavity. Congenital heart diseases Congenital heart diseases are those which have been present since birth. They are largely present as left to right shunts, where blood is shunted from areas of

higher pressure to areas of lower pressure. Oxygenated blood is passed back to the right side of the heart and mixed with deoxygenated blood. Such shunts can go unnoticed in a number of patients, while others may require surgical intervention. An atrial septal defect occurs when blood is shunted from the left atrium (higher pressure) to the right atrium (lower pressure) through an opening in the interatrial septum. This opening usually results from the failure of an embryological shunt, the foramen ovale, to close after birth. This defect is specifically referred to as a patent foramen ovale. A ventriculoseptal defect is when an opening in the interventricular septum allows blood to pass from the left ventricle into the right ventricle. Another embryological shunt exists near the heart in the embryo, shunting blood from the pulmonary trunk into the aorta. This is called the ductus arteriosus, and pressure changes after birth usually force this opening to shut. A patent ductus arteriosus occurs when the ductus does not close after birth, and allows blood to flow from the higher pressure arch of the aorta into the lower pressure pulmonary trunk.

BLOOD DISORDERS

These are disorders affecting the components of the blood. They can largely be divided depending on which of the blood cells they affect.

Anemia

Anemia is a blood disorder affecting red blood cells. Patients suffering with anemia have a decreased oxygen carrying capacity due to a decrease in the number of red blood cells, or a reduced amount of haemoglobin in the blood. There are multiple different types of anemia, some of which are the following:

Iron deficient anemia is the most common form of anemia. It is the result of insufficient intake of iron, an increase in the amount of iron lost, or inadequate absorption of iron. Women are more likely to be affected by this form of anemia due to menstruation and the higher demands of iron placed on their body during pregnancy.

Megaloblastic anemia is caused by a decrease in the intake or absorption of vitamin B12 or folic acid. This results in the production of large, insufficient red blood cells.

Pernicious anemia is the result of insufficient hemopoiesis, or production of red blood cells by bone marrow.

Hemorrhagic anemia is caused by loss of red blood cells through excessive bleeding.

Aplastic anemia occurs due to the destruction of red bone marrow, which leads to a reduction in the number of red blood cells being produced.

Sickle cell anemia is a condition in which the shape of the red blood cells is altered into a sickle shape. These cells cannot easily pass through capillaries and tend to clump together, blocking the blood vessel. They are also prone to rupturing, with their rapid break down resulting in a reduced oxygen carrying capacity.

LEUKEMIA

Leukemia refers to a group of cancers affecting the red bone marrow. These cancers cause abnormal white blood cells to multiply uncontrollably, which interferes with normal red blood cell, white blood cell and platelet production. This results in a decrease in oxygen carrying capacity, susceptibility to infection, and abnormal clotting. Leukemia spreads easily from the bone marrow to the lymph nodes, liver and spleen, causing them to enlarge. Symptoms are caused mainly by disruption to the production of other blood cells, including fatigue, pale skin and cold intolerance that is usually observed in Chronic leukemia develops over an extended period of time. The second classification is based on the type of cells affected: Lymphoblastic affects lymphoid stem cells; Myelogenous affects myeloid stem cells. Thus, there are four types of leukemia:

Acute lymphoblastic leukemia is the most common form of the disease occurring in children, though it can also affect adults as well.

Acute myelogenous leukemia is found in both adults and children. Chronic lymphoblastic leukemia is usually present in adults.

HEMOPHILIA

This is an inherited blood disorder that causes spontaneous bleeding or bleeding where only minor trauma has occurred. It is caused by deficiencies of different clotting factors and can vary significantly in severity.

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