

Introduction

The heart is the life-giving, ever-beating muscle in your chest. From inside the womb until death,. The heart for the average human will contract about 3 billion times; never resting, never stopping to take a break except for a fraction of a second between beats. Many believe that the heart is the first organ to become functional. Within weeks of conception the heart starts its mission of supplying the body with nutrients

The primary function of the heart is to pump blood through the arteries, capillaries, and veins. Blood transports oxygen, nutrients, disease causing viruses, bacteria, hormones and has other important functions as well. The heart is the pump that keeps blood circulating properly.

The Heart

The heart is a hollow, muscular organ about the size of a fist. It is responsible for pumping blood through the blood vessels by repeated, rhythmic contractions. The heart is composed of cardiac muscle, an involuntary muscle tissue that is found only within this organ. The term "cardiac" (as in cardiology) means "related to the heart" and comes from the Greek word kardia, for "heart." It has a four-chambered, double pump and is located in the thoracic cavity between the lungs. The heart's rhythmic contractions occur spontaneously, although the frequency or heart rate can be changed by nervous or hormonal influence such as exercise or the perception of danger.

Myocardium

The myocardium is the muscular tissue of the heart. The myocardium is composed of specialized cardiac muscle cells with an ability not possessed

by muscle tissue elsewhere in the body. Cardiac muscle, like other muscles, can contract, but it can also conduct electricity, like nerves. The blood to the myocardium is supplied by the coronary arteries. If these arteries are occluded by atherosclerosis and/or thrombosis, this can lead to angina pectoris or myocardial infarction due to ischemia (lack of oxygen). Failure of the heart (for various reasons) is termed heart failure, generally leading to fluid retention, edema, pulmonary edema, renal insufficiency, hepatomegaly, a shortened life expectancy and decreased quality of life.

Pericardium

The pericardium is the thick, membranous sac that surrounds the heart. It protects and lubricates the heart. There are two layers to the pericardium: the fibrous pericardium and the serous pericardium. The serous pericardium is divided into two layers; in between these two layers there is a space called the pericardial cavity.

Atrium

There are two atria on either side of the heart. On the right side is the atrium that contains blood which is poor in oxygen. The left atrium contains blood which has been oxygenated and is ready to be sent to the body. The right atrium receives de-oxygenated blood from the superior vena cava and inferior vena cava. The left atrium receives oxygenated blood from the left and right pulmonary veins.

Ventricles

The ventricle is a heart chamber which collects blood from an atrium and pumps it out of the heart. There are two ventricles: the right ventricle pumps blood into the pulmonary circulation for the lungs, and the left ventricle pumps blood into the systemic circulation for the rest of the body. Ventricles have thicker walls than the atria, and thus can create the higher blood pressure. Comparing the left and right ventricle, the left ventricle has

thicker walls because it needs to pump blood to the whole body. This leads to the common misconception that the heart lies on the left side of the body.

Valves

The two atrioventricular (AV) valves are one-way valves that ensure that blood flows from the atria to the ventricles, and not the other way. The two semilunar (SL) valves are present in the arteries leaving the heart; they prevent blood from flowing back into the ventricles. The sound heard in a heart beat is the heart valves shutting. The right AV valve is also called the tricuspid valve because it has three flaps. It is located between the right atrium and the right ventricle. The tricuspid valve allows blood to flow from the right atrium into the right ventricle when the heart is relaxed during diastole. When the heart begins to contract, the heart enters a phase called systole, and the atrium pushes blood into the ventricle. Then, the ventricle begins to contract and blood pressure inside the heart rises. When the ventricular pressure exceeds the pressure in the atrium, the tricuspid valve snaps shut. The left AV valve is also called the bicuspid valve because it has two flaps. It is also known as the mitral valve. This valve prevents blood in the left ventricle from flowing into the left atrium. As it is on the left side of the heart, it must withstand a great deal of strain and pressure; this is why it is made of only two cusps, as a simpler mechanism entails a reduced risk of malfunction. There are two remaining valves called the Semilunar Valves.

Aorta

The aorta is the largest of the arteries in the systemic circuit. The blood is pumped from the left ventricle into the aorta and from there it branches to all parts of the body. The aorta is an elastic artery, and as such is able to distend. When the left ventricle contracts to force blood into the aorta, the aorta expands. This stretching gives the potential energy that will help maintain blood pressure during diastole, as during this time the aorta contracts passively.

Superior Venae Cavae

The superior vena cava (SVC) is a large but short vein that carries deoxygenated blood from the upper half of the body to the heart's right atrium. It is formed by the left and right brachiocephalic veins which receive blood from the upper limbs and the head and neck. The azygous vein (which receives blood from the ribcage) joins it just before it enters the right atrium.

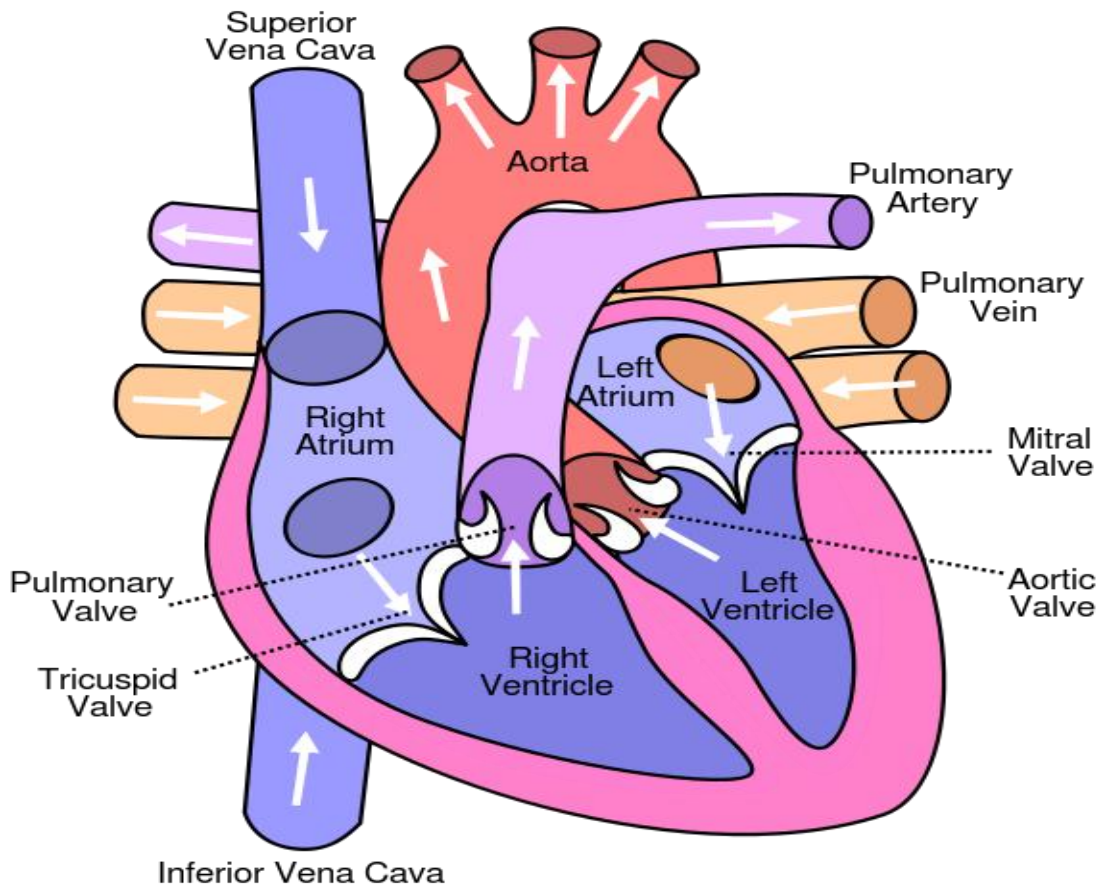
Inferior Venae Cavae

The inferior vena cava (or IVC) is a large vein that carries deoxygenated blood from the lower half of the body into the heart. It is formed by the left and right common iliac veins and transports blood to the right atrium of the heart. It is posterior to the abdominal cavity, and runs along side of the vertebral column on its right side.

Passage of Blood Through the Heart

The heart works as two pumps, one on the right and one on the left that works simultaneously. The right pump pumps the blood to the lungs or the pulmonary circulation at the same time that the left pump pumps blood to the rest of the body or the systemic circulation. Venous blood from systemic circulation (deoxygenated) enters the right atrium through the superior and inferior vena cava. Venous blood from systemic circulation (deoxygenated) enters the right atrium through the superior and inferior vena cava. The right atrium contracts and forces the blood through the tricuspid valve (right atrioventricular valve) and into the right ventricles. The right ventricles contract and force the blood through the pulmonary semilunar valve into the pulmonary trunk and out the pulmonary artery. This takes the blood to the lungs where the blood releases carbon dioxide and receives a new supply of oxygen. The new blood is carried in the pulmonary veins that take it to the left atrium. The left atrium then contracts and forces blood through the left atrioventricular, bicuspid, or mitral, valve into the left

ventricle. The left ventricle contracts forcing blood through the aortic semilunar valve into the ascending aorta. It then branches to arteries carrying oxygen rich blood to all parts of the body.



Blood Flow Through Capillaries

From the arterioles, the blood then enters one or more capillaries. The walls of capillaries are so thin and fragile. Inside the capillaries, exchange of oxygen and carbon dioxide takes place. Red blood cells inside the capillary release their oxygen which passes through the wall and into the surrounding tissue. The tissue then releases waste, such as carbon dioxide, which then passes through the wall and into the red blood cells.

SA Node

The sinoatrial node (abbreviated SA node or SAN) is the impulse generating (pacemaker) tissue located in the right atrium of the heart. Although all of the heart's cells possess the ability to generate the electrical impulses (or action potentials) that trigger cardiac contraction, the sinoatrial node is what normally initiates it, simply because it generates impulses slightly faster than the other areas with pacemaker potential. The sinoatrial node (SA node) is a group of cells positioned on the wall of the right atrium, near the entrance of the superior vena cava. Because the sinoatrial node is responsible for the rest of the heart's electrical activity, it is sometimes called the primary pacemaker. These cells form the atrioventricular node (AV node), which is an area between the right atrium and ventricle, within the atrial septum. The impulses from the AV node will maintain a slower heart rate (about 40-60 beats per a minute). When there is a pathology in the AV node or purkinje fibers, an ectopic pacemaker can occur in different parts of the heart. The sympathetic nerves are distributed to all parts of the heart, especially in ventricular muscles. The parasympathetic nerves mainly control SA and AV nodes, some atrial muscle and ventricular muscle. Parasympathetic stimulation from the vagal nerves decreases the rate of the AV node by causing the release of acetylcholine at vagal endings which in turn increases the K⁺ permeability of the cardiac muscle fiber.

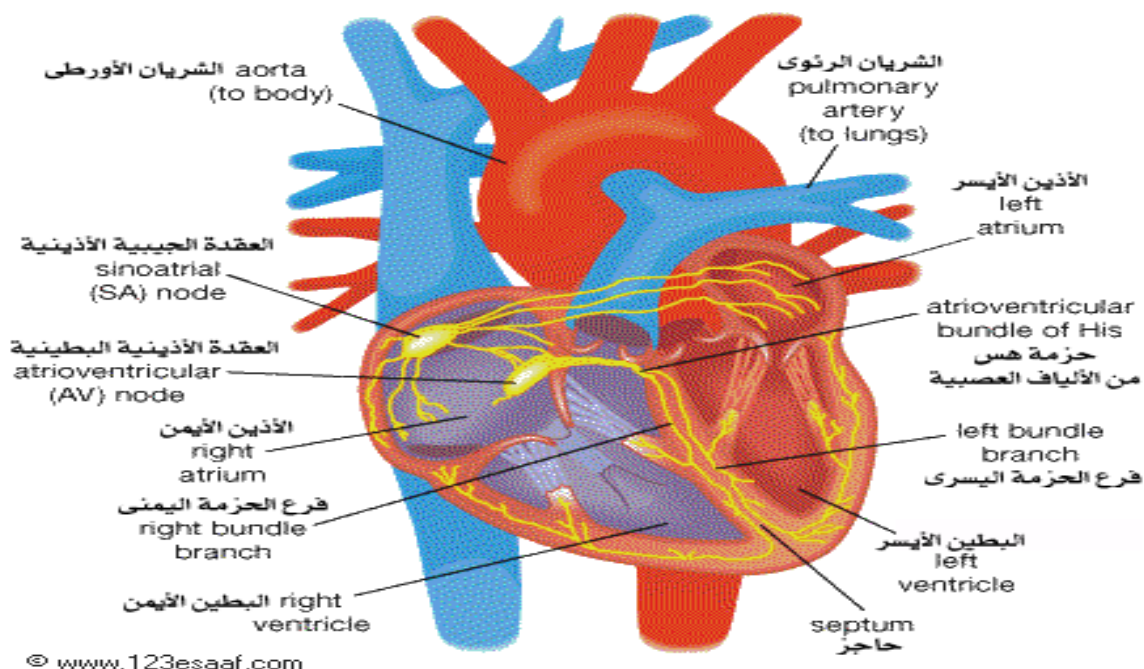
AV Node

The atrioventricular node (abbreviated AV node) is the tissue between the atria and the ventricles of the heart, which conducts the normal electrical impulse from the atria to the ventricles. This is the property of the AV node that prevents rapid conduction to the ventricle in cases of rapid atrial rhythms, such as atrial fibrillation or atrial flutter. The atrioventricular node delays impulses for 0.1 second before spreading to the ventricle walls. The

reason it is so important to delay the cardiac impulse is to ensure that the atria are empty completely before the ventricles contract. The blood supply of the AV node is from a branch of the right coronary artery in 85% to 90% of individuals.

Purkinje Fibers

Purkinje fibers (or Purkyne tissue) are located in the inner ventricular walls of the heart, just beneath the endocardium. These fibers are specialized myocardial fibers that conduct an electrical stimulus or impulse that enables the heart to contract in a coordinated fashion. Purkinje fibers work with the sinoatrial node (SA node) and the atrioventricular node (AV node) to control the heart rate. During the ventricular contraction portion of the cardiac cycle, the Purkinje fibers carry the contraction impulse from the left and right bundle branches to the myocardium of the ventricles. This causes the muscle tissue of the ventricles to contract and force blood out of the heart — either to the pulmonary circulation (from the right ventricle) or to the systemic circulation (from the left ventricle). They were discovered in 1839 by Jan Evangelista Purkinje, who gave them his name.



AV Bundle

The bundle of HIS is a collection of heart muscle cells specialized for electrical conduction that transmits the electrical impulses from the AV node (located between the atria and the ventricles) to the point of the apex of the fascicular branches. The fascicular branches then lead to the Purkinje fibers which innervate the ventricles, causing the cardiac muscle of the ventricles to contract at a paced interval. These specialized muscle fibers in the heart were named after the Swiss cardiologist Wilhelm His, Jr., who discovered them in 1893. Cardiac muscle is very specialized, as it is the only type of muscle that has an internal rhythm; i.e., it is myogenic which means that it can naturally contract and relax without receiving electrical impulses from nerves. When a cell of cardiac muscle is placed next to another, they will beat in unison. The fibers of the Bundle of HIS allow electrical conduction to occur more easily and quickly than typical cardiac muscle. They are an important part of the electrical conduction system of the heart as they transmit the impulse from the AV node (the ventricular pacemaker) to the rest of the heart. The bundle of HIS branches into the three bundle branches: the right left anterior and left posterior bundle branches that run along the intraventricular septum. The bundles give rise to thin filaments known as Purkinje fibers. These fibers distribute the impulse to the ventricular muscle. Together, the bundle branches and Purkinje network comprise the ventricular conduction system. It takes about 0.03-0.04s for the impulse to travel from the bundle of HIS to the ventricular muscle.

Pacemaker

The contractions of the heart are controlled by electrical impulses, these fire at a rate which controls the beat of the heart. The cells that create these rhythmical impulses are called pacemaker cells, and they directly control the heart rate. Artificial devices also called pacemakers can be used

after damage to the body's intrinsic conduction system to produce these impulses synthetically.

Blood Pressure

Blood pressure is the pressure exerted by the blood on the walls of the blood vessels. blood pressure refers to arterial blood pressure, i.e., the pressure in the large arteries delivering blood to body parts other than the lungs, such as the brachial artery (in the arm). The pressure of the blood in other vessels is lower than the arterial pressure. Blood pressure values are universally stated in millimeters of mercury (mmHg). The systolic pressure is defined as the peak pressure in the arteries during the cardiac cycle; the diastolic pressure is the lowest pressure (at the resting phase of the cardiac cycle). The mean arterial pressure and pulse pressure are other important quantities. Typical values for a resting, healthy adult are approximately 120 mmHg systolic and 80mm Hg diastolic (written as 120/80 mmHg), with individual variations. These measures of blood pressure are not static, but undergo natural variations from one heartbeat to another, and throughout the day (in a circadian rhythm); they also change in response to stress, nutritional factors, drugs, or disease.

Stroke

A stroke, also known as cerebrovascular accident (CVA), is an acute neurological injury whereby the blood supply to a part of the brain is interrupted. Strokes can be classified into two major categories: ischemic and hemorrhagic. ~80% of strokes are due to ischemia.

Heart Attack

Acute myocardial infarction (AMI or MI), commonly known as a heart attack, A heart attack occurs when the supply of blood and oxygen to an area of heart muscle is blocked, usually by a clot in a coronary artery.

Often, this blockage leads to arrhythmias (irregular heartbeat or rhythm) that cause a severe decrease in the pumping function of the heart and may bring about sudden death. If the blockage is not treated within a few hours, the affected heart muscle will die and be replaced by scar tissue. It is the leading cause of death for both men and women all over the world.

Angina Pectoris

Angina Pectoris is chest pain due to ischemia (a lack of blood and hence oxygen supply) of the heart muscle, generally due to obstruction or spasm of the coronary arteries (the heart's blood vessels).

The Lymphatic System

The lymphatic system is closely related to the cardiovascular system. There are three main ways that they work together to maintain homeostasis: the lymphatic system receives the excess tissue fluid and returns it to the bloodstream, lacteals take fat molecules from the intestinal villi and transport them to the bloodstream and both systems work together to defend the body against disease.

Aging

The heart muscle becomes less efficient with age, and there is a decrease in both maximum cardiac output and heart rate, although resting levels may be more than adequate. The health of the myocardium depends on its blood supply, and with age there is greater likelihood that atherosclerosis will narrow the coronary arteries. Atherosclerosis is the deposition of cholesterol on and in the walls of the arteries, which decreases blood flow and forms rough surfaces that may cause intravascular clot formation. High blood pressure (hypertension) causes the left ventricle to work harder. It may enlarge and outgrow its blood supply, thus becoming weaker. A weak ventricle is not an efficient pump, and may progress to

congestive heart failure. This process may be slow or rapid. The heart valves may become thickened by fibrosis, leading to heart murmurs and less efficient pumping. Arrhythmias are also more common with age, as the cells of the conduction pathway become less efficient.

The ECG

E.C.G stands for Electrocardiogram and represents the electrophysiology of the heart. Cardiac electrophysiology is the science of the mechanisms, functions, and performance of the electrical activities of specific regions of the heart. The ECG is the recording of the heart's electrical activity as a graph. The graph can show the heart's rate and rhythm, it can detect enlargement of the heart, decreased blood flow, or the presence of current or past heart attacks. ECG's are inexpensive, quick, and painless. Depending on the results, the patient's medical history, and a physical exam; further tests or a combination of medications and lifestyle changes .