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Your Heart and Circulatory System

Your heart is a vital organ, tirelessly pumping blood throughout your body whether you are resting, carrying out your daily activities, or exercising strenuously. It is the muscular powerhouse at the center of your circulatory system, and its healthy function keeps you alive, delivering nourishing blood to every cell of every tissue in your body.

The heart and the circulatory system together make up your cardiovascular system, which accomplishes the complex function of distributing oxygen and other nutrients to body cells, as well as carrying away carbon dioxide and other waste products of cellular function for elimination. Your heart provides the pumping action and force to push your blood first through the lungs to take on oxygen, and then out into the circulatory system. Your circulatory system ferries the blood out to body tissues via arteries, then back to the heart through veins. More than 60,000 miles of blood vessels are involved in this vast network.

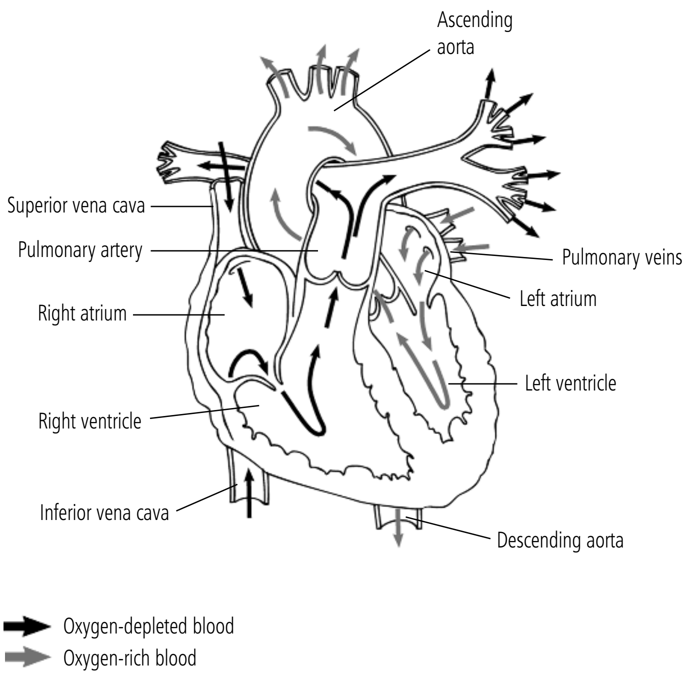
The heart itself is about the size of a fist and weighs less than a pound. To "put your hand over your heart," you place it just to the left of your sternum, or breast bone, which is located in the center of your chest. You can usually feel your heart's regular beat, because the right side of the roughly cone-shaped organ tilts closest to your chest wall at this point. Behind the heart are the lungs. These organs are well protected within the bony structure of your chest cavity, with the spinal column and ribs behind them.

The Structure and Function of the Heart

In the heart, blood makes a figure-eight passage. It enters on the right side through two major veins, moves through the two right chambers, loops back through the lungs to pick up oxygen, then passes back into the left chambers and out through the aorta. The blood flow is propelled through the heart and body as the heart's muscles contract. Flow is directed by the opening and closing of one-way heart valves between the chambers of the heart and the great vessels, or veins and arteries.

The Heart Chambers

The heart is constructed of four chambers: the right atrium and the right ventricle, and the left atrium and the left ventricle. These four chambers function as two side-by-side pumps, each of which sends blood through a completely different system of circulation. The right side of the heart pumps blood through the less forceful pulmonary circulation of the lungs, where oxygen-depleted blood is replenished in lung tissue with oxygen from the air we breathe. The left side of the heart pumps blood into the rest of your blood vessels, allowing



How your heart pumps blood

The four chambers of your heart function as two side-by-side pumps. On the right side, oxygen-depleted blood that has circulated through the body passes into the right atrium through the superior vena cava and inferior vena cava. The right atrium pushes it into the right ventricle, which moves it into the pulmonary artery to flow into the lungs. In the lungs, the blood is enriched with fresh oxygen. Then the oxygen-rich blood flows through the pulmonary vein into the left side of the heart. The left atrium sends the blood into the left ventricle, which contracts forcefully enough to pump the blood into the aorta, the major artery at the top of the heart. From the aorta, the oxygen-rich blood is distributed throughout the body to nourish cells.

nourishing, oxygen-rich blood to leave the heart and travel throughout the rest of the body.

The atria receive blood from the body on the right side and from the lungs on the left side. The two ventricles are the pumping chambers that expel the blood. The two pumps operate in synchronized fashion, the two atria and then the two ventricles contracting and relaxing simultaneously. The two sides of the heart are separated by a thick muscular wall called the septum, which prevents blood from passing directly from one side of the heart to the other.

To understand the mechanics of pulmonary (lung) circulation, you can trace the path of about half a cup of blood—the amount pumped in a given heartbeat—through the right side of the heart. Blood enters the right atrium of the heart through two large veins: the superior vena cava, which collects blood from your head and upper body, and the inferior vena cava, which collects blood from your legs and abdomen. At this point, the red blood cells in the blood returning to the right atrium have delivered oxygen and nutrients to other body tissues. The depleted blood has a low oxygen content. The right atrium contracts and sends the blood through a one-way valve into the right ventricle, which in turn contracts and pushes the blood out through the pulmonary artery into the lungs. As the blood circulates through the lungs, it unloads carbon dioxide, a waste product of cellular function that it has carried from body tissues. The red blood cells then pick up fresh oxygen, and the blood is enriched, or oxygenated.

Similarly, on the upper left side of the heart, circulation to the rest of your body starts with the left atrium. Bright red, oxygen-rich blood enters the chamber via the pulmonary vein, from the lungs. The walls of the left atrium contract and push the blood through a one-way valve into the left

Heart Tissue

Your heart is composed of cardiac muscle: specialized, involuntary muscle tissue that is structured differently from the muscle tissue elsewhere in your body. The muscular wall of your heart chambers is called the myocardium. The fibers of cardiac muscle are uniquely networked to respond to the electrical impulses that initiate a heartbeat and coordinate the continuous, rapid, rhythmic contractions of the heart. At a cellular level, individual muscle cells shorten, causing the wall to tighten and the chamber to squeeze blood out. When the cells lengthen, the wall relaxes and the chamber becomes larger and allows blood to enter.

A layer of tissue called the endocardium lines the interior of the heart, including the surfaces of the valves. This membrane is smooth muscle tissue.

In addition, a layer of smooth, protective tissue covers the outer surface of the myocardium. This outer membrane, the pericardium, is actually a two-layer fibrous sac that encases the heart itself and the base of the major blood vessels. The outer sac holds the heart in place, while the inner sac is attached to the heart muscle. A lubricating fluid forms a film between these three layers to allow the heart to move freely within the pericardium.

ventricle. Then the left atrium relaxes while the powerful left ventricle contracts with the considerable force required to propel the blood into the aorta—the major artery at the top of the heart that directs the blood throughout the body. The left ventricle is the main pump and the strongest muscle tissue in the heart.

The Heart Valves

The blood flow through the heart needs to be one-way and carefully regulated. Four one-way valves between the chambers ensure that the blood moves through the heart and lungs in sequence and never dams up or back-flows. All the heart valves are constructed of overlapping flaps (leaflets or cusps) that open and close to control blood flow. The valves differ by structure and function.

The pulmonary and aortic valves between a ventricle and the great artery are called the semilunar valves because of their crescent-shaped leaflets. The tricuspid and mitral valves between the right and left atria and a ventricle are also called atrioventricular valves. The leaflets of the two atrioventricular valves are attached to the ventricular walls by fibrous cords. When the ventricle contracts and the valve closes, the cords secure the leaflets in place so they are not blown backward by the force of the contraction.

The tricuspid valve, on the right side of the heart, is named for its three leaflets, or cusps. Returning, oxygen-depleted blood flows through this valve into the right ventricle.

As the blood flows out of the right ventricle and into the pulmonary circulation, it passes through the pulmonary valve. The pulmonary valve's three leaflets open as the right ventricle contracts and close again as it relaxes.

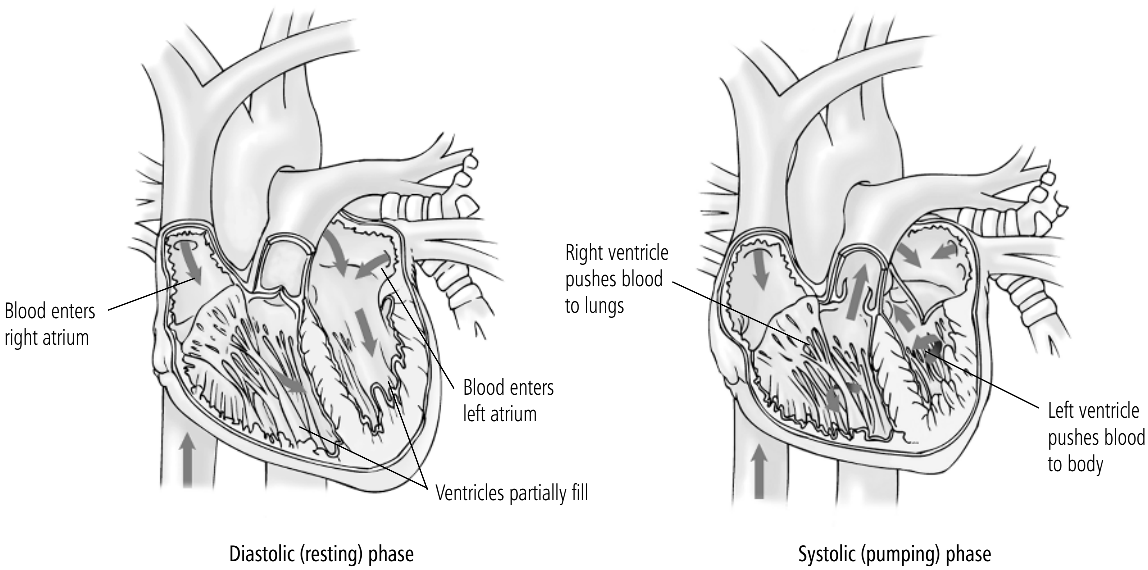
As the oxygen-enriched blood passes back into the left atrium, it passes through the mitral valve (named for its shape, which resembles a type of bishop's hat called a miter). This valve has just two highly mobile cusps that can close rapidly when the powerful left ventricle contracts. This valve is attached by cords to muscles within the ventricle.

Finally, as the blood flows out of the left ventricle and into the aorta, the three-part aortic valve opens against the walls of the aorta. When the blood has passed into the aorta, the valve falls shut.

The Heartbeat

The continuous function of your heart is probably easiest to understand if you break it down into a single unit of pumping action, the heartbeat. A healthy heart beats between 50 and 75 times per minute, so a single heartbeat may occur in less than a second. It involves two distinct phases, the systole and the diastole. The systole is the pumping phase and the diastole is the resting phase.

The systole actually occurs in two sequential pumping actions: the atrial systole and the ventricular systole. The lub-dub that is heard through a stethoscope is the sound of the heart valves closing during the heartbeat's pumping cycle. The first heart sound, the "lub," coincides with the closing of the mitral and tricuspid valves. The second heart sound, the "dub," occurs with the closing of the aortic and pulmonary valves.



The heartbeat

A single heartbeat moves a quantity of blood through the heart in two phases: a resting, or dilating (diastolic), phase and a pumping, or squeezing (systolic), phase. During the diastolic phase, the heart relaxes and fills, as oxygen-depleted blood flows into the right atrium from the body, and oxygen-rich blood flows from the lungs into the left atrium. The ventricles fill partially. Then, during the systolic phase (right), an electrical impulse causes the heart to contract. First, the atria contract and completely fill the ventricles with blood. Then the ventricles contract, pumping blood out of the heart.

The diastole, the first and longer resting phase, occurs as blood collects in the two (right and left) atria. In the right atrium, depleted blood enters from the body, and in the left atrium, oxygen-rich blood flows in from the lungs.

Systole begins when an electrical signal from the heart's pacemaker cells stimulates the atria to contract and empty. The tricuspid and mitral valves open and blood flows into the two ventricles.

When the ventricles are full, the electrical impulse passes into an area just above the ventricles and triggers the ventricular systole, the third and final step. All four valves are in action: the tricuspid and mitral valves close to prevent backflow from the ventricles to the atria, and the pulmonary and aortic valves are pushed open as blood surges out. On the right side of the heart, oxygen-poor blood travels from the right ventricle into the pulmonary artery on its way to the lungs to acquire oxygen. On the left side of the heart, oxygen-enriched blood flows from the left ventricle through the aorta and into the general and coronary circulation.

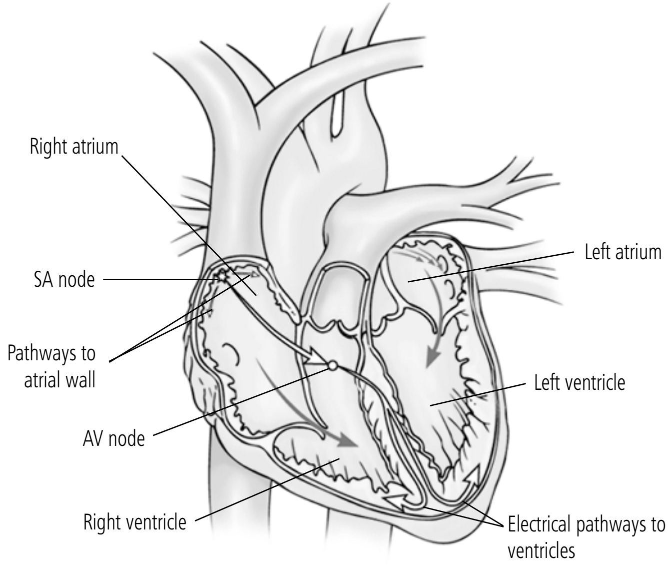
After the blood has left the ventricles, they relax, and the pulmonary and aortic valves close. As the ventricles relax, the pressure in the ventricles lowers, allowing the tricuspid and mitral valves to open, and the cycle begins again.

Throughout this cycle, the two adjacent pumps move exactly the same amounts of blood; the volume of blood that enters and leaves the right chambers is the same as the volume that passes through the left chambers. Any change in the amount of blood entering the right side of your heart—in response to exertion, stress, or temperature changes, for example—causes a corresponding change in the amount of blood passing through the left side. Your brain is constantly monitoring the conditions that might require a change in blood supply and adjusting your heart's function accordingly.

The Heart's Electrical Conduction System

The electrical activity that stimulates and paces the heartbeat is critical. In order to deliver an appropriate blood supply to body tissues, the heart must beat at an adequate rate, and the timing and sequence of muscular contractions must be precisely coordinated.

Your heart's natural pacemaker is the sinoatrial (SA) node, a



Your heart's electrical activity

Areas of specialized cells in heart tissue can initiate and conduct electrical impulses. The sinoatrial (SA) node, an area of electrical cells at the top of the right atrium, fires an impulse that initiates each heartbeat. The impulse first stimulates the walls of the atria to contract, allowing blood to fill the ventricles, and then travels to the atrioventricular (AV) node (over the ventricles). The AV node acts as a relay station for the signal before passing the impulse into the ventricles via branching electrical pathways.

microscopic group of specialized electrical cells located at the top of the right atrium. Each heartbeat originates in the SA node when it fires off an electrical impulse. This impulse travels via specialized pathways to the cells in the muscle tissues of the heart wall. The impulse first stimulates the upper chambers, the atria, to contract and squeeze blood out into the ventricles.

Then the impulse moves to another area of electrical cells called the atrioventricular (AV) node, located over the ventricles. This node acts as a relay station, allowing for a brief interval during which the atria empty completely before releasing the impulse along branching pathways that travel to the two ventricles to stimulate ventricular contraction. The ventricles similarly contract and empty, and blood is pumped into the pulmonary artery and the aorta.

The SA node speeds up when your body needs more blood. It also slows down during rest or in response to some medications. The message to increase or decrease the rate of impulses is controlled by the autonomic nervous system—the part of the nervous system that controls unconscious, automatic body functions including heart rate, blood pressure, and breathing. Autonomic nervous system activity regulates the release of the hormones epinephrine and norepinephrine, which act as accelerators for the heart's electrical impulses during times of stress or exercise.

Your heart's electrical activity can be followed and recorded on paper as an electrocardiogram (ECG, see pages 122–125). The initial impulse from the SA node is seen as a wave on the ECG, followed by a more static interval. The ECG recording shows spikes as the impulse travels from the AV node through the ventricular pathways and is again followed by a static interval that is a segment of recovery.

Coronary Circulation

Because your heart must operate continuously to supply the rest of your body with blood, it works harder and requires a richer blood supply of its own than any other muscle in your body. It cannot extract oxygen and nutrients from the blood that moves through it, so it maintains its own dedicated circulatory system of arteries and veins. This coronary circulation begins with two coronary arteries that branch off of the aorta just above the aortic valve (on the left side). These arteries extend over the surface of the heart and branch into smaller vessels that penetrate the heart muscles to provide oxygen. After the muscles of the heart have been nourished, the blood travels through coronary veins into the coronary sinus and then the right atrium. At this point, it flows in with the oxygen-depleted blood from the rest of the body.

The left coronary artery supplies blood to most of the powerful left ventricle. The circumflex coronary artery is really a branch of the left coronary artery. It wraps around the back of the heart and has several smaller branches. The right coronary artery supplies part of the left ventricle and most of the right ventricle. Interestingly, the configuration and even the sizes of the coronary arteries differ significantly from person to person.

The coronary arteries deliver oxygen-rich blood to the cardiac muscle cells according to the demand at the moment. If you are exerting yourself physically, your heart beats faster and more vigorously, and your coronary arteries expand to allow greater blood flow.

Your Heart's Performance

Both the rate at which your heart beats and the volume of blood your heart moves in a single beat determine how efficiently your heart pumps blood. Cardiologists calculate cardiac output to measure your heart's efficiency. Cardiac output is, quite simply, the amount of blood your heart pumps through your circulatory system in one minute. It is calculated by multiplying how much blood the left ventricle squeezes out in a single contraction (stroke volume) by the number of times the heart contracts in a minute (heart rate).

Most typically, when your body needs more blood (for instance, when you are running up stairs) the heart increases its output by beating faster. If your heart beats at a fast rate for very long, the muscle begins to tire and the resting phase of the heartbeat becomes too short for the chambers to fill adequately. If you are physically fit, your heart muscle is stronger and can pump more blood with each contraction. That is, your stroke volume is higher, so your heart can deliver adequate blood to your body without tiring as quickly. A physically fit person may actually have a low resting heart rate, because he or she has strengthened the heart muscle so that it can pump more blood, delivering adequate oxygen to the body with fewer strokes. When a fit person exercises, he or she may have the same heart rate as someone who is less fit, but the fit person is able to do more work, such as run longer without tiring.

A healthy resting heart rate is usually between 50 and 75 beats per minute. When you exercise, your heart rate may increase to as much as 165 beats or more. Age plays a role in determining your maximum heart rate; the maximum number of beats per minute can be very roughly predicted by the formula 220 minus your age. A number of other factors can cause your heart rate to increase, including stress, some medications, caffeine, alcohol, and tobacco. When a healthy person sleeps, his or her heart rate may dip to as low as 40 beats per minute. As you age, your heart rate may decrease somewhat.

Stroke volume in most people is about 3 ounces. That means that the ventricles pump out about half the blood they contain. A good athlete may be able to increase his or her stroke volume by 5 percent or more. A diminishing stroke volume is one of the first signs of a failing heart.

A pregnant woman's body demands more blood flow and oxygen for the developing placenta. Stroke volume increases early in pregnancy, and later the heart rate increases to maintain a cardiac output 40 to 50 percent above normal. These changes reverse after the baby is delivered.

The Circulatory System

Your systemic circulation is the vast highway system that carries blood from your heart to every part of your body, and then returns it to the heart. The vessels that carry blood away from the heart are the arteries; the vessels that carry blood back to the heart are veins. Like a system of roads, your circulatory system keeps branching off into successively smaller vessels that carry blood to and from the smallest structures and finally individual cells in body tissues. At a cellular level, single red blood cells exchange oxygen and nutrients with single body cells through the walls of microscopic capillaries.

The Arteries and the Capillaries

The aorta, the largest artery in your body, emerges from the left side of your heart. About 1 inch in diameter, it ascends from your left ventricle engorged with oxygen-rich blood, then arches down the chest into the abdomen. Major arteries branch off it to supply different areas of your body. The carotid and vertebral arteries travel to your head and neck. The subclavian arteries supply the arms. The abdominal (descending) aorta provides branches to your stomach, liver, kidneys, and intestinal tract. The aorta then divides into the iliac arteries and then the femoral arteries of the legs.

The pulmonary artery carries blood from your heart to your lungs. Exiting from your right ventricle, it transports oxygen-depleted blood into your lungs to replenish the oxygen. This pulmonary circulation functions similarly to your systemic circulation but is limited to the lungs, where oxygen exchange occurs at a cellular level.

The arteries subdivide into smaller vessels called arterioles. The arteries and arterioles have flexible muscular walls that can dilate (widen) and contract, with a critical impact on directing blood flow. Blood flows more easily to areas where there is less resistance, so arteries that widen increase the circulation to that area, while a constricted artery reduces blood flow. Branching off from the arterioles are the smallest vessels, the capillaries. Most capillary walls are only one cell thick. Specialized capillaries in different types of body tissue allow the passage of different types of molecules through their walls. In the lungs, for example, molecules of carbon dioxide (a waste product) pass into the tissue to be breathed out, while molecules of oxygen pass into the blood cells. In your intestinal system, nutrients from digested food pass through the capillary walls into the blood.

The Veins

At the level of individual cells throughout your body, the capillaries receive spent blood from body tissue that has a lower level of oxygen. The capillaries flow into larger vessels called venules, which converge and form still larger veins. The pressure in veins is significantly lower than the pressure in arteries, and the walls are thinner, which is why blood samples are typically taken from a vein. As with arteries, the walls of veins can expand or contract. Any tensing of your muscles squeezes the veins, helping to counteract gravity and keep blood flowing toward your heart. Larger veins also have a system of one-way valves that keep the returning blood flowing the right way.

Venous blood from the body enters the heart via two major vessels: the superior vena cava, bringing blood from the upper part of the body, and the inferior vena cava, returning blood from the lower part. These large veins enter the right atrium, where the blood is sent into the pulmonary circulation for oxygen pickup.

Blood

Blood is the fluid vehicle by which oxygen, enzymes (proteins that promote body processes), and other life-sustaining nutrients are brought to body cells in order to maintain an optimal environment for growth. Blood is composed of specialized blood cells—red blood cells, white blood cells, and platelets—and of plasma, the fluid in which the blood cells are suspended.

The vast majority of blood cells are red blood cells, also called erythrocytes or red corpuscles, which do the work of oxygen transport. An individual red blood cell is saucer-shaped to maximize its surface area for efficient oxygen exchange. Chemically, a red blood cell contains large quantities of hemoglobin, an iron-rich protein that is the body's oxygen transport carrier molecule. As red blood cells travel through the lungs, where oxygen levels are high, the hemoglobin readily combines with oxygen. When the blood cells reach body tissues where oxygen levels are relatively low, the hemoglobin just as effectively releases oxygen. The red blood cells also pick up the waste product carbon dioxide and carry it back to the lungs, where it is released and then exhaled out of the body. Red blood cells are formed in the bone marrow at the rate of about 8 million a second, or many billion in a single day. They live from 3 to 4 months.

White blood cells, or leukocytes, play a critical role in protecting the body against infection. One type of white blood cell, called a lymphocyte, identifies invading microorganisms or other harmful substances in the body and triggers the body's immune response. The number of white blood cells increases when your body is fighting infection. Also suspended in the plasma are cell fragments called platelets, which initiate a blood-clotting response when you are injured or a blood vessel is damaged. White blood cells and platelets make up about 1 to 2 percent of blood volume.

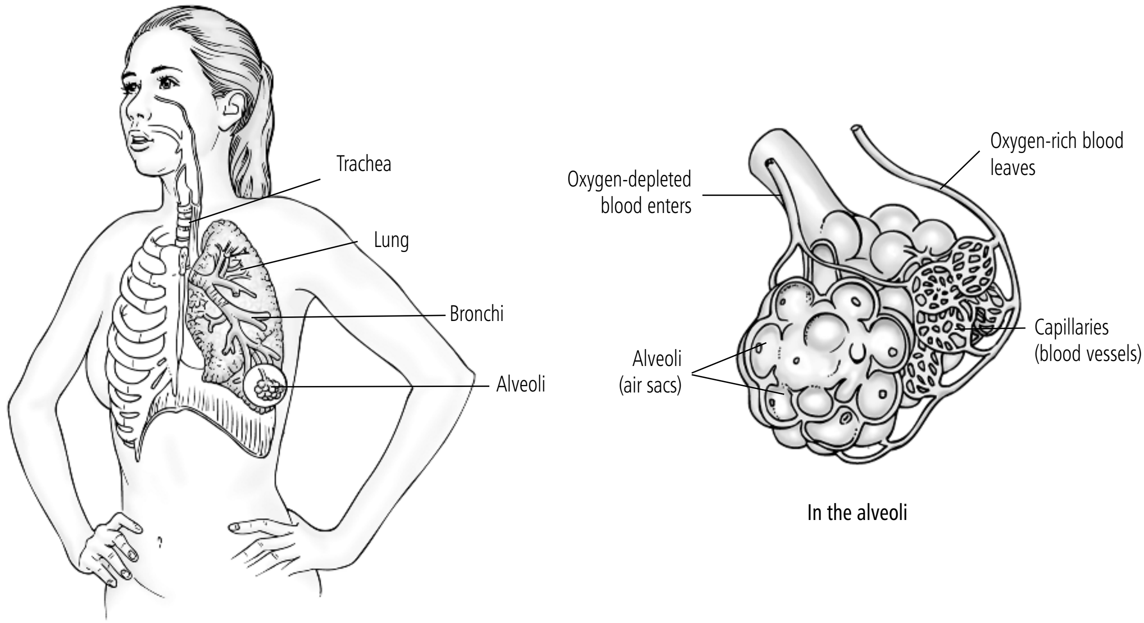
About 55 percent of the blood volume is plasma, a yellowish, watery substance that contains proteins, glucose (sugar), cholesterol, and other components. Proteins in the plasma perform varied roles such as carrying nutrients, contributing to the clotting factor, and acting as infection-fighting antibodies in an immune response.

The Lungs and the Respiratory System

The story of oxygen transport to body cells is not complete without a look at the respiratory system, which brings oxygen from the air into the body, transfers it to the blood, and then rids the body of the waste products of cellular energy. When you breathe, the organs of your respiratory system perform the physical job of bringing air into the body and expelling it. The same organs are the site of the more complex biochemical process of respiration, the oxygenation of blood at a cellular level.

When you inhale air, it passes down your trachea, into the tubular bronchi that branch into your lungs, and through a system of subdividing air passages that end deep in lung tissue as microscopic tubes called bronchioles. The bronchioles open into tiny, elastic air sacs called alveoli.

Parallel to these branching air passages, a network of blood vessels brings blood into lung tissue. Minute capillaries cover the surface of the alveoli, and through the walls of these capillaries oxygen passes from the air sacs into the blood. Carbon dioxide molecules, carried in the blood from body tissues, pass into the alveoli. The oxygen-laden blood flows



The respiratory system

When you inhale, you bring air into your lungs via the trachea, or windpipe. In the lungs, branching air passages (bronchi) end deep in lung tissue in microscopic clusters of air sacs called alveoli. In these clusters, networks of tiny blood vessels (capillaries) cover the air sacs. Oxygen exchange takes place through the walls of the alveoli and capillaries, as oxygen passes from lung tissue into the bloodstream and waste products (such as carbon dioxide) pass from the bloodstream into the lungs to be exhaled out of your body.

back into the heart, where it then can be circulated throughout the body, while the carbon dioxide moves back through the lungs to be exhaled.

The Heart and Other Body Systems

Your heart beats and your blood circulates with little or no conscious awareness on your part. Even though circulation is an involuntary function, it is a dynamic one. Your cardiovascular system is constantly adjusting to changes in the external environment or to demands you place on it. It adapts quickly, or directs other systems to adapt to changing conditions in order to maintain a constant flow of blood to body tissues. Even the simple act of standing up requires increased blood flow to the legs, because the heart must work harder to counteract the effects of gravity. This means that either blood flow to other parts of the body must be decreased or the heart must pump blood faster or in greater volume to accommodate the activity.

The two main systems that help regulate cardiac function are first, the brain and the nervous system, and second, the kidneys.

The Brain and the Nervous System

Nervous system receptors throughout your body constantly gather information about factors such as stretching of the arterial walls or the amount of oxygen in the blood. This information is relayed to the brain by chemicals called neurotransmitters. In the brain stem, at the base of the brain, regulatory centers involved with automatic body functions including heart rate, blood pressure, and respiration receive the messages and formulate a response. Neurotransmitters such as adrenaline carry messages back that direct a response in the target tissue, such as commands to constrict the blood vessels or increase the rate of respiration to deliver more oxygen to your lungs.

The Kidneys

The kidneys influence the volume of fluids in the body, so they can change the volume of circulating blood. In this way, they significantly affect blood pressure. They release enzymes that can raise blood pressure by constricting blood vessels, raising sodium levels, and increasing water retention. The kidneys can adapt to changing environmental conditions by, for instance, concentrating your urine if your body is dehydrated. If, on the other hand, you eat a lot of salty foods and start to retain water, your kidneys will produce less urine.

Preventing Heart Disease

Cardiovascular disease is the leading cause of death of men and women in the United States. Cancer, the second most common killer, accounts for the deaths of only half as many people. Heart and blood vessel disease takes many forms: high blood pressure, coronary artery disease, valvular heart disease, congestive heart failure, atherosclerosis, and stroke. Because of the enormous toll that the burden of these diseases has taken on the nation's health, extensive research has focused on preventing these problems. Over a period of decades, numerous studies involving hundreds of thousands of people have identified the major risk factors that indicate an individual's chances of developing cardiovascular disease. Understanding these risk factors and how you can control them gives you a good chance to prevent or modify heart disease in your own body. Even though cardiovascular disease is still a major threat, the death rates today are substantially lower than they were because so many people have been able to make effective changes in their lifestyle that prevent the development or the worsening of the disease.

These preventive changes—including how we eat, how physically active we are, and how we approach risky habits like smoking or drinking—make common sense in part because of the nature of heart disease and its treatment. Cardiovascular disease develops slowly and often without symptoms. Factors such as cholesterol buildup or rising blood pressure can start in childhood but may not become apparent as disease for decades, so prevention is the best answer.

About half the deaths from heart disease are sudden—an unexpected fatal occurrence that leaves little opportunity for intervention. Many treatments—for instance, the coronary artery bypass procedures that have become so common—can have side effects and are inappropriate to perform on every person at risk. Other technologies, such as balloon angioplasty or drugs, can treat a problem, but they cannot stop the underlying disease process.

Most positively, the picture that emerges from decades of research is that the healthy lifestyle choices that prevent heart disease also reduce the risk of other major diseases such as cancer and diabetes.

Risk Factors for Heart Disease

Some risk factors for heart disease are within your control, while others are not. The number of risk factors that affect you may change over the course of your lifetime. Having one or more of the major, proven risk factors doesn't mean that you will develop cardiovascular disease or die of it. But generally, the more of these factors that apply to you, the more likely you are to develop the disease at some point. By knowing your own constellation of risk factors, you can control as many as possible and reduce your risk. These are the factors you can't control:

- **Gender.** Men are more likely than women to have a heart attack at a younger age. Women are generally protected from heart disease by their sex hormones until menopause. Cardiovascular disease is still the leading cause of death for women, however. After menopause, a woman's risk of heart disease starts to rise. After the age of 65, a woman's chance of having coronary artery disease is about the same as a man's, and after 75, a woman is at even greater risk than a man is.

- **Increasing age.** Your risk of disease increases as you grow older. More than 80 percent of people who die from heart disease are over 65. As you age, your heart's function tends to weaken. The heart is less able to pump blood, the walls of the heart may thicken, and the walls of the arteries may stiffen and narrow. In addition to atherosclerosis, other conditions such as hypertension may compound the problem. Clearly this process is affected by lifestyle, including diet and exercise.
- **Heredity.** Cardiovascular disease runs in families, and you are more likely to develop it if your parents or siblings have coronary artery disease. Increased risk is linked to a family history of death from heart disease at a young age. Specifically, this is defined as coronary artery disease in men before age 55 and women before age 65. Your racial or ethnic background is another aspect of your heredity. In the United States, blacks are at higher risk than whites, in part because of higher rates of high blood pressure. The risk of heart disease is also somewhat higher in Mexican Americans and native Hawaiians. You can't change your heredity, but it gives you strong motivation to manage other factors that you can change.

The major proven risk factors for heart disease that you can modify, control, or treat are:

- **High blood cholesterol.** High blood cholesterol directly increases your risk of heart disease. Cholesterol is a fatlike substance that is carried in your blood, but excess cholesterol enters your body through foods derived from animals (meat, eggs, dairy products).
- **High blood pressure (hypertension).** High blood pressure increases your risk of several forms of cardiovascular disease: coronary artery disease, heart attack, kidney failure, congestive heart failure, and stroke. Other factors, such as obesity, alcohol abuse, unhealthy diet, or physical inactivity can contribute to high blood pressure, but you can also have it independent of those other influences. (See chapter 3.)

- **Obesity and overweight.** Excess body fat contributes to the risk of heart disease, independent of other risk factors, because it increases the heart's workload. It also raises blood pressure, adversely affects cholesterol levels, and contributes to the development of diabetes.
- **Physical inactivity.** An inactive lifestyle increases the risk of becoming overweight and developing high blood cholesterol levels, high blood pressure, and diabetes. Even moderate amounts of regular exercise will lower your risk of heart disease.
- **Type 2 diabetes.** Having diabetes puts you at serious risk; about 65 to 75 percent of people with diabetes die from some form of cardiovascular disease. Controlling your diabetes may help control your risk of heart problems.
- **Smoking.** If you smoke, you are more likely to develop cardiovascular disease than a nonsmoker is—in addition to the risk of lung cancer. Smoking increases your heart rate, constricts your arteries and contributes to their obstruction with plaque, and can cause irregular heartbeat. It also increases your risk of blood clots, which cause heart attack or stroke. Even exposure to other people's smoke increases a person's risk of heart disease.
- **Early menopause.** Women who have early menopause, whether naturally or as a result of surgery, have a higher risk of coronary artery disease.

Other influences, called contributing factors, are linked to heart disease, but their significance is not fully understood or measured yet. These factors are:

- **Stress.** Stress, particularly in some people, appears to increase the risk of heart problems, perhaps because it raises your heart rate and blood pressure, damaging your arteries over time. It may also

Heart Disease and Genetics

Because heart disease tends to run in families, having parents or siblings with the disease is a major risk factor. But there is no single gene for cardiovascular disease; in fact, geneticists think that more than a thousand separate genes may influence the overall cardiovascular system. There are separate genes for obesity, high blood pressure, and diabetes, all risk factors for heart disease. Scientists are still identifying these genes and studying how they interact with one another—and with other influences such as diet—in an individual or a family. Many geneticists believe that one of the most effective approaches for a person at high genetic risk of heart disease is to ensure that the person follows a healthy lifestyle.

Other avenues of research include developing drugs that target a specific genetic predisposition, along with developing genetic tests that can screen for high-risk patients. The ultimate implications of genetic research for testing and treatment of heart disease are still far in the future.

contribute to other harmful behaviors such as overeating, smoking, or drinking too much.

- **Alcohol.** Drinking more than a moderate amount of alcohol can raise blood pressure, negatively affect cholesterol and triglyceride (blood fats) levels, and cause irregular heartbeats. However, modest amounts of alcohol may actually reduce the risk of heart disease. Since so many Americans drink to excess, doctors are reluctant to recommend moderate drinking to improve heart health, for fear that "moderate" usage will change to "excessive" use. Alcohol, whether wine, beer, or liquor, but only in moderate amounts, may be helpful to your health.
- **Birth control pills.** If you smoke or have high blood pressure, and especially if you are over 35, birth control pills may increase your risk of heart disease. Today's birth control pills contain much lower levels of hormones than early ones and are generally considered safe, independent of other risk factors. You should not smoke and take birth control pills, especially over age 35, due to the increased risk of heart attack and blood clots.