

# The Anatomy of the Heart

**Y**OUR CIRCULATORY SYSTEM (cardiovascular system) delivers oxygen and other nutrients to every cell in your body in addition to removing carbon dioxide and other wastes. Your circulatory system is composed of your heart, blood vessels (arteries and veins), and blood. As your heart beats, it moves blood through your blood vessels. Every minute, it pumps at least 9 pints (4.26 liters) of blood through your entire circulatory system. Blood is always flowing in two big cycles. The right side of your heart receives blood from tissues and pumps it to the lungs; the left side receives blood from the lungs and pumps it out to the tissues. Arteries carry oxygen-rich blood away from your heart; veins carry oxygen-depleted blood to your heart.



## Objectives:



1. Explain how the heart is the central organ that powers your body.
2. List the blood vessels that make up the network that connects, nourishes, and cleans your entire system.
3. Trace how blood flows from your heart and back to provide vital oxygen and to remove wastes.

## Key Terms:



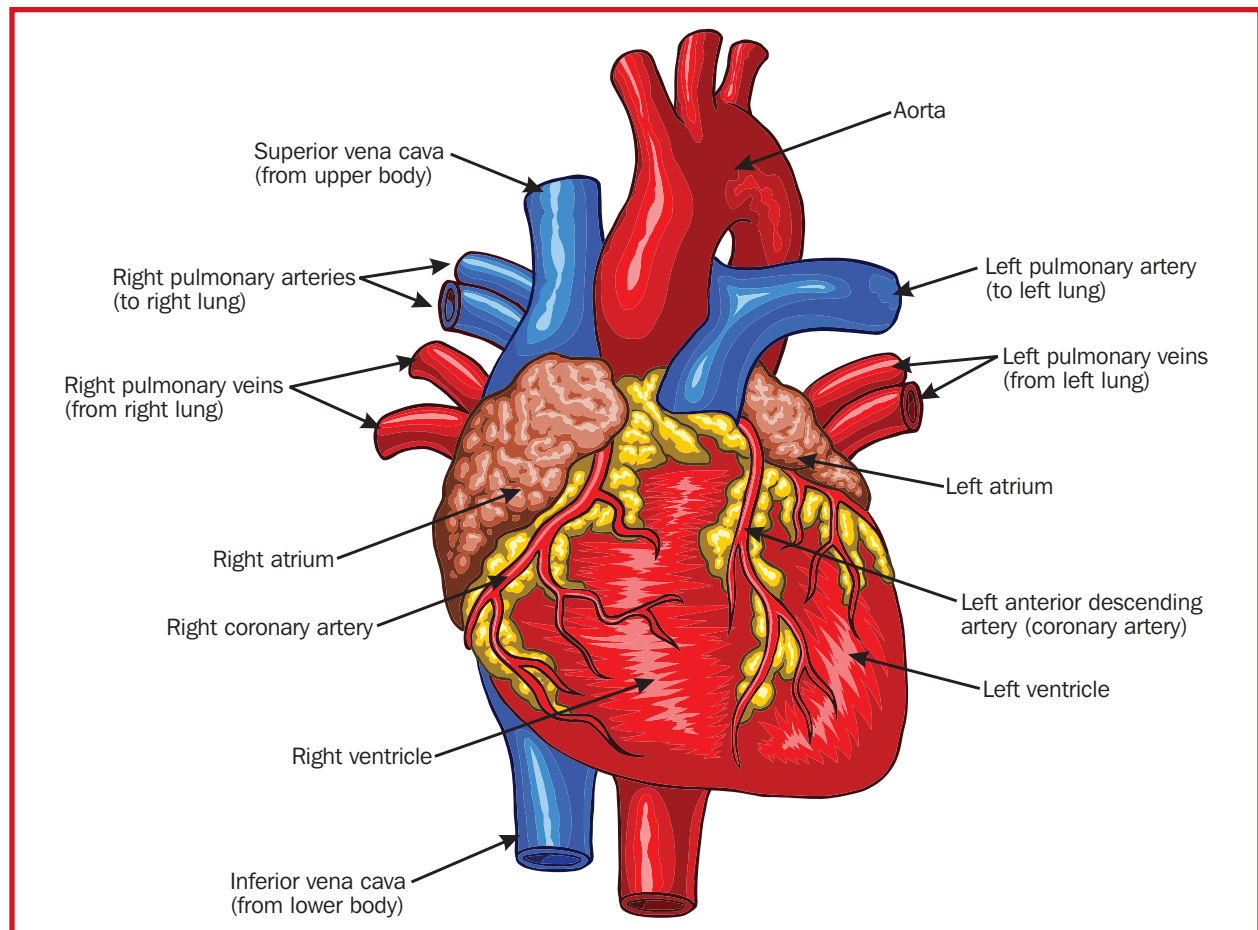
aorta	coronary arteries	pulmonary
apex	endocardium	superior vena cava
arteries	epicardium	veins
arterioles	inferior vena cava	ventricle
atria	mediastinum	venules
atrium	myocardium	
capillaries	pericardium	

# Understanding Your Heart

Your heart is a dynamic, untiring, double pump that forces blood around your body's entire network of blood vessels approximately 300 billion times during your lifetime or 100,000 times a day. Your heart is a hollow, muscular organ about the size of your clenched fist and weighs about 1 pound (450g). It is located in the center of your chest in the **mediastinum**, which is under your sternum. Two-thirds of your heart is to the left of your sternum. Most of the time, you are not aware of your heart. However, when you exercise or experience strong emotion, you feel your heart beat powerfully and can sense the blood pounding.

## HEART PARTS

The **apex** is the lowest part of your heart. In the middle of your heart is a thick wall of muscle (the septum), which separates your heart into right and left sides and keeps blood from leaking from one side to the other. Your heart is divided into four hollow chambers, and each functions as a pump. On the top are the small atria, with one **atrium** on the right and one on



**FIGURE 1.** This image of the outside of a healthy human heart illustrates the flow of blood through the heart's chambers, coronary arteries, and veins.

the left. The bottom larger chambers are the right **ventricle** and the left ventricle. The heart's power comes from the ventricles that have thick muscular walls that contract to squeeze blood into your arteries. The left ventricle is the largest, strongest chamber and is considered the most important pump of your heart.

## Upper Chambers

The upper chambers (**atria**) have thinner walls and act as a reservoir for blood coming in from the main veins. With each beat, 3 fluid ounces of blood are pumped into the main pulmonary artery. The blood pumps up to 1 and one-half gallons (6.7 liters) per minute. Strenuous exercise can increase this amount to 6 gallons (27 liters) per minute in the average adult.

## Main Veins

The main vein entering the right atrium and returning oxygen-depleted blood from the upper parts of your body and arms is the **superior vena cava**. The main vein entering the right atrium and returning oxygen-depleted blood from the lower parts of your body and legs is the **inferior vena cava**. Oxygenated blood from your lungs enters your left atrium via your pulmonary veins. Blood flows from your atria into your ventricles, filling them to about 80 percent of capacity.

## Natural Pacemaker

Your heart has a natural pacemaker (sinoatrial node) in the upper part of the right atrium. It sends electrical impulses that set off the contraction phase of your heart. Impulses spread through the atrial walls to stimulate your cardiac muscle to contract within 0.1 seconds. This squeezes blood from your atria through your atrioventricular valves into your ventricles. Atrioventricular valves keep blood from flowing backward. The valves open to let blood flow from the atria into the ventricles, and then they close quickly. The tricuspid valve guards the flow of blood between the right atrium and the right ventricle. Meanwhile, the bicuspid (mitral) valve guards the flow between the left atrium and the left ventricle.

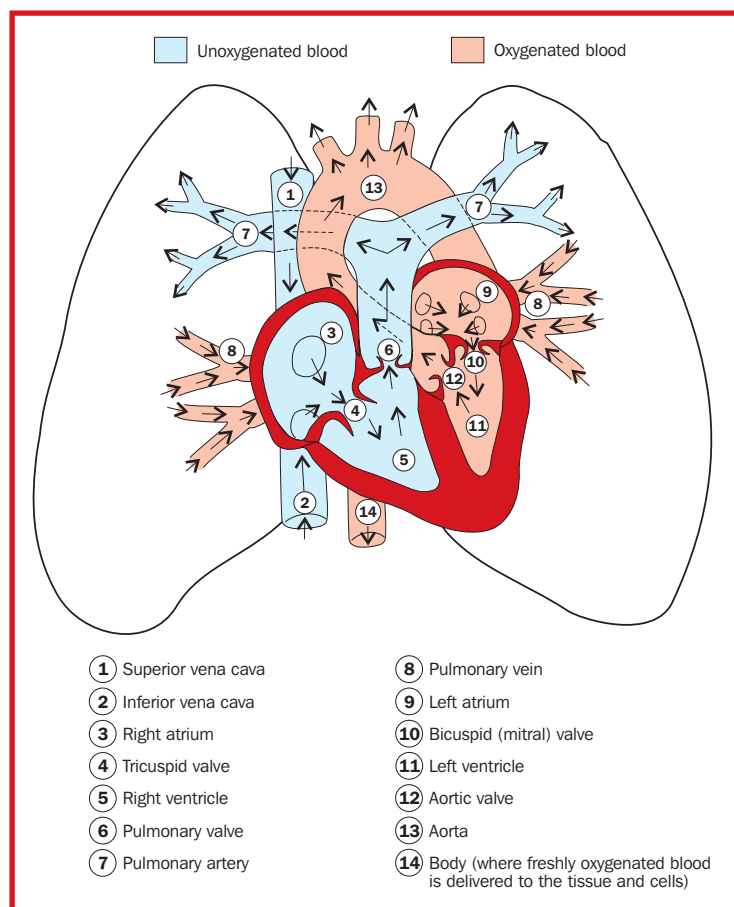


FIGURE 2. This diagram shows the flow of blood through the heart.

During this powerful phase of your heartbeat, the thick cardiac muscle in your ventricle walls contracts, stimulated by electrical impulses relayed by the atrioventricular node. This causes a rise in ventricular pressure that opens your aortic and pulmonary valves at the exits of the ventricles. Blood forced out into the main arteries makes the atrioventricular valves snap shut.

## Blood Vessels

The walls of the ventricles relax and reduce ventricular pressure as the blood empties into the somewhat elastic, but very strong arteries. The pressure of the blood ejected into the main arteries is high, causing the aortic and pulmonary semilunar valves to close, preventing backflow into the ventricles. The **pulmonary** artery opens to the right ventricle; the aorta opens to the left ventricle. As ventricular pressure on the atrioventricular valves relaxes, the valves open, reducing pressure in your atrium and allowing blood to enter again from the main veins. The entire cycle begins again when oxygen and depleted blood is returned to the right side of your heart. Routinely, your brain receives 13 percent of the heart's output of blood, your heart receives 3 percent, and the rest is distributed according to need. After a meal, more blood goes to your digestive system. When you are physically active, more blood goes to your skeletal muscles.

## PROTECTIVE LAYERS

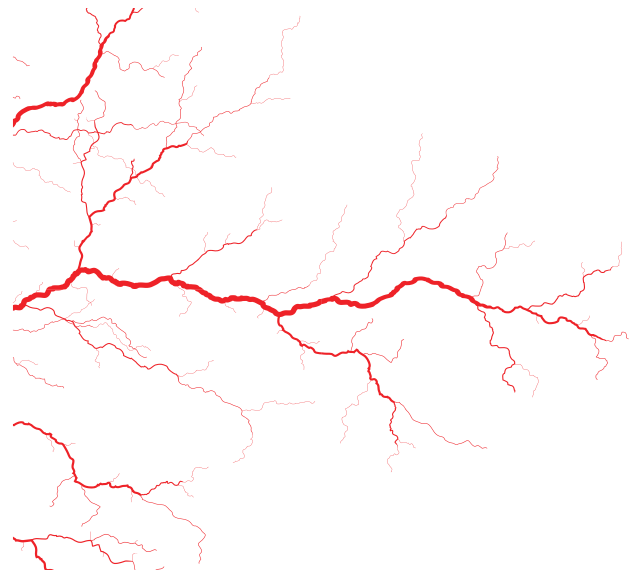
Your heart is covered by protective layers of tissue. The outermost layer is **epicardium**, which is surrounded by the **pericardium**—a fibrous sac of fluid. Under this is the muscular middle layer called the myocardium. The innermost layer that lines the chambers of your heart is the **endocardium**.

The **myocardium** muscle is composed of muscle fibers that stimulate heart contractions that pump blood from the ventricles and through your circulatory system and then relax the heart to allow the atrium to fill with blood. Your circulatory system provides your heart with a constant supply of oxygen and energy from blood. Supplying these is a network of blood vessels (right and left **coronary arteries**) that branch from the **aorta**—the main artery—just after it leaves your heart with oxygen-rich blood to be carried to all body tissues. Coronary arteries divide over your heart's surface and send smaller blood vessels, **arterioles**, into your heart muscle. Blockage of coronary arteries is the number one cause of death in the United States.

## CIRCULATION HIGHWAY

Arterioles divide into millions of tiny **capillaries** that have walls one cell thick, making them thin enough for oxygen, nutrients, and minerals to pass through to surrounding cells and

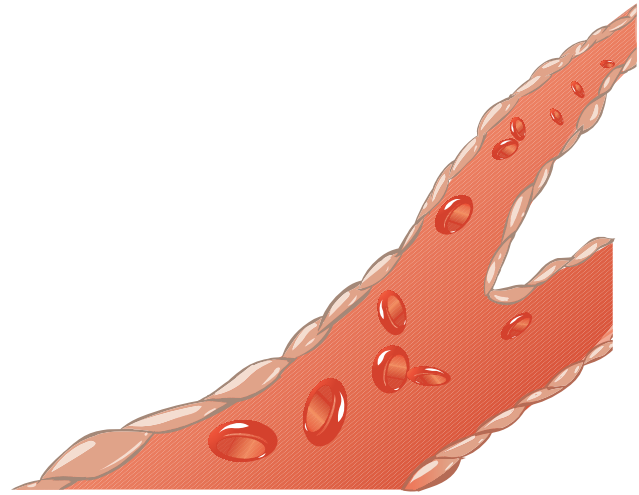
tissues. Capillaries are the smallest and most numerous blood vessels. They carry blood between arteries and veins. Waste material flows through capillaries back into your blood for disposal. Capillaries returning blood to your heart join and enlarge to become tiny blood vessels called **venules**, which enlarge to become veins. **Veins** carry oxygen-depleted blood from organs (e.g., kidney and liver) to remove waste and then back through the lungs for a fresh supply of oxygen. Vein walls have thinner layers of muscle and are less elastic than arteries because the blood flowing through them is not under pressure. From the lungs, the veins carry your blood back to your right atrium to begin the cycle of circulation again. This intricate network of arteries and veins is 90,000 miles long—equivalent to four times around Earth.



**FIGURE 3.** Capillaries are the smallest blood vessels in the human body.

## Arteries

**Arteries** carry blood away from the heart toward organs and tissues. Apart from pulmonary arteries, all arteries carry oxygenated blood. Arteries have thick walls with muscular layers to withstand the high pressure that occurs when your heart contracts. When the heart relaxes, an artery narrows to help push blood onward. Your aorta is your largest artery, with a diameter of 1 inch (25mm). Other arteries have diameters of one-sixteenth to one-fourth inch (4 to 7mm), and the walls are one-twenty-fifth inch (1mm) thick.



**FIGURE 4.** Unlike capillaries, arteries tend to be rather large.

## Veins

Veins carry blood toward your heart and have thinner, more flexible walls than arteries. Blood inside veins is under low pressure and flows slowly and smoothly. The larger, long veins in your legs contain valves formed from pouch-like pockets of single-cell lining tissue that keeps blood from flowing backward down your legs.

## The Blood Exchanging Circuit

Oxygen-depleted blood from the superior and inferior vena cava veins (carrying oxygen-depleted blood) enters the right atrium. That blood passes from the right atrium through the tricuspid valve to the right ventricle. From the right ventricle, oxygen-depleted blood is pumped through the pulmonary semilunar valve to the right and left pulmonary arteries.

Pulmonary arteries proceed to the lungs where oxygen and nutrients are exchanged, and carbon dioxide is shed. Newly oxygenated blood leaves the lungs through the right and left pulmonary veins to be transported to the left atrium of the heart. From your left atrium, oxygenated blood passes through the bicuspid (mitral) valve and into the left ventricle. Oxygenated blood is then pumped forcefully from your left ventricle through your aortic semilunar valve and into the aorta.

From the aorta, oxygen-rich blood is pumped out to the body to distribute fresh oxygen and nutrients to your body organs and tissues. Exchanged oxygen-depleted blood leaves the lungs through superior and inferior vena cava veins to begin the non-stop cycle again.

### Summary:



Your heart is a dynamic double pump that forces blood around your body's entire network of blood vessels. It is located in the center of your chest and controls your circulatory (cardiovascular) system. Your circulatory system is composed of your heart, blood vessels, and blood. As your heart beats, it moves blood through your blood vessels and into your lungs and every cell and tissue in your body.

Blood is always flowing in two big cycles. The right side of your heart receives blood from tissues and pumps it to the lungs. The left side receives blood from the lungs and pumps it to the tissues. Arteries carry oxygen-rich blood away from your heart; veins carry oxygen-depleted blood to your heart.

### Checking Your Knowledge:



1. Why is your heart considered a double pump?
2. List the four compartments of your heart.
3. What are the smallest vessels in your body that conduct gas exchange?
4. What keeps blood from flowing backwards?
5. What blood vessels carry blood away from your heart, and what blood vessels carry blood to your heart?

## Expanding Your Knowledge:

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You can feel your every heartbeat by pressing your fingertips tightly against the inside of your wrist or on your neck. Do you feel your blood pumping? What is the average heart rate of an adult? Does the heart beat at the same speed in babies? Use Web sites and library resources to learn more about the answers to these questions.

## Web Links:

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### **Anatomy of the Heart**

<http://www.texasheartinstitute.org/hic/anatomy/anatomy2.cfm>

### **Heart Anatomy—Interior View**

[http://www.gwc.maricopa.edu/class/bio202/cyberheart/hartint\\_.htm](http://www.gwc.maricopa.edu/class/bio202/cyberheart/hartint_.htm)