How Your Heart Works

BY CARL BIANCO **HEALTH | CIRCULATORY SYSTEM**

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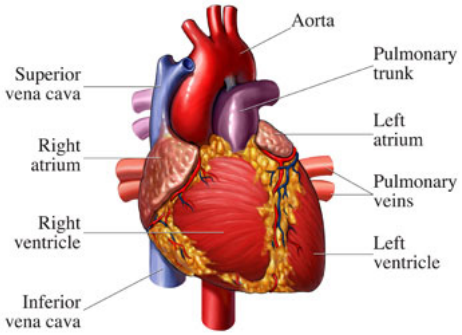

The human heart.
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Everyone knows that the heart is a vital organ. We cannot live without our heart. However, when you get right down to it, the heart is just a pump. A complex and important one, yes, but still just a pump. As with all other pumps it can become clogged, break down and need repair. This is why it is critical that we know how the heart works. With a little knowledge about your heart and what is good or bad for it, you can significantly reduce your risk for heart disease.

Heart disease is the leading cause of death in the United States. Almost 2,000 Americans die of heart disease each day. That is one death every 44 seconds. The good news is that the death rate from heart disease has been steadily decreasing. Unfortunately, heart disease still causes sudden death and many people die before even reaching the hospital.

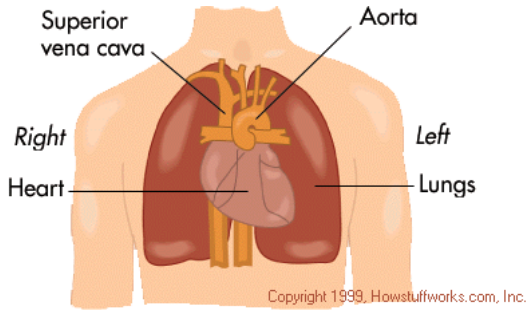
The heart holds a special place in our collective psyche as well. Of course the heart is synonymous with love. It has many other associations, too. Here are just a few examples:

- have a heart - be merciful
- change of heart - change your mind
- to know something by heart - memorize something
- broken heart - to lose love
- heartfelt - deeply felt
- have your heart in the right place - to be kind
- cry your heart out - to grieve
- heavy heart - sadness
- have your heart set on - to want something badly

Certainly no other bodily organ elicits this kind of response. When was the last time you had a heavy pancreas?

In this article, we will look at this important organ so that you can understand exactly what makes your heart tick.

The Human Heart



[Please note - Medical illustrations assume that the patient is facing you so that the right and left correspond to the patient's right and left. That's why the left and right labels here seem backwards.]

The heart is a hollow, cone-shaped muscle located between the lungs and behind the sternum (breastbone). Two-thirds of the heart is located to the left of the midline of the body and 1/3 is to the right (see Figure 1).

The apex (pointed end) points down and to the left. It is 5 inches (12 cm) long, 3.5 inches (8-9 cm) wide and 2.5 inches (6 cm) from front to back, and is roughly the size of your fist. The average weight of a female human heart is 9 ounces and a male's heart is 10.5 ounces. The heart comprises less than 0.5 percent of the total body weight.

The heart has three layers. The smooth, inside lining of the heart is called the **endocardium**. The middle layer of heart muscle is called the **myocardium**. It is surrounded by a fluid filled sac call the **pericardium**.

Heart Sounds

When someone listens to your heart with a stethoscope the sound is often described as lub-dub lub-dub. The first heart sound (lub) is caused by the acceleration and deceleration of blood and a vibration of the heart at the time of the closure of the tricuspid and mitral valves. The second heart sound (dub) is caused by the same acceleration and deceleration of blood and vibrations at the time of closure of the pulmonic and aortic valves.

Chambers and Valves

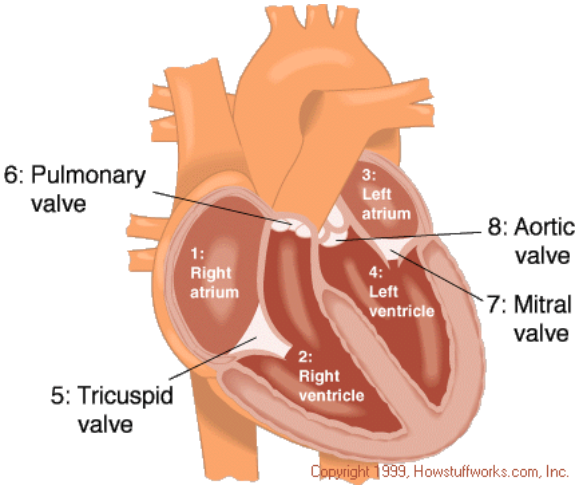


Figure 2
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The heart is divided into four chambers: (see Figure 2)

1. right atrium (RA)
2. right ventricle (RV)
3. left atrium (LA)
4. left ventricle (LV)

Each chamber has a sort of one-way valve at its exit that prevents blood from flowing backwards. When each chamber contracts, the valve at its exit opens. When it is finished contracting, the valve closes so that blood does not flow backwards.

1. **The tricuspid valve** is at the exit of the right atrium.
2. **The pulmonary valve** is at the exit of the right ventricle.
3. **The mitral valve** is at the exit of the left atrium.
4. **The aortic valve** is at the exit of the left ventricle.

When the heart muscle contracts or beats (called **systole**), it pumps blood out of the heart. The heart contracts in two stages. In the first stage, the right and left atria contract at the same time, pumping blood to the right and left ventricles. Then the ventricles contract together to propel blood out of the heart. Then the heart muscle relaxes (called **diastole**) before the next heartbeat. This allows blood to fill up the heart again.

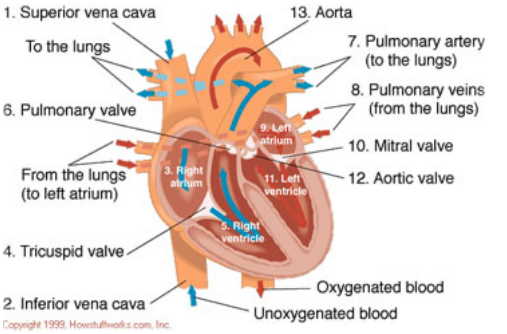
The right and left sides of the heart have separate functions. The right side of the heart collects oxygen-poor blood from the body and pumps it to the lungs where it picks up oxygen and releases carbon dioxide. The left side of the heart then collects oxygen-rich blood from the lungs and pumps it to the body so that the cells throughout your body have the oxygen they need to function properly.

Pulse Rates

Everyone's pulse (average heart rate per minute) changes as we age. Here is a list of average pulse rates at different ages:

- Newborn: 130 bpm
- 3 months: 140 bpm
- 6 months: 130 bpm
- 1 year: 120 bpm
- 2 years: 115 bpm
- 3 years: 100 bpm
- 4 years: 100 bpm
- 6 years: 100 bpm
- 8 years: 90 bpm
- 12 years: 85 bpm
- adult: 60 - 100 bpm

Blood Flow



All blood enters the right side of the heart through two veins: The **superior vena cava** (SVC) and the **inferior vena cava** (IVC) (see figure 3).

The SVC collects blood from the upper half of the body. The IVC collects blood from the lower half of the body. Blood leaves the SVC and the IVC and enters the **right atrium** (RA) (3).

When the RA contracts, the blood goes through the **tricuspid valve** (4) and into the **right ventricle** (RV) (5). When the RV contracts, blood is pumped through the **pulmonary valve** (6), into the **pulmonary artery** (PA) (7) and into the lungs where it picks up oxygen.

Why does it happen this way? Because blood returning from the body is relatively poor in oxygen. It needs to be full of oxygen before being returned to the body. So the right side of the heart pumps blood to the lungs first to pick up oxygen before going to the left side of the heart where it is returned to the body full of oxygen.

Blood now returns to the heart from the lungs by way of the **pulmonary veins** (8) and goes into the **left atrium** (LA) (9). When the LA contracts, blood travels through the **mitral valve** (10) and into the **left ventricle** (LV) (11). The LV is a very important chamber that pumps blood through the **aortic valve** (12) and into the **aorta** (13). The aorta is the main artery of the body. It receives all the blood that the heart has pumped out and

distributes it to the rest of the body. The LV has a thicker muscle than any other heart chamber because it must pump blood to the rest of the body against much higher pressure in the general circulation (blood pressure).

Here is a recap of what we just discussed. Blood from the body flows:

- to the superior and inferior vena cava,
- then to the right atrium
- through the tricuspid valve
- to the right ventricle
- through the pulmonic valve
- to the pulmonary artery
- to the lungs

The blood picks up oxygen in the lungs, and then flows from the lungs:

- to the pulmonary veins
- to the left atrium
- through the mitral valve
- to the left ventricle
- through the aortic valve
- to the aorta
- to the body

Heartbeat, It's a Love Beat

The average heartbeat is 72 times per minute. In the course of one day it beats over 100,000 times. In one year the heart beats almost 38 million times, and by the time you are 70 years old, on average, it's made it to 2.5 billion beats.

The Body's Electrical System

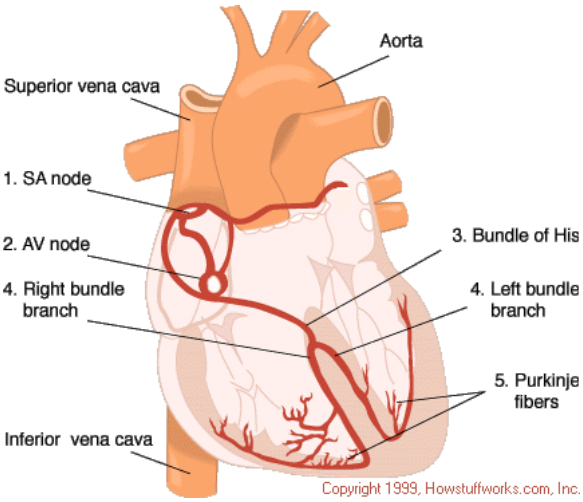


Figure 4

Have you ever wondered what makes your heart beat? How does it do it automatically, every second of every minute of every hour of every day?

The answer lies in a special group of cells that have the ability to generate electrical activity on their own. These cells separate charged particles. Then they spontaneously leak certain charged particles into the cells. This produces electrical impuses in the pacemaker cells which spread over the heart, causing it to contract. These cells do this more than once per second to produce a normal heart beat of 72 beats per minute.

The natural pacemaker of the heart is called the **sinoatrial node** (SA node). It is located in the right atrium. The heart also contains specialized fibers that conduct the electrical impulse from the pacemaker (SA node) to the rest of the heart (see Figure 4).

The electrical impulse leaves the **SA node** (1) and travels to the right and left atria, causing them to contract together. This takes .04 seconds. There is now a natural delay to allow the atria to contract and the ventricles to fill up with blood. The electrical impulse has now traveled to the **atrioventricular node (AV node)** (2). The electrical impulse now goes to the **Bundle of His** (3), then it divides into the **right and left bundle**

branches (4) where it rapidly spreads using **Purkinje fibers** (5) to the muscles of the right and left ventricle, causing them to contract at the same time.

Any of the electrical tissue in the heart has the ability to be a pacemaker. However, the SA node generates an electric impulse faster than the other tissue so it is normally in control. If the SA node should fail, the other parts of the electrical system can take over, although usually at a slower rate.

Although the pacemaker cells create the electrical impulse that causes the heart to beat, other nerves can change the rate at which the pacemaker cells fire and the how strongly the heart contracts. These nerves are part of the autonomic nervous system. The **autonomic nervous system** has two parts - The sympathetic nervous system and the parasympathetic nervous system. The **sympathetic nerves** increase the heart rate and increase the force of contraction. The **parasympathetic nerves** do the opposite.

All this activity produces electrical waves we can measure. The measurement is typically represented as a graph called an electrocardiogram (EKG). Here is an example of three heartbeats from an EKG (Figure 5):

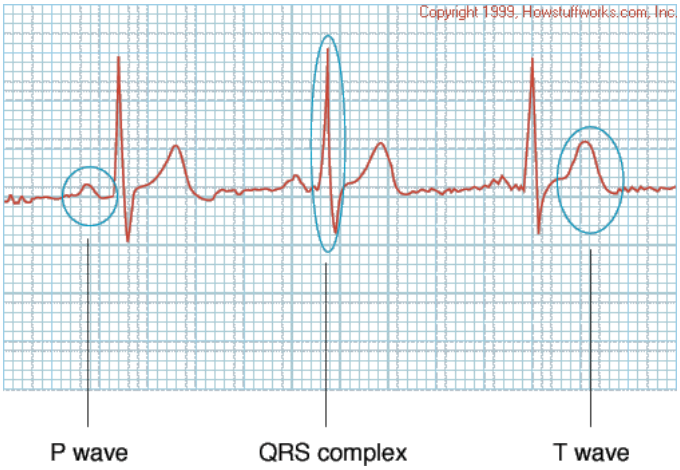


Figure 5

Each part of the tracing has a lettered name:

1. **P wave** - coincides with the spread of electrical activity over the atria and the beginning of its contraction.
2. **QRS complex** - coincides with the spread of electrical activity over the ventricles and the beginning of its contraction.
3. **T wave** - coincides with the recovery phase of the ventricles.

Electrical system abnormalities can range from minor premature beats (skipped beats) that do not require treatment, to slow or irregular beats that require an artificial pacemaker.

Blood Supply

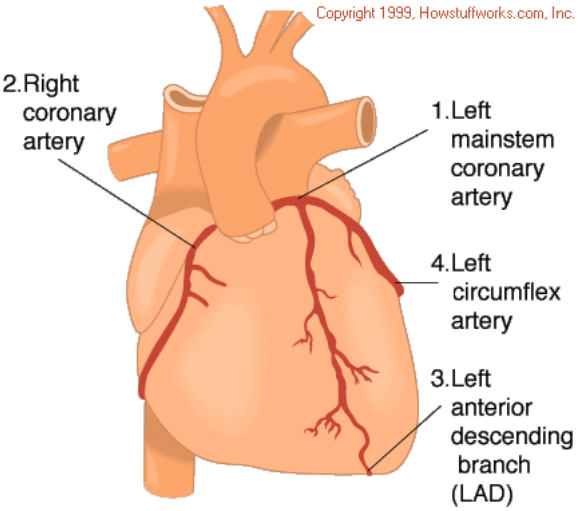


Figure 6

Coronary arteries are the ones that we try to keep clear by eating a healthy diet. If coronary arteries are blocked a heart attack results.