67: THE HEART

The heart is a living pump. It beats about 70-80 times per minute round the clock, not needing to rest like your other muscles do. A heart can pump up to 2,000 gallons (7,000 liters) of blood each day.

When we look at a diagram of the heart we need to remember that the left and right parts are labeled from the perspective of the owner of the heart. Therefore, the left side of the diagram is actually the right side of the heart, and the right side of the diagram is the left side of the heart. (Just imagine the heart inside your own chest think of it from that perspective.)

The heart has four main chambers. The two smaller ones on the top are the **atria** (plural of **atrium**) and the larger ones on the bottom are the **ventricles**. Ventricles have sort of a "V" shape, which makes it easy to remember their name, since ventricle begins with the letter "V." There are valves between the atria and the ventricles. The valve on the right side is called the **tricuspid valve** ("tri" means "three" and this valve has three flap pieces) and the valve on the left side is called the **bicuspid valve** ("bi" meaning "two"). Just to confuse you and make things harder, you also need to know that the bicuspid valve is also commonly called the **mitral valve**. The flaps of the valves are anchored to the ventricles by strings made of connective tissue. (This is perhaps where the term "heart strings" comes from. You may have heard the phrase, "tugging at someones' heart strings," meaning appealing to their emotions.)

The muscle tissue of the heart is called the **myocardium**. ("Myo" means "muscle" and "cardium" means "heart.") This muscle tissue needs it own blood supply so there are arteries and veins on the outside of the heart that go down into the muscles. The muscle fibers of the heart work very hard all the time and need a constant supply of nutrients. If one of these exterior **coronary arteries** or veins gets blocked, those muscle cells will not receive enough oxygen and the result will be a "heart attack."

The heart is actually two separate pumps sitting side by side. The right side receives "used" blood from the body (which contains very little oxygen and a lot of carbon dioxide), then pumps it into the lungs where it gets rid of the carbon dioxide and picks up fresh oxygen. The left side receives the re-oxygenated blood from the lungs and then pumps it out into the body. Blood vessels that are taking blood towards the heart are called **veins**. Blood vessels that are taking blood away from the heart are called **arteries**. Most often we see arteries and veins colored coded with red and blue indicating whether they have a lot of oxygen (red) or very little oxygen (blue). Here in the heart, we find the exception to this color coding rule. We will see veins bringing in blood from the lungs which is rich in oxygen.

The large veins coming into the heart are the **superior vena cava**, the **inferior vena cava**, and the **pulmonary veins**. (The words "superior" and "inferior" mean "top" and "bottom" in this case.) The arteries leading out of the heart are the **aorta** and the **pulmonary arteries**. The aorta has three branches that go off the top, the brachiocephalic ("brachio" means "arms" and "cephalic" means "head"), the carotid (which we saw in the head drawing), and the subclavian ("sub" means "under" and "clavia" refers to the clavicle bone that runs between the neck and the shoulders). After bending over the top of the heart, the aorta then goes down behind it and continues downward, going past the liver and kidneys and then into the legs. (This bottom part is called the **descending aorta**.)

The tip (very bottom) of the heart is called the **apex**. (The word apex is a very common word in science and always refers to the tip of something.) The entire heart is wrapped in a membrane "bag" called the pericardium. ("Peri" means "around" and "cardium" means "heart.") There is fluid inside the pericardium, to allow the heart to move around inside the bag without creating any friction.

When we look at the interior view, we can see these two sides of the heart. The wall between the sides is called the **septum**. The diagram shows the blood from the body coming in through the superior and inferior vena cavas and entering the right atrium. When the right atrium contracts, the blood is squeezed down into the right ventricle. As it flows into the ventricle the tricuspid valve opens. After the contraction is over, the valve goes shut, and this is the "lub" sound in the "lub dub" of the heartbeat. The ventricle then contracts and the blood is forced out into the pulmonary arteries where it then goes to the lungs. The valve at the top of the ventricle is called the **semilunar valve**. ("Semi" means "half, or part" and "lunar" refers to the moon. This valve must have flaps that reminded the discoverer of a half moon or perhaps a crescent moon.) When the semilunar valve snaps shut, this creates the "dub" of the "lub dub" sound.

The left side of the heart receives the oxygenated blood from the lungs through the pulmonary veins. (Again, this is why it is helpful to think of the definition of veins as being vessels that go towards the heart, because here we have veins filled with oxygenated blood which would be colored coded as red instead of blue.) The blood comes into the left atrium and then is squeezed through the bicuspid valve (also known as the mitral valve) into the left ventricle. When the left ventricle contracts, the blood goes up through another semilunar valve and into the aorta. The aorta branches off at various points so that blood is equally distributed to all parts of the body. A complete set of contractions—atria and ventricle—is called the **cardiac cycle**.

The steady rhythm of the heartbeat is controlled by special nerves in the right atrium. (These specialized cells start working when an embryo is only a few weeks old!) Neurons in an area called the **SA** (sinoatrial) **node** initiate an electrical signal that travels through specialized nerve fibers across to the left atrium. Thus, when the SA node gives the signal, both atria contract together. The signal also travels to another little spot of specialized cells called the **AV** (atrioventricular) **node**. When the AV node receives the signal, it relays the signal through nerve fibers that run down through the septum and out to the walls of the ventricles. This signal causes the muscles of the ventricles to contract. The timing of all of this works out just perfectly, and the ventricles contract a split second after the atria, resulting in a steady pumping motion. These nodes form the **intrinsic conduction system**. (Intrinsic just means internal.) The heartbeat is also influenced by the **extrinsic** (external) system, with the nodes being influenced by signals from the brain or by hormones released by various body parts. When you exercise, for example, your heart rate goes up as the brain signals it to speed up. When you sleep, your heart rate slows down, as your brain stem gives it signals to relax. A sudden jolt of adrenaline from the your adrenal glands will cause your heart to start thumping fast and hard. (We'll take another look at these "speed up" and "slow down" control systems when we do an overview of the entire nervous system.)