>> Steve Langjahr: Today is October 24th, 2016, and this is lecture 18, I'm guessing, which is the first lecture devoted to this system, the cardiovascular system, which obviously moves blood in a circular fashion around your body. The heart is a very beloved organ. That's almost a pun. And at least everybody knows where it is and what it does. It is a pump, and without it, of course, you're, well, deceased. So clearly we appreciate its value, its obvious function. We're going to consider today, of course, more than that. Rather, instead, its anatomy, its location, its composition and the manner in which it's controlled. So let's get into it. The heart is located in the thoracic cavity, of course. It's actually situated between the left and right pleural sacs. It's in a space of its own really, a space which is occupied by others but is generically called the mediastinum. There are other structures in the mediastinum, but the heart is clearly the largest and biggest member of this space. So, actually, we know also that it's not midline. Is it more off-centered to the left, or more off-centered to the right? Left. So more of the heart is seen on the left side of the chest than the right. And here it is inside a cadaver. Now the heart can be sectioned any way you'd like. But this section is a frontal or coronal section, which reveals a fact that you probably knew, and that is, your heart has four chambers. We'll get to those in a moment, but in terms of layers, the heart has three dissectible layers. So let's approach those from the inside out. The lining which is seen here in blue is very thing and lines not only the chambers but forms the valves that separate atria from ventricles. This tissue is very thin. It's made of simple squamous epithelium. In this location, it's also known as endothelium. And you could already see from this diagram that the endocardium continues into the vessels which bring blood to and take blood away from the heart. So endothelium is not limited to the heart but found lining blood vessels, vessels that carry blood to and from the heart as well. The endocardium then lines the chambers and also forms and creates the valves. What would a condition called endocarditis seem to mean? Endocarditis, inflammation of the endocardium. And the biggest impact that this would have would be on the performance of the valves. The valves would become sticky or stiff, and therefore, not work as well. But the real function of the endocardium, apart from the role they play forming the valves, is that it creates a very slippery surface, and therefore, minimizes trauma, injury to blood cells. In other words, it prevents blood cells from sticking, and therefore, keeps them moving. The endocardium reduces friction of blood against the heart chamber walls and, therefore, reduces trauma and potential injury to these blood cells. The next layer, which is the thickest and is easy to appreciate is called the myocardium. What's the prefix myo always refer to? Muscle. And what kind of muscle? Let's all put our heads together. What kind of muscle might you find in the heart?

>> Cardiac.

>> Steve Langjahr: Cardiac muscle. It's a no-brainer. One thing you notice in this illustration, which is no accident, is that the myocardium on the left side is thicker and, therefore, stronger than the myocardium on the right side. There must be a reason for that. The right side of the heart pumps blood to the lungs,

and those are pretty nearby. Yes? The left side of the heart pumps blood to the entire body, and it's much more difficult to do that. So why is the left side of the heart stronger? Simply to propel blood, again, to these distant locations in the body. The right ventricle has an easier job pumping blood only to the lungs. Here's a look of the heart from the outside, an actual photo of a human heart. And what's the usual comparison that's made with respect to the human heart, with respect to its size?

>> The fist.

>> Steve Langjahr: About as big as your fist, and that's approximately true. So this is the anterior view of a human heart, and of course, we're looking at a cross-section, a frontal section for now. The myocardium, to finish it off, is mainly designed to pump blood. And what would myocarditis suggest? Some sort of infection or trauma or inflammation of the myocardium. And that could be deadly, because if the myocardium isn't working, then obviously, you're not moving a lot of blood. The myocardium. And the outer layer, which you've learned about already, is a serous membrane which deserves the name pericardium, meaning around the heart. And what do you know about serous membranes? How many layers are there to any serous membrane?

>> Two.

>> Steve Langjahr: And the one which is in contact with the organ is called the visceral layer. In this case, it's the visceral pericardium, which is also incidentally known as the epicardium. The outer layer, which is in contact with the pleura, is called the parietal layer, and that, of course, encloses the fluid which separates these two. And the name of that fluid is pericardial fluid. What's the function of a serous membrane anywhere? What have we always said about a serous membrane? Reduces F word.

>> Friction.

>> Steve Langjahr: Friction. It lubricates. Is the heart in motion all the time? If yours is not, you're probably dead. Ooh, that's an interesting change of events. The picture just went out. Don't know why. Try that again. It's back. Only temporarily. It's back. Cross your fingers. So these are the three, count them, three layers of the heart from the inside out, endocardium, middle layer, myocardium. Outer layer, pericardium. The function of the pericardium is indeed to isolate the heart and also to lubricate the heart and, therefore, minimize friction and irritation to the heart. So these are the layers seen in cross section diagrammatically. The thinnest layer is on the inside. That's called the endocardium. The thickest layer is the muscle itself. That's the myocardium. And the outer is a serous membrane, a two-layered structure called the pericardium. Good. Let's move on. We've said from the beginning that the human heart has four chambers. And perhaps in other courses you've learned their names already. The chambers above are smaller, and these receive blood from incoming veins. The word for a receiving chamber is an atrium. Is that plural or singular?

>> Singular.

>> Steve Langjahr: Singular. What's the plural version of that.

>> Atria.

>> Steve Langjahr: Atria. So the left atria is obviously on the left side. Right atria over here. Now these receive blood from veins, and let's pause for a moment. An artery, by definition, carries blood away from the heart. And veins, by definition, return blood to the heart. So blood is entering both atria from corresponding veins, which we'll give names to in a moment. But the atria are receiving chambers then, which receive incoming venous blood. Now textbooks love to color-code vessels. And some people are so convinced that they're surprised when they find that vessels aren't that color. But what is the convention? What color represents an artery? Red. Because the blood that's carried through arteries is usually oxygenated and, therefore, bright red. Veins are not blue, but they're shown blue just for clarity. And that's because they carry deoxygenated blood. So obviously, the atria receives deoxygenate blood, at least on the right side. On the left side, it's actually oxygenated. But here's an interesting fact. Notice that atria, left and right, are divided and separated by a wall. It's called the interatrial septum. This is a septum. And in neonatal life, that is I should say, in prenatal life, there's actually a hole there. Now think about that. Why would you want a hole in this wall between the right atrium and the left atrium? In a moment, we're going to learn that the right ventricle sends blood to the lungs. And what's the status of the lungs in a fetus? Are the lungs inflated with air? Are they serving any purpose with respect to acquisition of oxygen? No. So in fetal life, there's very little reason to send blood to the lungs. In fact, the blood on the right side is already oxygenated having been oxygenated by the placenta. And so there's a hole in this wall which is called the foramen ovale. Now you've used and heard that word before as it applied to an oval hole in the skull. But here, it's an oval hole in the septum. And the function of this is to allow blood to bypass the lungs when? During fetal life. Why? Because in fetal life the lungs are not inflated and, therefore, can provide no oxygen. Would you hope that this opening would somehow close once you're born? In fact, if it doesn't now blood will avoid the lungs and, therefore, not oxygenate blood and create the syndrome you may have heard called the blue baby syndrome. So foraminal valley, it turns out, is one of two ways for blood to bypass the lungs when? During fetal life. Now as you notice the atria are situated above the ventricles. And when they contract, blood will move downward into the ventricles. And these ventricles are named left and right for obvious reasons. These pump blood out, out arteries which are not shown here, namely the aorta and the pulmonary artery, which we'll get to in a moment. So let's move away from that illustration, which is rather limited, to the one you see now on page 72. And you should label this illustration on the left anterior, because it is. And this is the back view or posterior view to the right. Once again, red and blue have some symbolism. Red meaning arteries. Blue referring usually to veins. The associated vessels that come to and carry blood

from the heart are as follows. First, coming from above, or I should say coming from below seen here, is a rather spacious vein which is called the inferior vena cava. Vena, a reference to vein, cava is a word meaning spacious. Inferior, a reference to its origin. Essentially, the inferior vena cava is collecting blood and returning blood from the lower extremities back to the right atrium. If there's an inferior vena cava, chances are there's one coming from above. And naturally, that would be called the superior vena cava. This also enters the right atrium from above. And essentially drains and collects blood from the shoulders, the arms, the head, the neck. In other words, the upper part of the body. So this is a better view perhaps. Here's the right atrium. And here on this illustration from above we see the superior vena cava. This would be the inferior vena cava. So blood returns from the upper body and lower body through these vena cava and spends a moment here in the right atrium. The right atrium contracts and puts blood obviously down into the right ventricle. From there, blood will go out a vessel which is headed to the lungs. What's the word for lungs? It's on the board here, the pulmonary. So this is the pulmonary what?

>> Artery.

>> Steve Langjahr: Artery. Now, the pulmonary artery is curious because it contains what sort of blood? What sort of blood has been brought to the right atrium? Deoxygenated. And the right ventricle then also contains deoxygenated blood. The pulmonary artery is, therefore, containing and conveying deoxygenated blood. But it's usually shown, that is, even though it's an artery, it's shown what color here? It's shown in blue. Why is it shown in blue? Because it's carrying what sort of blood? Deoxygenated. And keep in mind, why is blood going to the lungs but rather to become oxygenated. So it makes good sense. The pulmonary artery. An interesting structure exists that connects the pulmonary artery to the aorta. And it's designated here and perhaps seen better in the illustration you're looking at. It's called the, is it shown there? Yeah it is shown there, but it's not labeled. It's called the ductus arteriosus. The word ductus means duct or opening or tube. And the function of the ductus is to allow blood in the pulmonary artery to go directly into the aorta. But only when? When is this useful or important? Not in you or I but only in –

>> Fetal.

>> Steve Langjahr: Fetal life. This goes back to our earlier comment. What's the status of the lungs when you're a fetus? They're deflated. Do they contain any oxygen?

>> No.

>> Steve Langjahr: Is there any point in sending large volumes of blood then to the lungs? No. So there are two anatomical bypasses which allow blood to avoid the lungs. The first joins the atria. We gave that the name foramen ovale. And now the second one called the ductus arteriosus. Both of these seal off within the first day of your life and, therefore, once again, serve no function forcing blood, as it should, to go to the lungs. In fact, the ductus arteriosus changes

names. It becomes later known as the ligamentum arteriosus, which means that it's no longer a duct. It closes off. Once again, there's a condition where this might remain open, and it's called patent ductus arteriosus, meaning after you're born, blood still avoids the lungs. And what would that mean if blood is diverted away from the lungs? Well, that would prevent it from getting oxygen. And you would have this syndrome. It's called a blue baby syndrome because blood is not brightly red, having not received a lot of oxygen. Now once we go to the lungs, obviously blood is transformed. Blood which was deoxygenated is now oxygenated. And would be what color if we cared a lot about that? Bright red. And so now the blood is on its way back to the heart and does so through what are called pulmonary veins. There are four pulmonary veins. What kind of blood are they carrying?

>> Oxygenated.

>> Steve Langjahr: Oxygenated blood. So unlike ordinary veins, these would carry oxygenated blood, even though they're still technically veins. Why are they technically veins?

>> They're bringing blood back.

>> Steve Langjahr: They're bringing blood back to the heart, perfect. And there are two of these on the right and two on the left. And you can see them coming in here on the back side of the heart. Pulmonary veins. Four in number. Essentially returning blood to the heart, blood that's now been oxygenated. From there, where does blood go? Well, it fills the left atrium then drops down into the left ventricle. And then it goes out the aorta, which is the largest artery in the body. And the aorta is shaped like the letter U, and so it has an ascending and a descending component. And basically leaves the left ventricle and branches off immediately into smaller arteries, the first of which serve the heart itself. I think you've heard the term coronary as it pertains to heart. And these first vessels which feed the heart are called coronary vessels. And two immediately off the aorta are referred to as coronary arteries right and left. These are the first branches of the aorta, and their function is to supply oxygen and nutrients to the heart muscle itself. What's the name of the heart muscle? Myocardium. Now this couldn't be more significant, because if these arteries are blocked, you would not be able to deliver what to what? Oxygen to the myocardium. And you will have what's called a myocardial infarction. A lot of you have heard that term, an MI. And it'll also be simply commonly called a heart attack, which is synonymous with death in some cases, right. So the condition of the coronary arteries cannot be overexaggerated. In fact, coronary artery disease is the number one killer in the United States. Now, obviously, these arteries branch into smaller vessels, which permeate the myocardium, and then come back, back to the heart through what are called cardiac veins. Cardiac veins carry or contain what sort of blood

>> Deoxygenated.

>> Steve Langjahr: And that would be blue, wouldn't it? And these come

back to a pouch or collecting area behind the heart which is called the coronary sinus. The coronary sinus returns deoxygenated blood from the myocardium to the right atrium. So with that said, we could ask a question. How many vessels enter the right atrium? Let's count them. This one above we already gave a name to.

>> Superior.

>> Steve Langjahr: Superior vena cava. This one from the below?

>> Inferior.

>> Steve Langjahr: Inferior vena cava. The third one is actually the coronary sinus, which collects all the deoxygenated blood from the heart itself and returns it to the right atrium. Let's pause for a minute and catch up on some other slides. This is as section through the ventricles. So what ventricle is this? You might say, how am I supposed to know that? Well, what is this muscle here, what is all this? It's the myocardium. Is the myocardium thicker over here than it is here? So this must be what chamber?

>> Left.

>> Steve Langjahr: Left what? Left ventricle. This is the right ventricle. And this wall is called the interventricular septum which separates these as you can see. Here's yet another view of that same thing. This time it's flipped around. So clearly, this is thicker, so this is the left ventricle. Over here the right ventricle. So let's go on. The aortic arch which is this portion before the aorta starts to move south. Actually throws off three divisions which you can see cut short here. And these will give names to, and certainly, you'll have a chance to identify and see these in your cat as well as in human specimens. The first one is called the brachiocephalic which itself bifurcates. What's the mean to bifurcate? To split into two. So not seen here, but the brachiocephalic would split into two. The second one is called the left, what is it?

>> Common carotid.

>> Steve Langjahr: Left common carotid. And the third one is the left subclavian. So if you haven't already identified them, the first one is the brachiocephalic. Second one is the left common carotid. And the third one is the left subclavian. These are obviously headed north, that is, provide blood to the head, the neck and the shoulder and arms. Now what about the interior of the heart? Let's return there and spend some time with these valves. What's the function of a valve anywhere? You have valves in faucets, all sorts of machinery, open or closed, right. So the function of a valve is to open and close but also to prevent, in this case, blood from moving backwards. It prevents backflow, something that would be known as regurgitation. Here's the view of the four valves we're going to name now from above. And you have a picture just like that on page 73. The first valves are those which separate the atria from the ventricles. And for that reason, they're called the AV valves, nothing to do with Antelope Valley. Why AV? Atrioventricular. The AV valves are just that.

Situated between the atria and the ventricles. And they're named according to their location and/or anatomy. The one on the right side has three parts, three leaflets. These leaflets are called cusps, C-U-S-P-S. And for that reason, what should we call it if it has three of them?

>> Tricuspid.

>> Steve Langjahr: Tricuspid. It's on the right side. The one on the left side is similar in anatomy except only two, only two what? Cusps. So it can be called the bicuspid. But it's also called the mitral valve. Reason for that, a little obscure I suppose. But here's a headdress worn by the clergy, the Pope, and this thing this guy is wearing is called a mitre. That's what it's called. And from above, it looks like this valve. Hence the name what? Mitral valve. I don't make this stuff up. Just thought you'd want to know. So you can call this by a number of names. You can call the one on the left side.

>> Mitral.

>> Steve Langjahr: Mitral. You can call it the.

>> Bicuspid.

>> Steve Langjahr: Bicuspid. Or you can call it the left AV valve. It's all good. The most common name, the most common usage though, mitral. Now, these valves, these cusps, are restrained by cords which extend down into the ventricles and attach to nipple-like projections of the myocardium which are called papillary muscles. The word papilla means like a nipple. Papillary muscles are made of cardiac muscle, as is everything in the heart. And these tend to tug on these cords and, therefore, assist in the opening of these valves allowing blood to move from the atrium down into the ventricles. These cords, though, are much more important. Not in the opening of the valve but in the closure of the valve because as blood tries to move back into the atria, it pushes these cusps upward. But they snap, that is they stop. They are being restrained by these, what are they, they're called the chordae tendineae, which prevent these valves from moving upward and into the atria. So simply put, let's say these two pieces of paper represents these valves. Blood will push these valves open easy enough, right. And blood will push the valves closed. But what prevents them from, in fact, reversing is the tension, which is generated by the chordae tendineae. And that's illustrated nicely enough in this picture. And appreciated in this actual photo. So the valve is up here. These are the chordae tendineae, and these are the papillary muscles. Chordae tendineae and papillary muscles are features then of both AV valves. And the function of these is not to necessarily help open but rather prevent the reversal of these cusps and prevent backflow. What's the word for backflow which would be undesirable? Regurgitation. You don't want blood that's managed to get down into the ventricle to go back up to the atrium. You want it, of course, to leave the heart as we're about to describe. And blood leaves the ventricles through a second set of valves which are situated between the ventricles and the outgoing artery. These are called semilunar. Semi means what? Half. Half what? Half lunar. In other words, halve a moon. And these

are identical in anatomy. They're seen in different colors here. But they're identical in that they both have how many leaflets apparently? Both of these have three leaflets, so the name is given to its location. The right semilunar valve is called the pulmonary semilunar. The one on the left side is called the aortic semilunar. These valves are sealed, not by chordae tendineae, but by the redundancy, that is the extra tissue of the valves themselves. Once again, we could take two pieces of paper here, and we could push them together like this. Which way would blood have the easiest way of going would be right through like that, right. Can it go back? No. the valves open but they close. Open and close. There's just enough tissue to prevent this from happening. So the semilunar valves do not have and do not need what? They do not have and do not need chordae tendineae. They close simply by the proximation, that is the contact between these leaflets. Now, the operation of these valves is important, obviously, to keep blood from, what's the R word?

>> Regurgitating.

>> Steve Langjahr: Regurgitating. And in fact, here's a view of a semilunar valve when it's in what state? This must be open, and this is almost what?

>> Closed.

>> Steve Langjahr: Closed. But not quite. Sometimes these valves don't close properly and, therefore, allow the R word. What?

>> Regurgitation.

>> Steve Langjahr: Which creates an extra noise that can be heard with a stethoscope. An extra noise that's heard, an abnormal noise that's heard, due to what? It is called I guess you know a heart murmur and is diagnosed simply with a stethoscope. Before we can understand more, let's look through the events, the timeline of a typical contractile sequence in the heart. Let's step on the heart, that is, let's begin with the atria in a relaxed condition. If the atria are relaxed, they're now filling, right. They're receiving blood. So blood is entering both the left and right atria at this moment. When the atria are filling, what do you suppose is going on in the ventricles? Those are emptying out. To put it another way, when the atria are relaxed, the ventricles better be contracting. And that event of contraction is called systole. Systole is the scientific name for contraction. So blood is leaving the ventricles at this time, and it's filling the atria at this time. You should be able to imagine then what valves would be open and what valves would be closing during this moment. If the ventricles are contracting, obviously these valves would have to be opening. And at the same time, the AV valves would be closing. So the SL or semilunar are open or opening at this moment. And they AV valves are closed or at least closing. So what? When it comes to a doorway or just a door, what makes the most sound, the opening of a door or the closing of a door?

>> Closing.

>> Steve Langjahr: So which of these events create the most disturbance to

blood flow and therefore the greatest sound as would be heard through a stethoscope.

[Inaudible]

No, the opening of the valves creates very little sound. It's the closing of the AV valves. And for no good reason, this moment, this event, this sound, is called the lub sound. So to repeat, the sound that you hear is not the valve opening but these valves that are closing. The next event that follows this is the reverse. Now that the atria have filled, it's their turn to contract. And the ventricles are filling, and that moment of relaxation is called diastole. What valves would be opened? What valves would be closed? Well, obviously, just the reverse. The AV valves would have to be opening, pushed open really by blood which is forcing them open, moving as it is to the atrium down to the ventricles. And at this time, the SL valves are closing. Again, what makes the most sound? Closing. And this second sound which is shorter and slightly higher pitched is described as dub for no good reason. So if you combine these two words, you obviously go from lub dub, lub dub, lub dub. And that's the description of what can be heard through a stethoscope. What if you hear lub dub swoosh? Or lub swoosh fulf? What if there's an extra sound in there? That means a valve is what? Leaky, right. So there are murmurs which are classified according to when they occur. A systolic murmur would obviously occur during systole. What valve should be closing at that time?

>> Atrial.

>> And if they're not, then they're leaky and you would hear an extra sound. So a systolic murmur would be an extra heart sound heard during systole and, therefore, attributed to and caused by leaking of what valve? One of the two AV valves. So valves, of course, can become faulty and produce, as we've just said, a heart murmur. Can you replace heart valves? I don't mean you at home on your lunch break. But can surgeons replace heart valves? Yes. And these valves can be obtained from animal sources, or they can be crafted, that means made manually by human beings. And they can be sewn in place with a fair amount of expense and trouble. You must know somebody that's had a valve job, that is, had their valves replaced. Know anybody? No? All right. Well, our governor, our former governor, Arnold Schwarzenegger, the epitome of health and masculinity, he had a couple of valves done. Just thought you'd want to know. Returning to the coronary vessels briefly. We said there were two, one that serves the right side, one that serves the left. We spoke of their importance because they provide oxygen to the myocardium. And all of this will develop this condition with time. Nobody doesn't. The name of the condition is called atherosclerosis. Fatty deposits on the inside lining of these already small arteries. Robs the myocardium of oxygen, therefore creates the MI. What's the MI? Myocardial infarction or death. What are the symptoms of a heart attack? Sometimes there are none. But if there are, what are the symptoms that precede a heart attack? Chest pain, shoulder pain, neck pain, all sorts of pressure. And that usually gets the attention of folks in the ER. That is, they'll

rush you for what's called an angiogram, and they'll determine the condition of your coronary vessels. And maybe, maybe schedule you for a procedure called angioplasty. If you get to the hospital too late, you're gong to get a clot in this vessel. That's the T word, it's a thrombus. In which case, you're DOA. What's that.

>> Dead on arrival.

>> Steve Langjahr: Dead on arrival. So, obviously, the condition of the coronary vessels is important. Historically, although not so much today, these vessels were bypassed with venous grafts. You've heard the term. Coronary what? Bypass surgery. Don't hear much about it today because it's expensive. It's invasive. It's risky. Did I already say expense? Yes. And doesn't always work. So the procedure which has taken its place is coronary angioplasty, balloon angioplasty. You'll learn more about that in lab. But let's finish today off. We know that the heart rate is intrinsically set. Your rate might be right now 70 let's say, 70 what, 70 beats a minute. Can it be increased?

>> Yes.

>> Steve Langjahr: Yes. Can it be decreased? And if we took your heart out of your body and sat it on this desk, would it continue to beat all by itself? Yes. Those are fascinating truths. So where does the contraction emanate? Where's the source of this contraction? The electrical source emanates from a spot seen here, a so-called pacemaker site known as the SA node. The SA node is located on the superior portion of the right atrium. It's not something you can see in the lab. It's not something that's vivid enough to see, but it represents an area of noncontractual cardia cells, which is basically putting out a signal which then spreads across the atria from right to left. This goes to knowledge you already have. How are cardiac muscles joined? How are cardiac muscle cells connected? What's that bridge, that dark intercalated discs. So the signals spread from cell to cell, starting in this location and spreading from right to left. In the lower portion of the right atrium is another node which is designated the AV node, again, because of its location between the atria and the ventricles. It's basically situated on the lower portion of the interatrial septum. Its job is not to produce any signals but to receive. That means listen for and respond to electrical signals that are arriving from the atria. So you might describe it as a receiver of signals. And this AV node is designed then to accept the electrical excitation from the atria and then transmit it through the interventricular septum through a bundle of fibers first described by an individual whose name happened to be His. So in his honor, it's called the bundle of his. I don't make this up. If His name was Her, it would have been instead, the bundle of Her. But his name was actually His. Hence the name bundle of His. All right. But we don't call it that anymore. Because it's too darn useless. We call it the AV bundle, the atrioventricular bundle. Which is connected to and carries signals from the AV node, eventually bifurcating into smaller branches called Purkinje fibers. These are easy to show in a diagram, but they're not easy to see in actual specimens. So this diagram is pretty nice. This one up here, this bright yellow spot, is the SA

node. Its job is to create and disseminate signals from the right over to the left atria. As a result, the atria will contract and push blood into the ventricles. The AV node waits for and responds to these signals and carries those signals down and through the bundle of His, better known as the AV bundle, down into the Purkinje fibers. You might wonder, you should wonder, why all this complexity. The importance of this network is that it causes the ventricle to contact from the bottom up rather than from the top down. And that may not be instantly appreciated, but why do we want to push blood from the bottom up when we want to move it out the aorta and pulmonary arteries, so it's more efficient in terms of cardiac output. Final remark. Is the heart under the influence of the autonomic nervous system? Yes. Does it receive dual motor innervation? Yes. And the sympathetic fibers utilize a transmitter called norepinephrine. And the parasympathetic use a transmitter called acetylcholine. The parasympathetic fibers actually reach the heart by way of the tenth cranial nerve, the vagus nerve. And as you already know, the parasympathetic would do what then to the heart rate? It'll slow it down. So, strictly from an experimental standpoint, what would happen to the heart rate if you cut the vagus nerve which innervates the heart? If you cut that vagus nerve, you remove the –

[Inaudible]

And therefore leave the -

[Inaudible]

And therefore, the heart rate would go up. Now, this cutting is not, of course, done in any medical context. But there are drugs that block this effect. And if you block parasympathetic action, what do you leave unchecked? Sympathetic. So bottom line, if you block the vagus nerve or its effect, then the heart rate will go.

>> Up.

>> Steve Langjahr: Up. In a similar way, if you block the sympathetic effect, what happens? The heart rate would go down. And those drugs, incidentally, are called beta blockers, which you may or may not have heard of. But here's the final comment. Right now, your heart rate is what it is. What are two ways to make it go faster? Two ways. We could increase?

>> Sympathetic.

>> Steve Langjahr: Sympathetic. Or decrease parasympathetic. What are two ways to make it go slower? Increase parasympathetic or decrease sympathetic. And that arrangement is important because it can bring about quick, very immediate changes in heart rate. The name of this arrangement is called dual, what was that? Dual motor innervation, which applies to many organs but is most easily appreciated here in the heart. So that's it for our intro at least to the heart. You're going to get some hands-on experience later in the lab.