An Introduction To Cardiovascular Disorders

So, today we're going to be giving an introduction to cardiovascular disorders. The way we're going to do that is we're going to start all the way at the beginning with just a general review of the cardiovascular system.

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To do that, I'm going to start a place where people don't typically start. I'm going to start all the way from going to the grocery store.

You go to the grocery store, you pick up some food because you're hungry or you need to eat, and then, of course, when you're picking up that food, you're picking up a bunch of healthy stuff, right? You're picking up the fruits and the veggies and all that good stuff that you need so that you can live, so that you can thrive, and all that.

Now, once you pick that up, you go home, you cook it. Maybe you don't cook it, whatever you decide to do and yes, you eat it. I had to include this picture because I was looking for a picture of someone eating and this one was so cute. I know people would say, "Aw, that's so sweet!"

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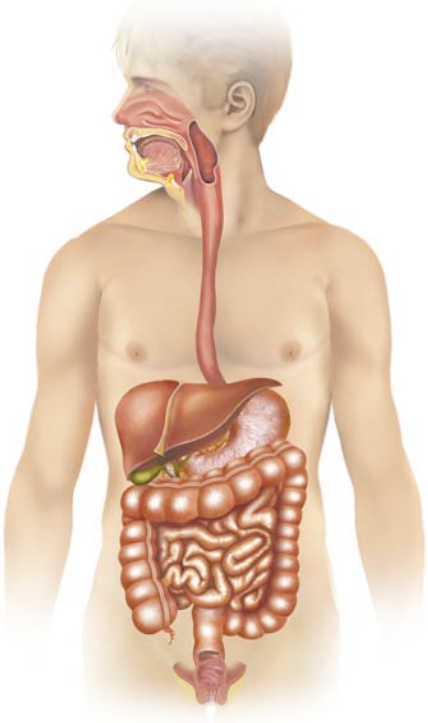
Anyhow, so you eat that food. What is going to happen with that food?



Well, of course, it's going to go down you're digestive tract. You have the food that is entering your mouth. It's going to go down to your esophagus and then, down from your esophagus to your stomach and once it gets into your stomach, we're going to start to break it down. Your stomach is churning. It's moving and the muscles are contracting so that, you can start breaking apart that food. You're going to have enzymes that are released to start breaking it down even more, and then, of course, from the stomach, it's going to go into your intestines.

One of the things that are happening is, as you are breaking down the nutrients, as you're breaking down the proteins and the carbohydrates and all these fun stuff that's happening inside your body, the nutrients get absorbed. The way they get absorbed is they go into your bloodstream.

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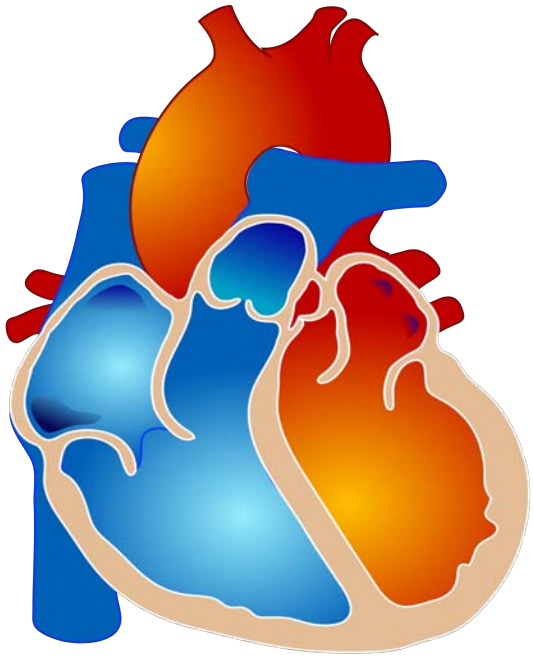
Then, your cardiovascular system has the beautiful job of taking those nutrients and circulating them throughout the body.

Here, we have our **heart** and the heart of course is going to be beating. As that heart beats, it's going to send blood really to two different places. It's going to send the blood to your **lungs** and it's going to send the blood to the rest of your body and those nutrients that you ate, those nutrients that got absorbed into the cardiovascular system, into the bloodstream are going to then circulate through the body.



It's not just going to circulate the nutrients but, there's also one other important thing that it's going to circulate. That is **oxygen**.

As I'm saying it, you guys are thinking it along with me. It's going to circulate oxygen because in order for you to get energy, in order for certain chemical reactions to happen inside your cells, you need to have oxygen to make that energy in the form of ATP (adenosine triphosphate). That is the energy currency of the body. In order for that to happen, you need to have that oxygen that is circulating.

[**00:03:20**]
Let's do a review of the path that the blood is traveling through the heart and then, how it gets through the rest of the body.

The blood that's coming back from the body, it's going to come via these two great vessels here. We have this one, (let's do it in blue right here) and we have this one right here. Those are your **superior** and **inferior vena cava**. The one on the top is your superior. The one on the bottom is your inferior.

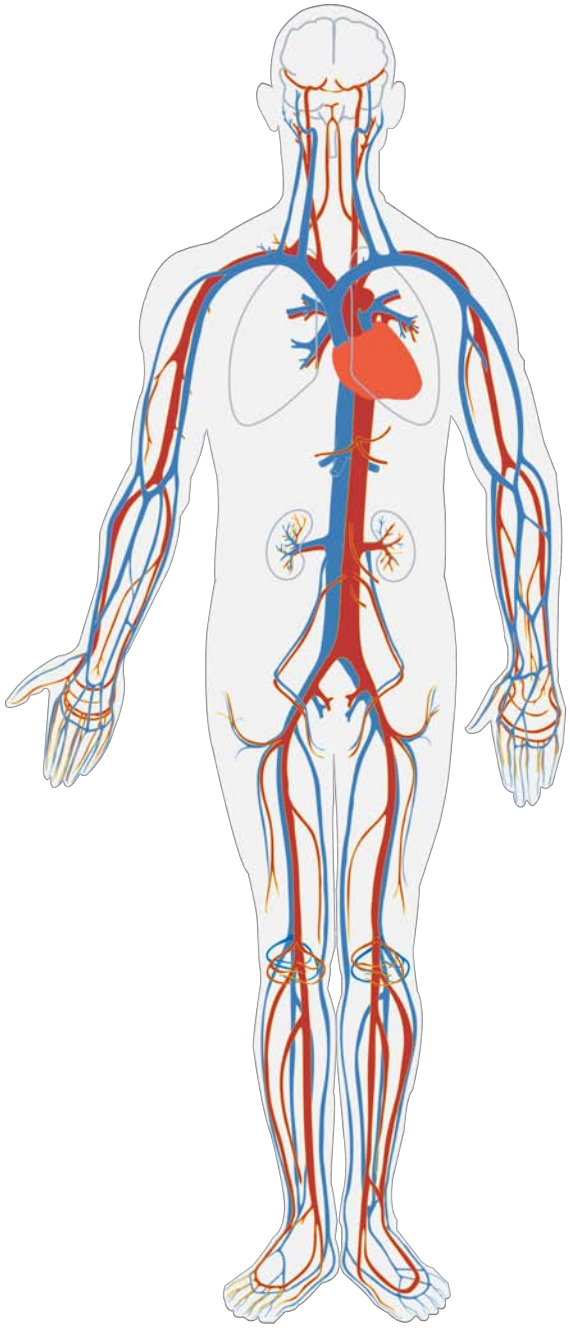
When the blood comes in to the superior and inferior vena cava from the rest of the body, that blood is going to enter your **right atrium**. The blood comes from the body,

enters your right atrium. When the atria contracts, the blood is going to go from the right atrium to your **right ventricles**.

You'll notice that it's going through this valve and that valve is going to be your atrioventricular valve. That's going to be your **right atrioventricular valve**. It's called "atrioventricula" because it's between the atrium and the ventricle.

From there, when the ventricles contract, that blood is going to leave your right ventricle and go into your **pulmonary arteries**. Now, you hear the word, "pulmonary," you're thinking it's going to your lungs, right? Over here and over here, that would be your pulmonary arteries.

Actually, this first part is called your **pulmonary trunk**. It's a trunk that branches off into your two arteries, your left and right pulmonary arteries that's going to your lungs. If you look over here, you're seeing that happening here. So, it's coming up from your right ventricle and going through this pulmonary arteries to go to your lungs.



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Once it goes to your lungs, what is it going to get from your lungs? It's going to pick up some oxygen. That oxygen is a key component. That oxygen is needed for that energy for cellular respiration to happen, the chemical reactions that are happening inside the cell so that, you can generate ATP which is that energy.

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From your pulmonary arteries, it's going to the lungs. It's picking up that oxygen and then, it is coming back via your **pulmonary veins** and it's going to your left atrium. From your **left atrium**, it's going to go into your left ventricle. From your left ventricle, when that contracts, it is going to come out here and go into your **aorta**. From your aorta, it's going to be pumped out to the body.

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We have blood that came in on the right side. It came in without oxygen. It's getting pumped to

the lungs. It's going to pick up oxygen and then, it's going to get back to your left side and then, from there, now we know that it has that oxygen, it can then be pumped through the rest of the body.

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Just a few more terms here, of course, these valves here would be your **left atrioventricular valve**. This valve here where it's leaving to go to the pulmonary trunk and then, the pulmonary arteries, that is going to be your **pulmonary valve**.

The one where it's going into the aorta, that, of course is going to be your **aortic valve**. A few other names that you might hear, the atrioventricular valves on the right side, we can call this one the **tricuspid valve** and on this side, we're going to call this the **bicuspid or mitral valve**. On the right side, it is tricuspid.

Then, some more terms… This is just a nomenclature. I want you to know these names. I want you to get used to them. The reason this is called tricuspid is because you actually have three of these cusps. You're only seeing two because this is a cut through the heart but, there are actually three of these and on this side, we have two of them.

The pulmonary and aortic valves, another name for those would be your **semilunar valves**.

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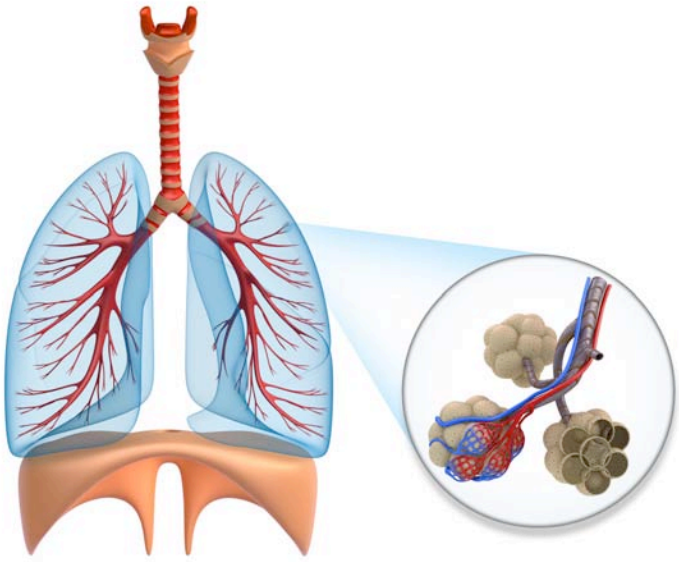
All right, so let's continue on from there. Now, we spoke about the fact that the right side of the heart, that is going to be pumping the blood to the lungs. I want to get a picture of how that's happening.



Here, we have our **lungs**. You have your lungs. You have your trachea and your bronchii that are going to your lungs, and of course, in here, what's happening is you're breathing in when you take that deep breath or a shallow breath, whatever breath you take, you have air that's coming in and that air is going to have oxygen.

As we look at the little branches of the bronchi and the little segments of the lungs, we're going to have these little structures that we call **alveoli**. These little sacs that you see here, those are called alveoli and the important thing is that, yes, we said that the blood was leaving the right side of the heart and going to the lungs and there are going to be a bunch of branching of those arteries.

Eventually, we're going to see that we have this blue vessel that's coming in here and eventually, we're going to get all these little capillaries. That is where air is coming in to the lungs. It's coming in to this alveoli and the oxygen is going into those capillaries.

This is showing you blue because it's de-oxygenated. It doesn't have any oxygen in it. But, once it gets to the alveoli and you're breathing in oxygen in those alveoli, you're going to get **respiratory exchange** – oxygen going into the blood supply and then, carbon dioxide coming from the blood supply into your lungs, into the alveoli, and you breathe that out.

So, there's exchange that's happening right here that makes it so that when the blood comes back to your heart, on the left side, now we have oxygen. All right… I hope you guys are still following me. This should be a review. Or, if you're just getting into the cardiovascular system, this might be a little new for you. But, I hope you got a good overview.

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There's something else that you have to mention when we're talking about this especially as we are going into talking about disorders. That is what is happening once the blood is leaving the heart and it's going to the rest of the body, we're going to have arteries (I'm going to draw this over here).

Let's say we have, (let's do that in red). We have arteries that are coming down. The arteries that are coming down are then going to give off these little tiny branches. Those little tiny branches are your capillaries. (Okay, so I'm doing this very raw, and I'm doing it red because this is coming away from your heart. It's oxygenated.)

Now, let's do the other half in blue. The capillaries are going to continue on and as the capillaries continue on, they're going to go to your little venules and then, to your veins.

[**00:13:02**]
By the time they reach over here, they are **deoxygenated**. We're going to give some terms here.

Here, we have (let's do that in red) an artery on one end. On the other end, we have, (oh man, I just messed it up. What's going on here? Sorry about that. Let's go back to where we were. Okay, quick drawing. This one is not going to be as neat even though the other one wasn't neat. It's going to be really rough. Okay, coming off on this side… You get the point what's going on there.)

Let's try that again. Here, we have our artery. Over here, we have our vein. Here, we have an arteriole and here, it's like a tiny artery, right? And here, we have a venule. All of these in between here, that would be our capillaries.

So, when the blood is leaving the heart, it is going to go to your arteries. From the arteries, it's going to your arterioles. From the arterioles, it's going to your capillaries. From your capillaries, it's going to your venules. And, from your venules, it's going to the vein.

The main thing that I want you to notice is here is that it's going from red to blue. The reason it's going from red to blue is because as the capillaries are circulating through all of the tissues, the blood is giving up oxygen. It's giving oxygen to the tissues. That's what we're illustrating here.

Here we have one capillary. We're taking all of these stuff here. We have one capillary. Just for simplification, we're going to have blood because you see the red blood cells circulating.

The key thing here, I'm not going to talk too much about hydrostatic pressure and oncotic pressure now. I'll get into that in a later one of these sessions. The key thing is that oxygen is being deposited. We have O_2 which is oxygen that is being deposited or delivered to the tissues.

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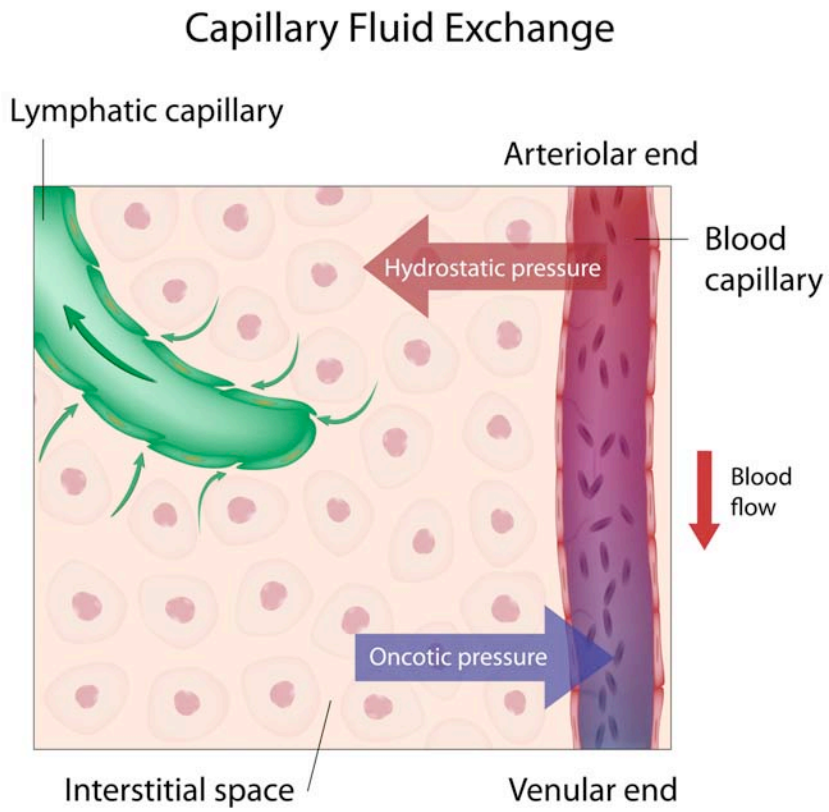
Then, of course, we're going to have waste that is coming back into the blood supply, into the capillaries so like carbon dioxide. We're delivering the good stuff. We're delivering oxygen. We're delivering nutrients. Some of that would be like glucose because the cells need it. The cells need it for energy and we're getting rid of waste. We're getting rid of carbon dioxide.



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Now, some fascinating things that's happening here. When you look at this capillary, you're just seeing one, and you're seeing a bunch of blood cells but, capillaries can be so small that here is one capillary and here is a red blood cell.

At some point, it's so small that the red blood cells are basically going through like a single file. That's how small these capillaries are. However, all the cells in the body need to be very close to the blood supply.

So, if this is one red blood cell, I want to let you know that every cell in the body is within two red blood cell distances away from a capillary. So, we think about these as if they are individual capillaries that are going through but, in reality, you have a ton of these capillaries permeating all throughout the tissues and they are so intimately involved with the tissues that every cell is within two blood cell diameters. The size of one blood cell, every cell in the body is within two of those distances from a capillary.

Why?

Because you need to get that oxygen. You need to get that oxygen to the cells. Cells are metabolically active. A lot of processes are happening inside of them and you need to be close enough to the blood supply that you can get that exchange happening.

Okay, so that's a review of the circulatory system.

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The question then becomes, what happens when things don't function the way they are supposed to function? What happens when one of these arteries get an occlusion? Something is blocking the flow of blood in those arteries. What happens when an individual has high blood pressure?

Actually, going back here… let's say an individual has high blood pressure. We'll talk about that a little bit first.

The **blood pressure**, the pressure that's in the capillaries and in the circulatory system, in the blood vessels, that is forcing stuff out. It's forcing the oxygen out. It's forcing the nutrients out. It's also, and this is a big thing that it's forcing out in terms of force because a lot of the other stuff is just going along concentration gradients, it's going to be forcing fluid out.

I'm going to have H_2O going into the tissues but, I'm not only going to have H_2O going into the tissues, I'm going to have H_2O coming from the tissues and back into your capillaries. You have a mix of water leaving and water coming back in.

(I hope you guys aren't hearing my son is crying in the other room, oh man. Sorry, I got distracted by that.)

The blood pressure is forcing water out and then, you're going to have water also coming back in.

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What's going to happen if the blood pressure is really high, if an individual has hypertension?

Well, what's going to happen is you're going to get more water leaving than you have water coming in. So, if you have more water leaving than water coming in, what's going to be the problem? What's going to be the situation?

The situation is you're going to get water build up in the tissues and that is called **edema**. Water accumulation in the tissues, you're going to get edema. That's what we're talking about there.

So, high blood pressure causing more water to be pushed out and if more water is pushed out, water is going to accumulate in the tissues and that leads to edema that leads to swelling basically, that will happen in the tissues.

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What happens in the case where there's swelling in the tissues or if there's water accumulation in the tissues? What's the big deal? Why is that such a problem? So, you have more water. What's the big deal?

I'll tell you what's the big deal.

We have edema, water accumulation. Remember, I told you that all of the cells in the body are very close to your capillaries. They are very intimately involved within two cell diameters away from a capillary. That's how far each cell in the body is.

But, if you have a bunch of water now accumulating, that is going to mess up with that balance. It's going to cause the cells to be a little further away from the capillaries. And, if it's farther away from the capillaries, you're not going to get as much of the nutrient exchange, oxygen delivery, and that will compromise the tissue.

Does that make sense? You have a greater distance. You have farther distance for stuff to travel via diffusion and with that, that can cause dysfunction in the tissues.

That's one general problem that you can have with the circulatory system. In response to high blood pressure, you can get accumulation of fluid in the tissues. And, with that, if you're not getting the nutrients in the tissues as you should, that can lead to other complications.

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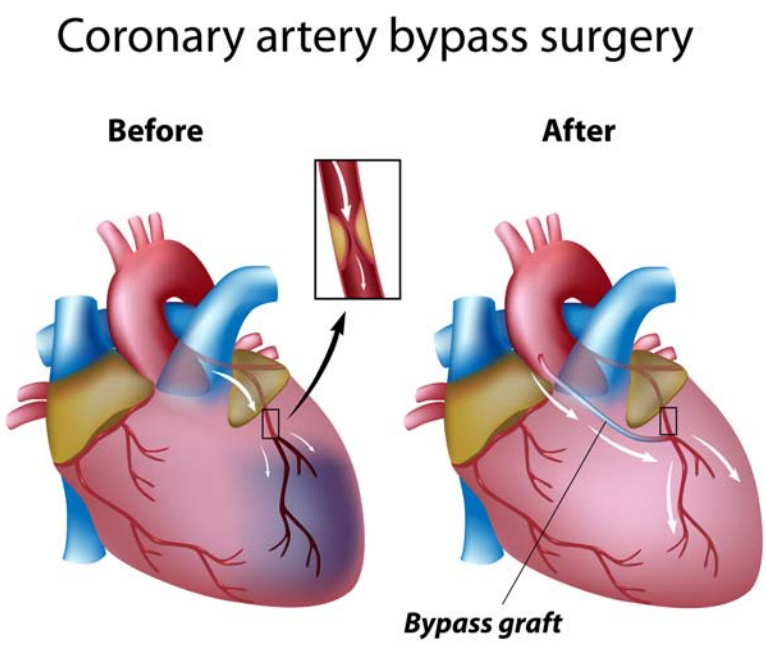
Now, going back to this picture that we have where we had something that's blocking the capillaries or an artery or something of that sort, the problem here, of course, what is that going to do to the blood supply?



That's going to reduce the blood supply and anytime you reduce the blood supply to tissues, that makes the tissues susceptible to injury.

So, let's throw some terms out there.

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First term is going to be **ischemia**. Ischemia is basically a reduction in blood supply. In this case, it's a reduction in blood supply because you have an occlusion, something that is blocking the flow of blood to a specific area.

In this case, we're looking at some of the **coronary arteries**, that arteries that are actually supplying blood and nutrients and oxygen to the heart muscle itself so that, the heart muscle can get the energy that it needs in order to contract, it can get the nutrient, the glucose, and other substances that it needs so that, those cells can live. They can thrive and they can do what they need to do.

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Now, if the blood supply is reduced enough, you lead to this type of condition here. It's showing it to you that it's a little darker illustrating the fact that the tissue is actually dying. If you don't get food, you are going to die. If the tissues don't get the nutrients that they need, they are going to die or they potentially can die.

That is called an **infarction**. That is basically tissue death. Another name for the death of tissue would be **necrosis**. This is actually cell death. The cells are dying. Because

the cells are dying, the tissues are… The tissues are made of cells so, you get tissue death and that is an infarction.

Issue here is we have blood that's circulating through the heart going to the body. Part of that going to the body is these coronary arteries that we have that's supplying blood to the heart muscle itself. If this gets occluded, individual has really high cholesterol, or cholesterol accumulates in the vessels, there's hardening of the arteries and there's occlusion in this case so, we're not getting blood past this point. This tissue can die.

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Once that happens then, that causes complications with the way the heart is contracting. The heart is not able to do its job and the tissue can die.

One of the things that we see with this is that individuals have to go in for bypass surgery. If the occlusion is right here in this point, we're going to have to artificially go in and do surgery and remove a vessel from one place. One of the vessels that are used often for this would be one of the **saphenous veins**. We remove that and we construct an artificial connection between the aorta and a little beyond where that occlusion is because then, that restores blood supply.

This is a **coronary artery bypass**. An individual goes through bypass surgery. This is what is happening. The main goal here is since this is blocked, since this vessel is damaged or occluded, we need to have an alternate route to get to those muscle cells and we're going to artificially do this bypass graft so that, we can get blood there.

That's a basic introduction to cardiovascular disorders. I hope that makes sense. I want to go into much more detail in future presentations and in some of the tutoring sessions we're going to do in the future.

But before we dive deep into those things, I wanted to give a general introduction. I hope you got value from that. That is it for the presentation.