

# Young Scientist Program

## Anatomy Teaching Team



### “Basic Cardiac Pathology: What can go wrong with the heart?”

#### *Lesson Goals:*

1. Know the medical term for a heart attack, and understand what causes a heart attack.
2. Understand why hypertension is a problem for the heart, and know why doctors screen patients’ blood pressure
3. Understand what an arrhythmia is and how it could cause the heart to not pump blood properly.
4. Know the basic problem of heart failure, and understand that many heart diseases can lead to heart failure.

#### Introduction

There are many things that can go wrong with the heart. Some of these problems have been briefly mentioned in the previous modules that you have seen today, and some of these problems you have probably learned about by interacting with friends, family members, or relatives. Some problems with the heart are very common, such as the enlargement of the heart (**left ventricular hypertrophy**) which can result from having high blood pressure and congested arteries, and affect a large number of people. Others diseases are very rare; for example, some conduction problems (WPW syndrome) that result in a very fast heart rate only affect a few people. **Overall, the fact that the heart is so critical to the overall function of our body (given that it pumps blood to every organ) suggests that any problem with the heart will have a big effect on the health and welfare of an individual.** Even small changes in the way that the heart works can cause big problems in terms of a person’s everyday health and well being. Therefore, many patients that are seen in hospitals have heart disease.

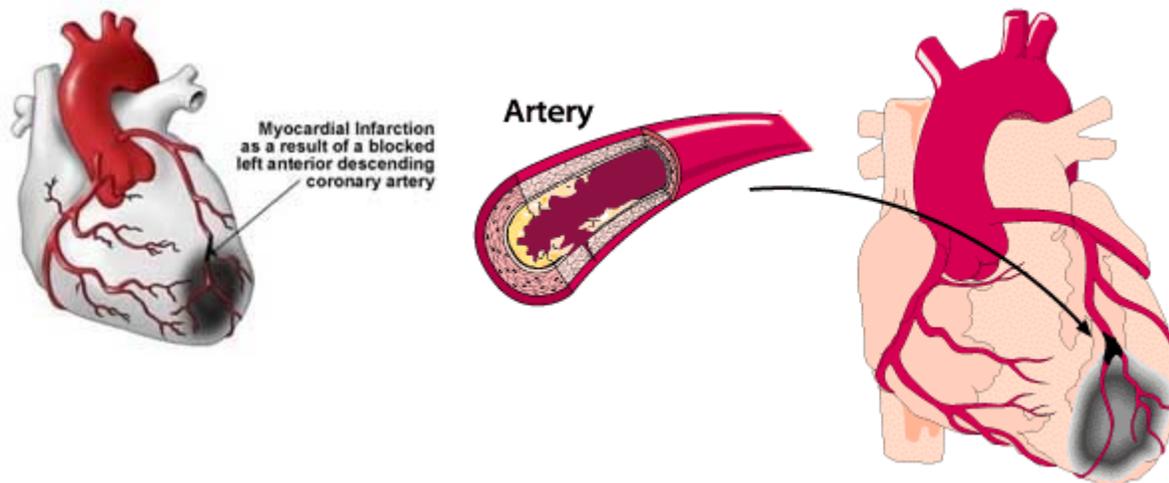
*What kind of heart diseases have you heard of from your friends or relatives?*

#### Heart Attack (Myocardial Infarction)

One of the most common heart-related problems are those of “heart attacks”, which are known medically as a “MIs” or “**myocardial infarctions**”. What a heart attack actually entails can be deduced from the medical name. **Myocardial = the muscular layer of the heart, and infarction = loss of blood supply causing tissue damage.** Therefore, from this examination we have figured out that a “heart attack” is caused by the loss of blood supply to the muscular walls of the heart. But that doesn’t make sense, right?

**How could an organ filled with blood lose blood supply?** Actually, the muscular walls of the heart are supplied by a very specific set of arteries on the outer surface of the heart called the **coronary arteries**. Every heart has a few different coronary arteries, which are very small, which serve different areas of the heart. When one of these arteries is blocked, typically by **plaque** and/or **blood clots**, the muscular portion of the heart loses blood supply and begins to die, a process called **necrosis**. The damage that this loss of blood causes in the heart tissue gets worse over time. If the blockage can be removed within an hour the effects may not be that bad, but if the blockage continues for a long time the portion of the heart can be permanently damaged. This can cause large problems in the heart's ability to pump blood around the body.

There are many risk factors that individuals can be exposed to that can increase their risk of **myocardial infarction** including **cholesterol** and fatty molecules in the diet, smoking, and lack of exercise. These risk factors promote the formation of **atherosclerotic plaques**, which are collections of cholesterol and inflammatory cells, inside vessels. This is especially important in small blood vessels, like the coronary arteries, in which atherosclerosis can lead to blockage of the arteries preventing the flow of blood to the heart. **Show the cut aortic specimen with atherosclerosis lining the walls.**



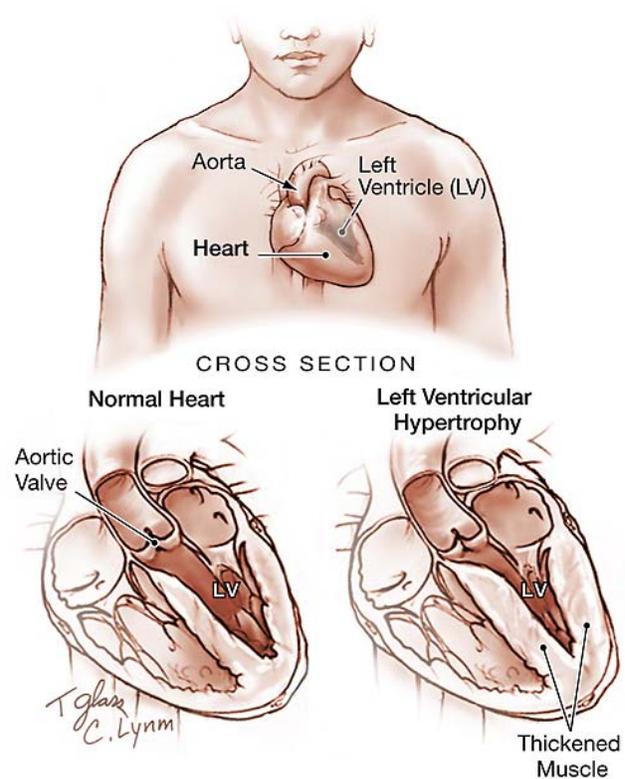
**How can we tell if someone is having a heart attack?** Typically, the person will have some very common symptoms such as **pain in the chest, neck, or left arm** (due to common origins of the nerves going to both, termed "referred pain"), trouble breathing or feeling a pressure on the chest, a feeling of "doom", anxiety, lightheadedness, pallor, and/or a change in heart rate, just to name a few. Doctors can also use a number of tests to determine if someone is having a heart attack. One method measures the amount of specific proteins, called **troponins**, in the blood that are released when heart cells die. Another looks at characteristic changes that can occur on a patient's EKG (**ST elevation**, T wave inversion). Another uses ultrasound to look at the movement of the walls of the heart.

### **High Blood Pressure (Hypertension)**

Another common disease of the cardiovascular system is that of hypertension (or high blood pressure). Although likely not a problem of the heart initially, hypertension can have significant consequences for the heart (and other systems). **If the pressure in the vascular system is higher than normal, what will**

**the heart have to do in order to compensate for this?** It will have to work harder to pump blood out to the body, and this will cause the heart muscle to grow, which is a condition known as **ventricular hypertrophy**. Hypertrophy of the heart muscle is similar to building muscles by lifting weights at the gym; the key difference, however, is that hypertrophy due to hypertension actually makes the heart sicker.

**Although it is a serious condition, hypertension will not usually make a person feel any different than normal**, which is why it is so important for doctor to **screen** for it. A patient's blood pressure is typically measured at every doctor's appointment, to make sure it is within the normal range. If a patient is found to have abnormal blood pressure, they should be advised to reduce their **sodium (salt)** intake, and there are many medications available to help bring it back within the normal range.



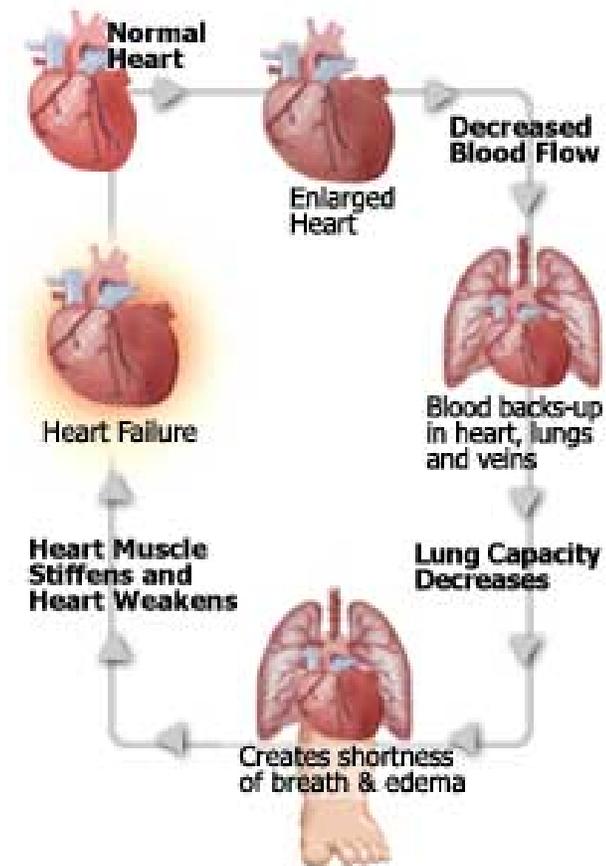
### **Cardiac Rhythm Disorders (Arrhythmias)**

Another set of problems in the heart are related to improper pacing or improper conduction of electrical activity throughout the heart. These problems can range from more common, such as partial conduction blocks, to very rare, such as Wolf-Parkinson-White syndrome (where electricity is conducted in a loop through the heart from the atria to ventricles to atria, etc.). Cardiac electrical problems are generally the result of three different problems: 1) Congenital disorders, in which the patient is born with a heart that is formed differently or with cells that function differently, 2) Acquired damage, such as past infections or heart attacks that result in scar tissue), or 3) Chemical or drug stimulation, which can cause the heart cells to behave abnormally. In general, improper cardiac electrical activity, also known as **arrhythmias**, have the potential to cause serious harm. **Recall that the electrical activation of the heart is responsible for stimulating contraction of the heart.** If the electrical conduction pathways of the heart are altered, the atria and the ventricles may not beat in proper relation to one another. Also, if the ventricles do not electrically activate and contract simultaneously, they will not be able to pump effectively. This will lead to a significant decrease in the output of blood to the lungs and the body and can be fatal if not treated emergently.

### **Heart Failure**

Heart failure occurs when the heart cannot contract/beat hard enough or fast enough to push enough blood through the body. **Heart failure is the common end pathway for many types of heart disease.** Typically, it results from long term accumulation of damage due to increased stress placed on the heart. The sources of stress can include long-standing hypertension, damaging myocardial infarctions, or valve disease, all of which make the heart work extra hard to pump blood. Over time this stress

## Congestive Heart Failure



causes the muscle layers in the heart to increase in thickness (**hypertrophy**) and eventually to increase the size of the chambers of the heart (**dilation**). While both of these “coping strategies” can temporarily increase the ability of the heart to pump more blood out into the body, they cannot offer a permanent solution, and eventually the heart cannot adapt any more to increasing stresses. At this point the heart **cannot pump enough blood to supply the demands of the body**. So what can doctors do to help a patient with a failing heart? Artificial pumps called **left ventricular assist** devices can be implanted to help the patient improve their ability to pump blood for a period of time, but eventually the patient may need a **heart transplant**.