Slide 2

The heart is an organ located in the thoracic cavity. It provides the force for the circulation of blood through the blood vessels, acting as a double pump that sends blood both to the lungs and to the body.

Slide 3

The two routes the blood takes from the heart are called the **pulmonary** and **systemic** circuits. The **pulmonary** circuit involves the route the blood takes from the right side of the heart to the lungs and back to the left side of the heart. This route is used to pick up oxygen from the lungs and drop off carbon dioxide from the blood to be eliminated. The **systemic** circuit involves the route the blood takes from the left side of the heart to the tissues of the body and back to the right side of the heart. This route is used to deliver oxygen to the tissues and pick up carbon dioxide from them.

Slide 4

The heart has a double-layered covering called the **pericardium**. The **parietal pericardium** is the outer layer, and the **visceral pericardium** is the inner layer. There is a space between the parietal and visceral layers called the **pericardial cavity**. It is filled with **pericardial fluid** that lubricates the layers and allows the heart to beat with little to no friction against surrounding tissues

The wall of the heart has three layers. The **epicardium** is the outer layer and made of a thin layer of epithelium and areolar tissue (serous membrane). The middle layer is the **myocardium**. It is made of cardiac muscle and is the thickest layer. It is the performance layer of the heart. The **endocardium** is the inner layer. It is similar in structure to the epicardium and lines the chambers of the heart.

Slide 5

The coverings and the wall of the heart. Notice how thick the myocardium is in comparison to the endocardium and epicardium. You can also see the pericardial cavity and the visceral and parietal layers.

Slide 6

The heart is composed of four hollow chambers and four valves that allow the heart to serve as a pump. In addition, there are several blood vessels attached to the four chambers that facilitate the entry and exit of the blood from the four chambers.

Slide 7

The two upper chambers of the heart are called **atria**. The **right atrium** receives deoxygenated blood from the body and delivers it to the right ventricle below. The **left atrium** receives oxygenated blood from the lungs and delivers it to the left ventricle below. Each atrium has an attached extension called an **auricle** that help increase the capacity of the atria should the need arise. The right and left atria are separated from each other by a wall of tissue called the **interatrial septum**.

The two lower chambers are called **ventricles**. The **right ventricle** receives deoxygenated blood from the right atrium and delivers it toward the lungs. The **left ventricle** receives oxygenated blood from the left atrium and delivers it toward the body. The right and left ventricles are separated from each other by a wall of tissue called the **interventricular septum**.

Slide 8

There are four valves in the heart, each positioned at the exit to one of the chambers. The valves ensure that blood can't flow backward, acting as one-way doors.

There are two **atrioventricular (AV) valves**. These are located between the atria and ventricles. In order to allow blood to flow from the atria to the ventricles but not vice versa, the cusps of the AV valves have numerous rope-like **tendinous cords** that connect the underside of the cusps to **papillary muscles** at the floor of the ventricles. These cords prevent the cusps from opening back up into the atria. The **right AV valve** is also known as the **tricuspid valve**, and the **left AV valve** is also known as the **bicuspid valve** or the **mitral valve.**

The **semilunar valves (2)** are located between the ventricles and their respective exiting blood vessels. These valves have cusps that part when blood pushes from below to escape the ventricles but close together when blood pushes from above to fall back into the ventricles. The **pulmonary valve** is located between the right ventricle and the pulmonary trunk, and the **aortic valve** is located between the left ventricle and the aorta.

Slide 9

There are several major blood vessels that are involved with bringing blood to the atria and with bringing blood away from the ventricles. In general, blood vessels that take blood away from the heart are called arteries and those that bring blood toward the heart are called veins.

The **superior vena cava** is a large vein that eventually brings all of the blood that has delivered oxygen and picked up carbon dioxide from the tissues in the arms, upper torso, neck, and head back to the right atrium. The **inferior vena cava** is a large vein that eventually brings all of the blood that has delivered oxygen and picked up carbon dioxide from the tissues in the legs and lower torso back to the right atrium.

The **pulmonary trunk** is a large artery that carries deoxygenated blood from the right ventricle toward the lungs. It quickly splits to form the **left pulmonary artery** and the **right pulmonary artery**, which each carry a portion of the blood toward their corresponding lungs. Eventually, after the blood has dropped off its carbon dioxide and picked up new oxygen at the lungs, it returns to the left atrium via the **left pulmonary veins** or the **right pulmonary veins**.

Finally, the **aorta** is a large artery that carries oxygenated blood from the left ventricle out to be delivered to the tissues of the body.

Slide 10

You need to be able to know the steps of blood flow through the heart forward and backward. One way to learn it is to focus on the structures. Start on the pulmonary side and work your way through the systemic side of the heart.

Slide 11

Cardiac muscle tissue is unique to the heart. Its cells are called **cardiocytes**. They are striated, involuntary, and are frequently branched. As with skeletal muscle fibers, cardiocytes use the proteins myosin and actin to contract. Due to their reliance on aerobic respiration for their ATP production, cardiocytes have an abundant number of mitochondria.

Cardiocytes are connected to each other with **intercalated discs**. These discs contain special gap junctions, which are channels that allow for the rapid movement of ions between neighboring cells. By being connected so well electrically, these discs allow the myocardium of the atria to contract at the same time and the myocardium of the ventricles to contract at the same time.

Slide 12

The system within the heart that provides the electrical stimulation for contraction is the Cardiac Conduction System. It is composed of specialized cardiocytes that are **autorhythmic**, meaning they have the ability to generate electrical signals on their own. There are a few key structures involved in the system:

1. The **sinoatrial node (SA Node)** is a group of specialized cardiocytes located in the upper right corner of the right atrium. The SA node initiates the action potential that begins the stimulation of the other cardiocytes to cause the heart beat. For this reason the SA node is also called the pacemaker. Due to the intercalated discs, the SA node signal travels rapidly through the entire atrial myocardium.

2. The **atrioventricular node (AV node)** is located in the lower left portion of the right atrium. It is also a specialized area of autorhythmic cells, but it usually responds to the pacing and signals from the SA node. Once stimulated by the SA node signal, the AV node sends a second signal toward the ventricles.

3. The **AV bundle** is a nerve-like collection of specialized cardiocytes that comes off the AV node and begins to descend within the interventricular septum. Rather than traveling from cell-to-cell, the AV node's signal to the ventricles needs to be delayed to give the ventricles time to fill with atrial blood.

4. The **bundle branches** are two cardiocyte collections that branch off the AV bundle to the left and right to carry the message down the rest of the septum to the apex of the heart.

5. **Purkinje fibers** are multiple small nerve-like cardiocyte branches off of the bundle branches that extend up through the walls of the ventricles. They help to finally distribute the delayed AV node's signal to the ventricular myocardium.

Slide 13

As with blood flow, you need to be able to go through these 5 steps of how the electrical signal flows through the heart.

Slide 14

An **electrocardiogram** (EKG or ECG) is a way to graph the changes in the electrical activity of the cardiac conduction system during the heart cycle and is a helpful tool for studying the conduction system. By placing electrodes that are sensitive to electrical changes at various points on the skin, the EKG can detect and display the actions of the cardiac conduction system. The fluctuations in electricity (called waves) correspond with the actions of the myocardium. **Systole** is the term that describes the contraction phase of a heart chamber, and **diastole** describes the relaxation phase of a chamber.

During a heart cycle, there are typically three prominent fluctuations in the electrical activity of the cardiac conduction system:

1. The **P wave** is produced when the SA node sends out the signal throughout the atria, causing them to depolarize. This, in turn, leads to atrial contraction (systole)
2. The **QRS complex** is caused by the signal from the AV Node that spreads throughout the ventricles and causes them to depolarize and contract (systole) at the same time the atria are repolarizing and relaxing (diastole).
3. The **T wave** is generated by the repolarization and relaxation of the ventricles (diastole).

Slide 15

This is the EKG. The spikes in blue represent the electrical impulses being sent and the depolarizing and repolarizing events occurring in the heart. The line in grey underneath demonstrates when the muscle contraction is occurring. The P wave represents the depolarizing and contracting of the atria. The QRS complex represents the repolarizing of the atria and depolarizing of the ventricles. The atria will relax at the beginning of the complex and ventricular contraction begins with the spike or “R” portion of the complex and continues until the beginning of the T wave. In the T wave we have ventricular repolarization and relaxation. There is a brief moment when neither the atria nor the ventricles are contracting, at which point the cycle starts again.

Slide 16

In this picture you can see what is happening electrically as well as what the muscle itself is doing. This combines what we see on the EKG and what is actually happening in the heart. You can also consider how this is affecting blood flow through the heart.