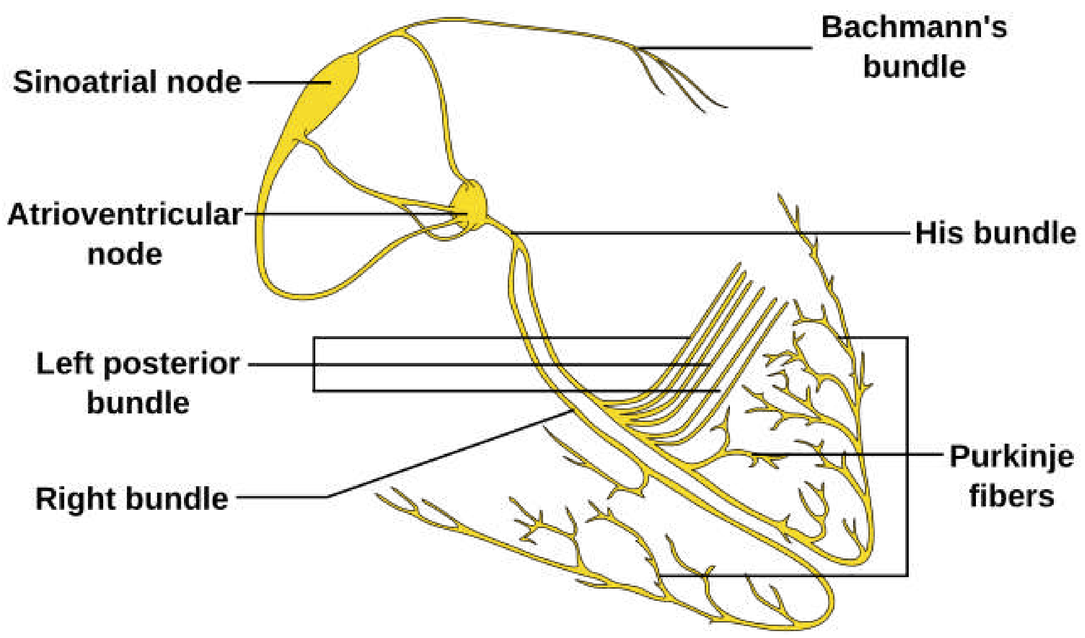
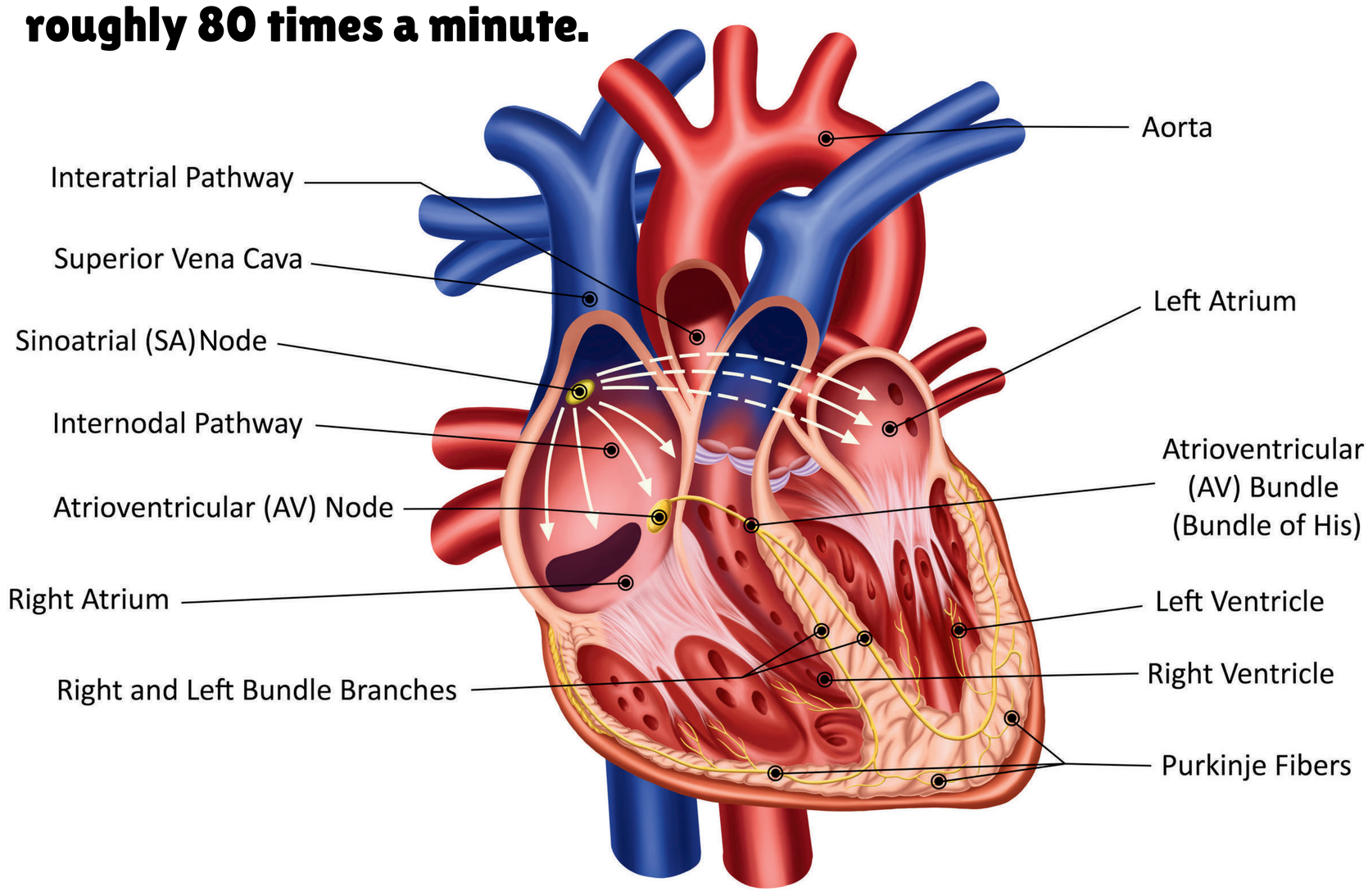
Cardiovascular System

Functions of the Heart

- The heart is one of the most important organs in the body. It is a muscular powerhouse that pumps blood throughout the systemic and pulmonary circuits. This supplies the body with oxygen and nutrients, and gets rid of the waste.
- The autorhythmic cells (pacemaker cells) control the contraction of the heart.
  - Pacemaker potentials are electrical impulses that generate the rhythmic contractions of the heart and are produced by the pacemaker cells.
- There is a bundle of conducting cells that come off the AV node.
  - These bundle branches lower and continue to the apex of the heart. They branch to where there are Purkinje fibers going up the sides of the heart. These are the fibers that cause the muscles to contract.

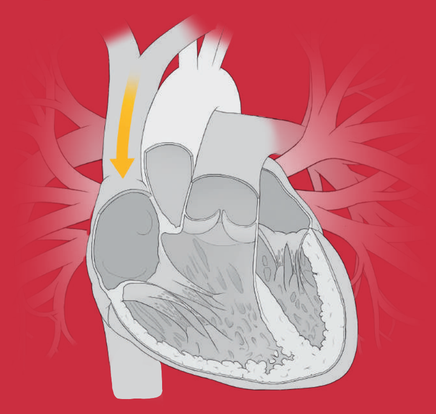


- Three groups of cells control the contraction of the heart: the sinoatrial node, the atrioventricular node, and the Purkinje fibers.
  - The SA node is the pacemaker. It is located in the right atrium and pulses roughly 80 times a minute.



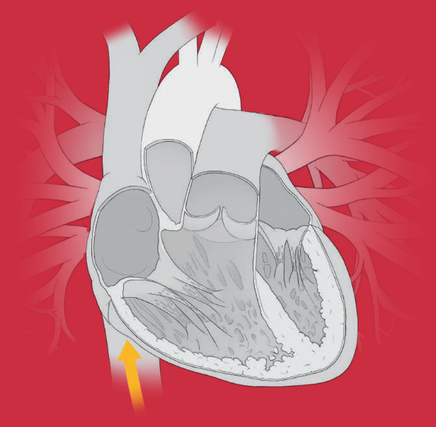
Definitions

Superior vena cava



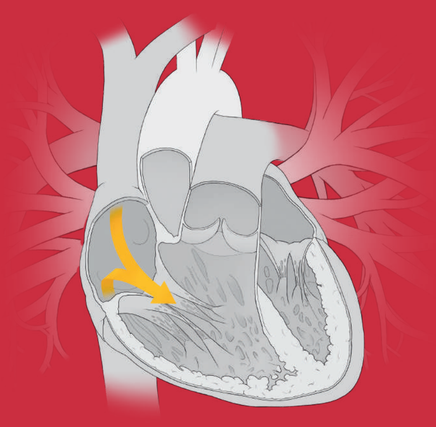
This is a large vein that carries deoxygenated blood and deposits it into the right atrium. This vein carried the blood from the head, neck, arms, and chest.

Inferior vena cava



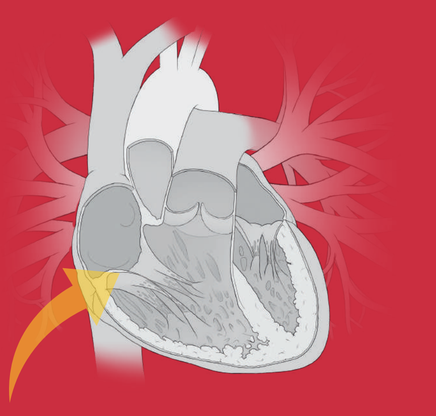
This comes from the lower part of the body (such as the legs and torso) and deposits deoxygenated blood into the right atrium.

Right atrium



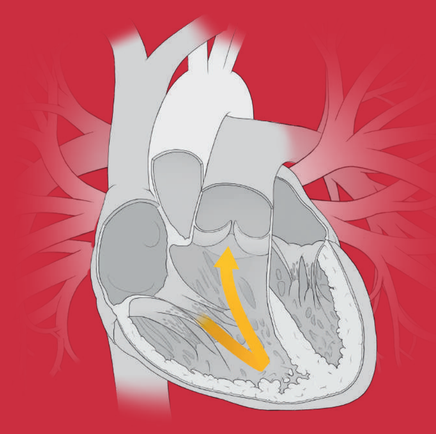
This holds the deoxygenated blood and is the first of four chambers that the blood passes through. This chamber has thin walls because it does not need a lot of force in order to pass the blood on to the next chamber. This chamber also holds the sinus node.

Tricuspid valve



This separates the right atrium from the right ventricle. One of the main functions of this valve is to prevent blood from going backward into the right atrium. There are papillary muscles that control when the valve opens and closes.

Right ventricle



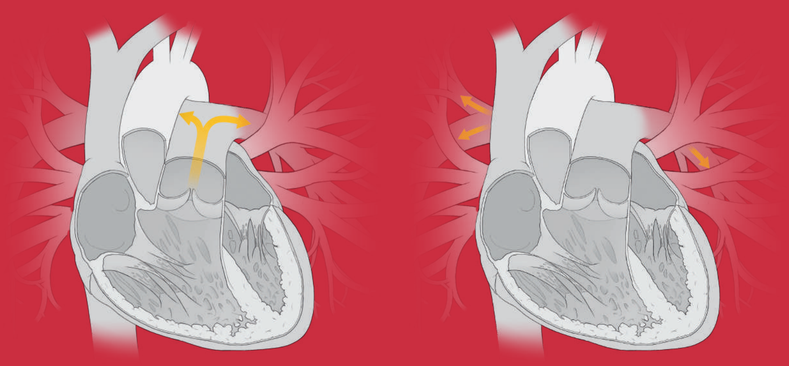
This is the chamber underneath the right atrium. It sends the deoxygenated blood into the pulmonary circuit to collect oxygen from the lungs.

Definitions

Pulmonary valve

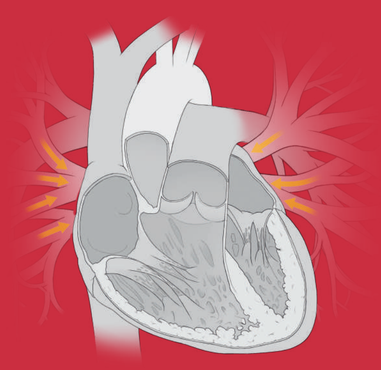
This prevents the blood from going back into the right ventricle after it is pushed into the pulmonary artery.

Pulmonary artery



This takes the deoxygenated blood to the lungs where the oxygen is replenished through external respiration.

Pulmonary veins

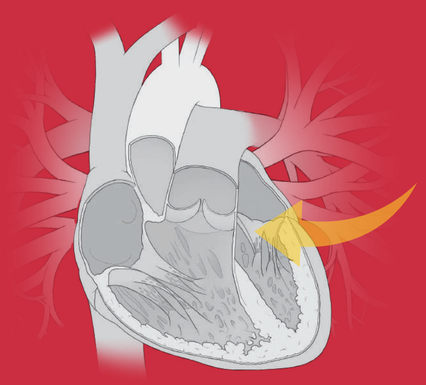


These take the oxygenated blood from the lungs to the left atrium of the heart.

Left atrium

This receives the blood from the pulmonary veins and holds it until the mitral valve opens.

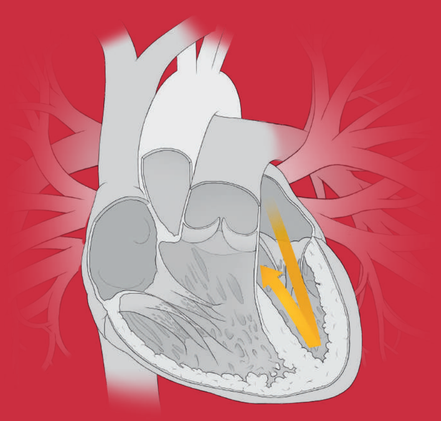
Mitral valve (Bicuspid valve)



This is located between the left atrium and the left ventricle. It functions as a trap door between the two chambers.

Definitions

Left ventricle

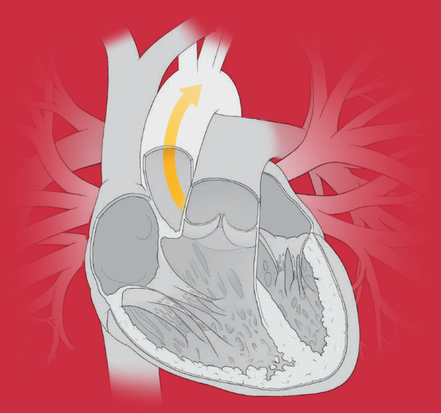


This is the most muscular part of the heart, responsible for ejecting blood into systemic circulation. It generates enough power and pressure for the blood to travel to the capillaries for internal respiration. It is a complete powerhouse.

Aortic valve

This is located between the left ventricle and the aorta. This valve is extremely durable because it has to withstand the pressure of the blood that has been ejected into the aorta and prevent regurgitation of blood back into the left ventricle.

Aorta

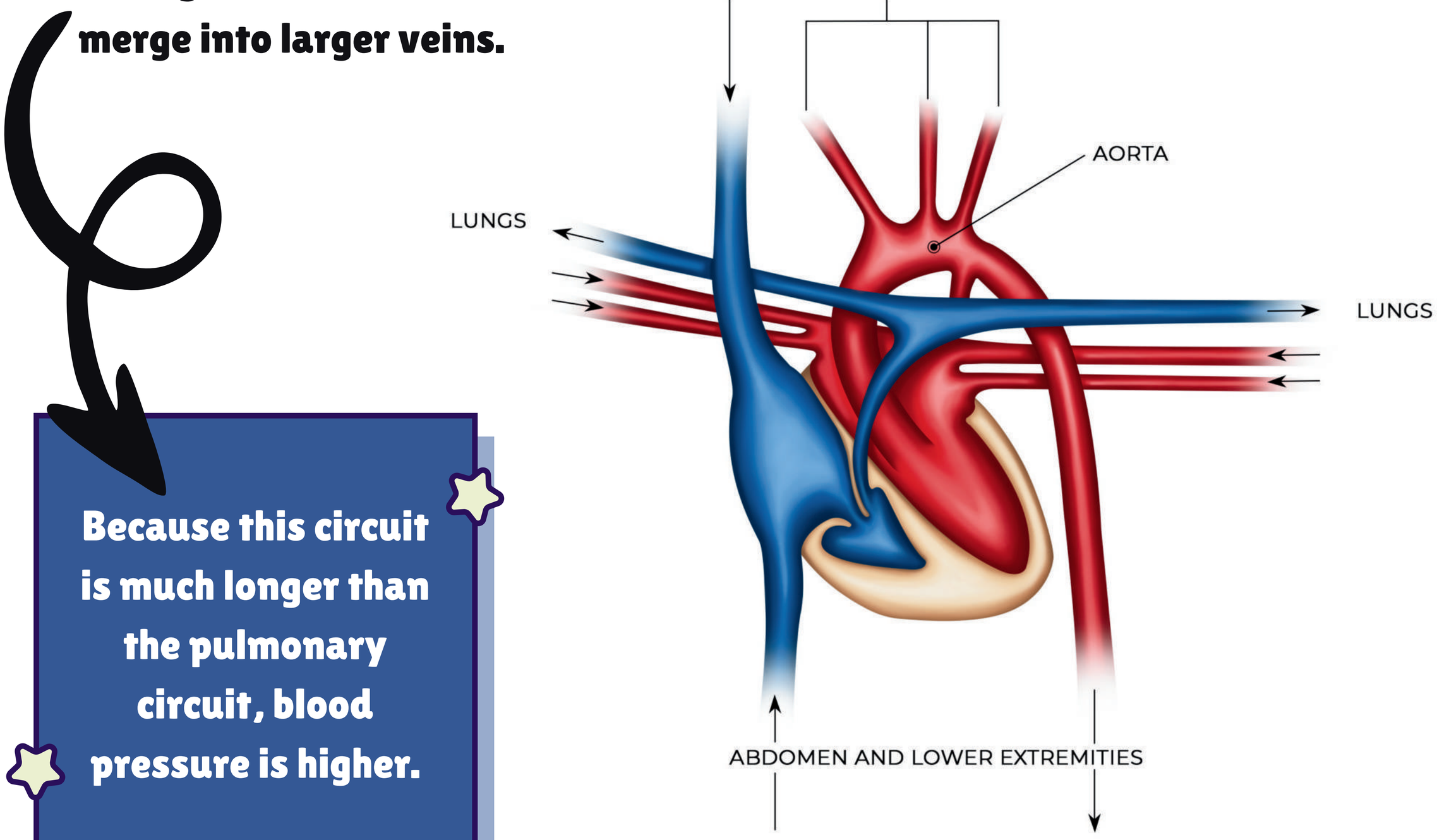


This is the body's largest artery. Its job is to transport oxygenated blood that is ejected from the left ventricle and distribute this blood into systemic circulation.

Additional Personal Notes:

Systemic Circulation

- The systemic circuit carries blood that is ejected from the muscular left ventricle of the heart to the more distal arteries that eventually branch into arterioles, and then the capillary beds within the tissues of the body.
- Oxygen and nutrients enter the tissues, and carbon dioxide and other wastes enter the blood.
- When oxygen levels are low, vessels dilate to promote blood flow to tissues that need it.
- Deoxygenated blood leaves the capillary beds through venules, which merge into larger veins.



Because this circuit is much longer than the pulmonary circuit, blood pressure is higher.

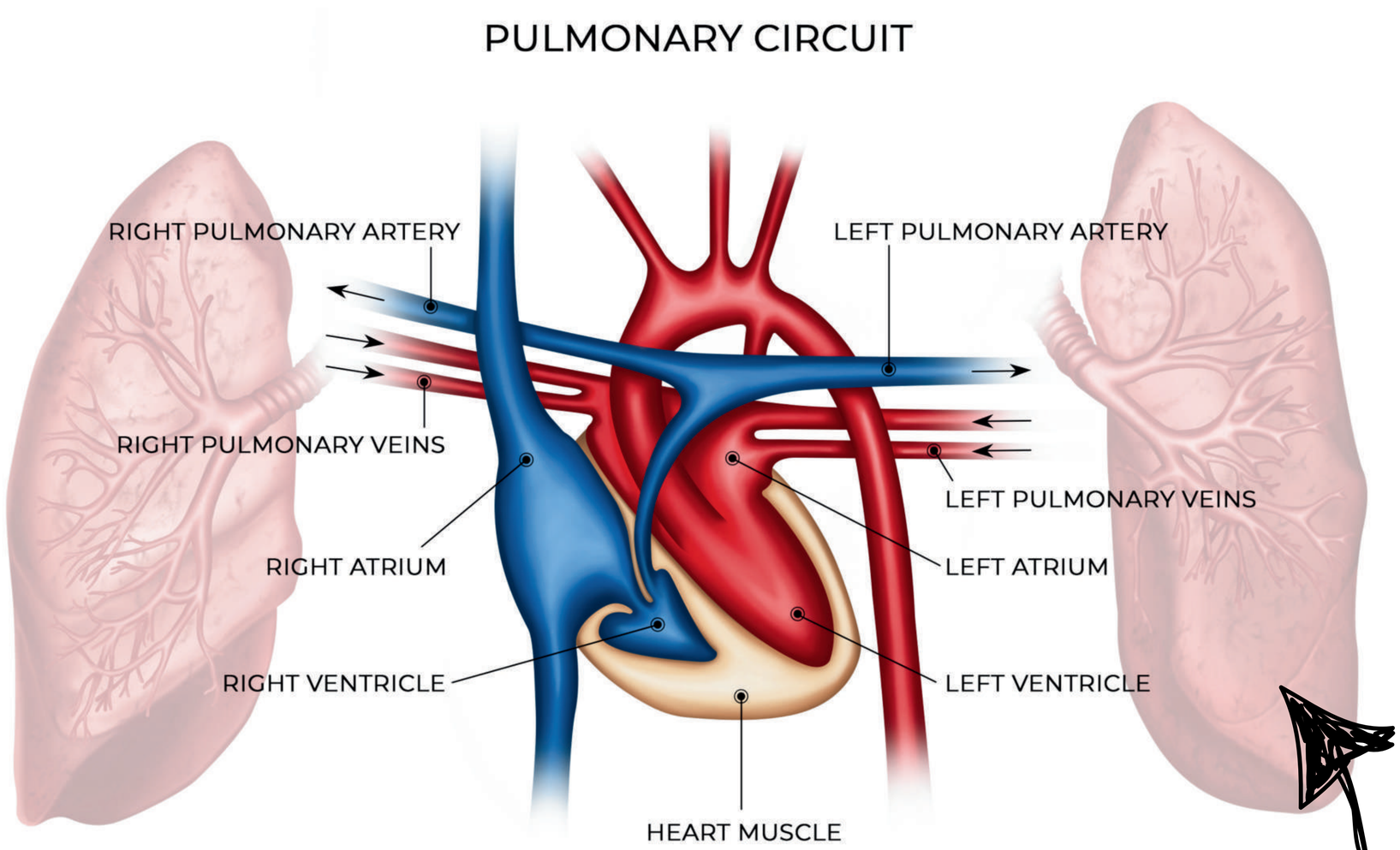
Pulmonary Circulation

- **The pulmonary circuit is the part of the circulatory system that carries blood from the heart to the lungs and back to the heart.**

- **When deoxygenated blood is expelled from the right ventricle, it moves through the pulmonary trunk, which splits into the right and left pulmonary arteries.**
- **Each branch extends into the lungs, eventually giving rise to arterioles and then the capillaries where gas exchange occurs by diffusion.**
- **Oxygenated blood leaves the capillaries through venules which fuse into veins, finally merging into four pulmonary veins that return blood to the left atrium.**

NOTE TO SELF:
This is one of the few times that veins carry oxygenated blood

NOTE TO SELF:
This is the one and only time that arteries carry deoxygenated blood



Low blood oxygen in the pulmonary circuit triggers vasoconstriction, which redirects blood to better-ventilated parts of the lung.

Electrical Conduction System

Each heartbeat is seen as three major waves or complexes on an ECG.

First, the SA node generates a spontaneous electrical impulse that stimulates both right and left atrial contraction through the interatrial pathway, corresponding to the P wave on the ECG.

Depolarization is when the heart muscle contracts, while repolarization is when the muscle relaxes

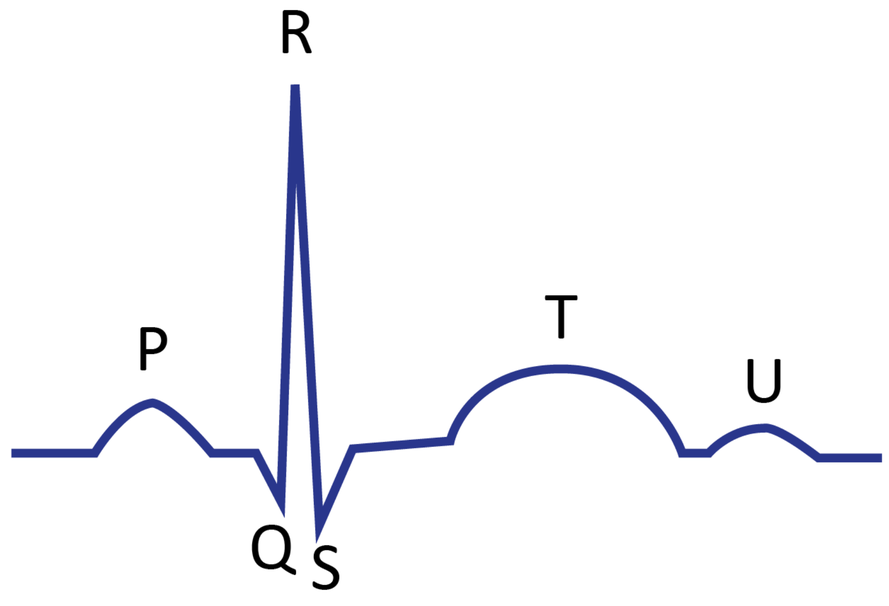
Next, the electrical impulse reaches the AV node, slowing down the depolarization throughout the heart and allowing for complete ventricular repolarization.

The electrical impulse travels from the AV node through the bundle of His and the bundle branches, taking the impulse to both ventricles.

The electrical impulse then travels to the Purkinje fibers, which stimulates the ventricles to depolarize and contract, corresponding to the QRS complex.

Next follows the ST segment and T wave, corresponding to repolarization of the ventricle.

A small U wave may follow the T wave and represents further repolarization of the ventricle.



Contractions of the Heart

- The rate of the heart is determined by the fastest group of cells. The autonomic nervous system and the endocrine system are the only things that can modify the rate of the heart.
- The sympathetic nervous system speeds the process up, while the parasympathetic nervous system slows it down.
- The cells in the SA node depolarize and reach the threshold for an action potential.
- After the threshold is reached, the signal moves through the cells of the atria via gap junctions.

This wave of depolarization causes the atria to contract.

- Eventually, the signal spreads to the AV node and travels down the interventricular septum via those left and right bundles.
- Then the signal travels up the walls of the ventricles via the Purkinje fibers.

The signal sent from the SA node is delayed through the AV because the chambers of the heart have to contract at different times.