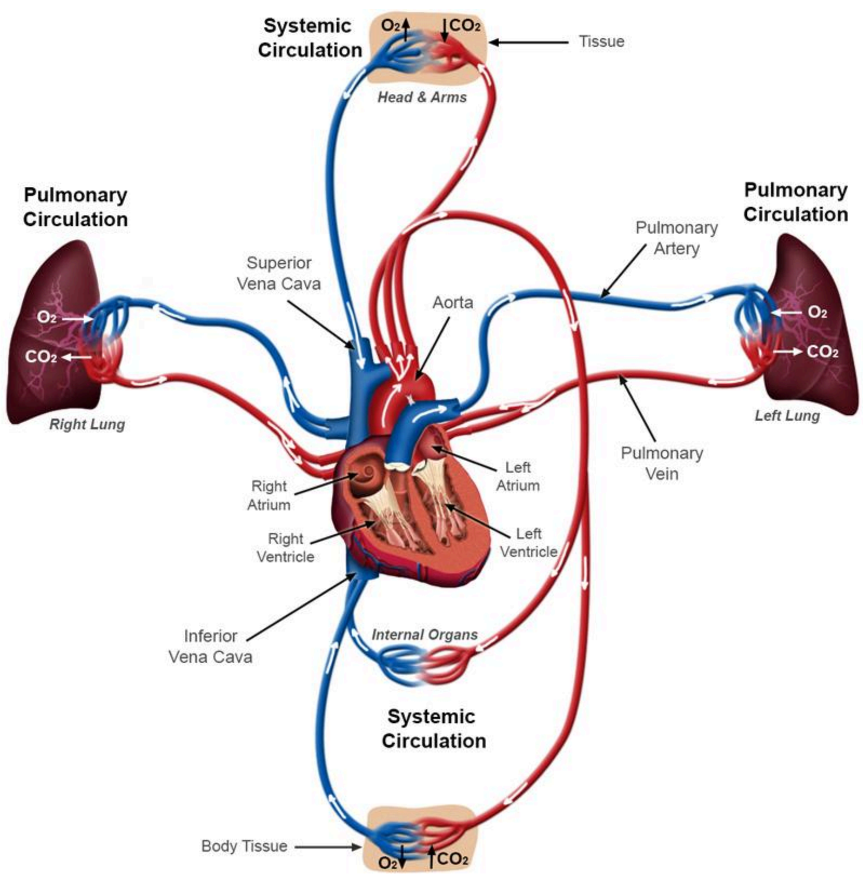
1.1.1

Chambers and Circulation

It is never wise to single out one organ or system as the "most" important in the body, but if we did, the heart might be at the top of the list. It is such an amazing muscle! It begins beating at around the 3^{rd} or 4^{th} week of development and continues, night and day, never stopping, until we die. A conservative estimate would be that your heart will beat about 3 billion times in your lifetime! No other muscle in your body has that kind of stamina. Few words conjure up so many images in our mind as the word ‘heart’. Think of these phrases: "He has the heart of a lion", "She broke my heart", "He is the heart of the team", "That is the heart of the problem", and "With all your heart, might, mind, and strength". The word heart appears 1473 times in the LDS standard works. What is it about this organ that makes it so special? It is our goal in this unit to answer this question.

Although many things come to mind when we hear the word heart, when it comes to the physiology of the body one word succinctly describes the heart. That word is "pump". It is at the center of the circulatory system and functions to pump the blood to the rest of the body. In doing this it is responsible for ensuring that oxygen, nutrients and other important substances are delivered to the tissues and that wastes are removed.



Systemic and Pulmonary Circulation.
Image created by BYU-Idaho student Tabitha Daughtery Spring 2014

In reality, the heart is composed of two pumps. The right side of the heart receives oxygen-poor blood, known as deoxygenated blood, from the systemic circulation and pumps the blood to the lungs where oxygen and carbon dioxide are exchanged. The left side receives oxygen-rich, known as oxygenated blood, from the lungs and pumps it to the rest of the body. These two circulations are referred to as the **pulmonary circulation** (to the lungs) and the **systemic circulation** (to the rest of the body), respectively.

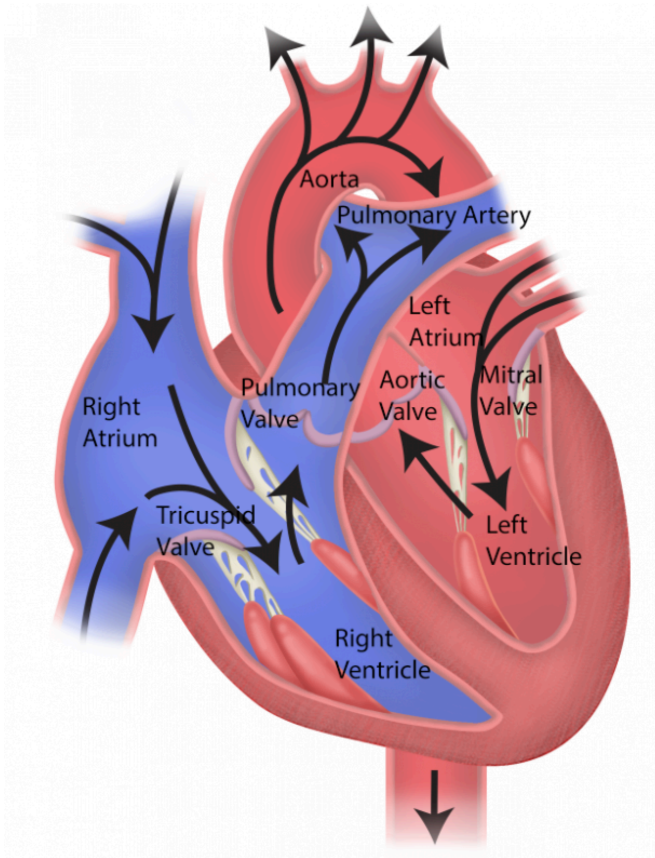


Image created by Becky T. BYU-Idaho, S20

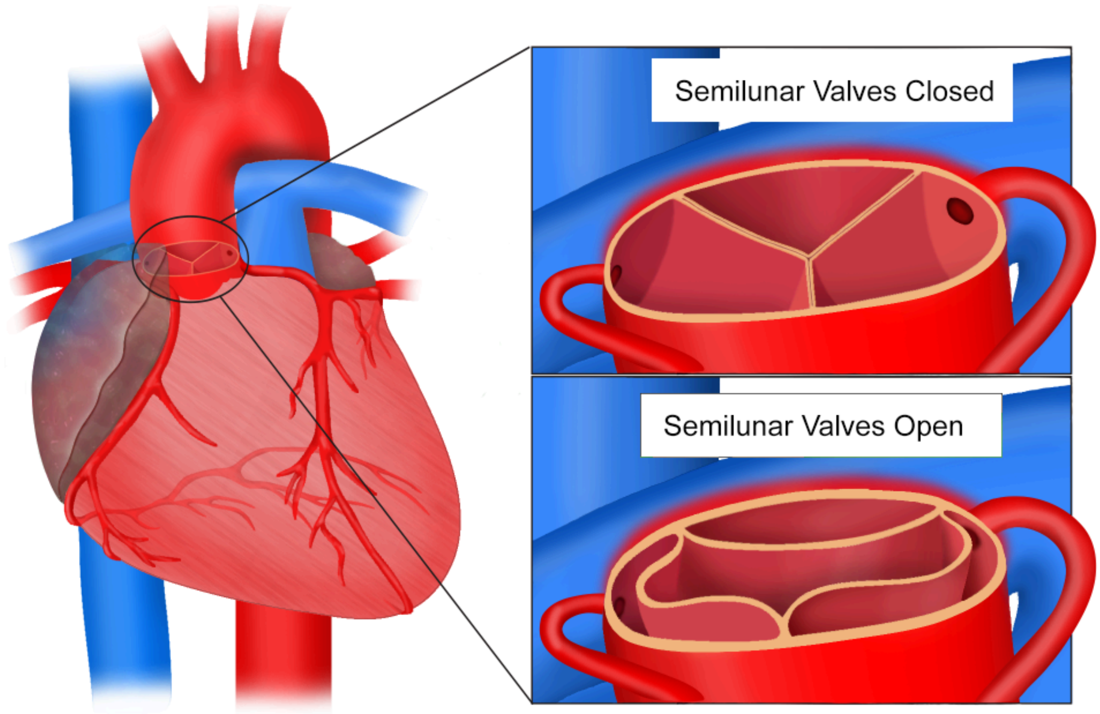


Image by BYU-I Student Becky T. – S18

Heart Chambers: Mammalian hearts have four chambers, two upper chambers called **atria** and two lower chambers called **ventricles.**

The right side of the heart is separated from the left side of the heart by a thick wall known as the **septum.** As previously stated, the right atrium receives oxygen-poor blood from the systemic circulation and the left atrium receives oxygen-rich blood from the pulmonary circulation. Blood from the systemic circulation enters and passes through the right atrium and into the right ventricle, which then pumps the blood to the lungs. The right side of the heart is a **low-pressure** system (only needs to pump to the lungs that are next to the heart) and seldom produces pressures above 40 mmHg. Blood from the pulmonary circulation enters and passes through the left atrium and into the left ventricle, which pumps the blood to the systemic circulation. The left side of the heart is a **high-pressure** system (needs to pump blood to the entire body) and routinely produces pressures of around 120 mmHg and during times of physical stress can generate pressures over 200 mmHg. The left ventricle pumps blood to the systemic circulation starting at the aorta, a major artery in the body. Branching immediately from the aorta are two smaller arteries called **coronary arteries (See image above).** These arteries supply the heart with oxygen-rich blood.

Heart Valves (See Images above): To ensure that the blood moves efficiently through the heart, two sets of one-way valves prevent the blood from flowing backward. The **atrioventricular (AV) valves** are located between the atria and the ventricles. Between the right atrium and right ventricle is the **right AV or tricuspid valve** and between the left atrium and left ventricle is the **left AV, the bicuspid or the mitral valve.** The names bi- and tricuspid are derived from the number of cusps or flaps that make up the valve. A closer look at these valves reveals that they are supported by small tendon-like attachments called **chordae tendineae,** which attach the edges of the valves to small nipple-like projections of muscle called **papillary muscles.** This arrangement prevents the valves from pushing back into the atria when the ventricles contract. If a valve becomes compromised, a condition known as **prolapse** of the valve can occur.

The **semilunar valves** are located between the ventricles and the large arteries that receive blood from them. Between the right ventricle and the pulmonary trunk is the **pulmonary semilunar valve** or simply pulmonary valve and between the left ventricle and the aorta is the **aortic semilunar valve** or aortic valve. The structure of these valves is different from the AV valves. Each valve is composed of three pocket-like structures. When blood from the large arteries moves back toward the ventricles, these valves balloon out like small parachutes. Their three cusps come together preventing blood from moving backward. Due to the unique structure of these valves they do not require support from other structures to prevent them from prolapsing.

Clinical Note: Heart murmurs can be caused by improperly functioning heart valves. There are two basic types of problems that can occur with valves, either **stenosis** or **regurgitation.** A valve that has become stiff causes valvular stenosis, and the stiffness then interferes with the opening of the valve. When blood is pumped through a stiff, partially opened valve, the blood flow becomes very turbulent and causes a vibration (turbulence) in the vessel, which resonates as a sound. This sound is called a **murmur** and can be detected with a stethoscope. (The art of listening to body sounds via a stethoscope is called auscultation.) Conversely, the valve may not close properly and blood will backflow through the valve. This is referred to as valvular regurgitation. Again, the backflow of blood creates turbulent flow, generating a detectable murmur. Valvular disease increases the workload on the heart and if severe and not treated can lead to heart failure. Historically, it was a fine art to detect the type of valvular abnormality based on the sound and timing of the murmur. Modern technology, such as cardiac ultrasonography, has made it much easier to determine the nature of the valvular disease and determine the proper course of treatment.

A murmur is simply the sound of turbulent blood flow. A diseased valve can certainly cause blood flowing passed it to be turbulent and this noise can be heard.

However, being young or thin does not mean that one has a greater risk of a dangerous heart murmur. Sometimes a young, very strong heart can cause blood flow to move with higher velocity and be a bit more turbulent (even with normal valves). Also, a thin person can have a heart that is much easier to hear and even slightly turbulent blood flow might make a noise that is picked up by the stethoscope. When this “normal” turbulent blood flow is heard in a young, and otherwise healthy individual, an experienced physician may dismiss it as normal variation and it may be called a “benign murmur”.