THE HEART

Structure & Function

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BIOTECH ENGINEERING, 2015

Function of the Heart:

The heart is muscular organ that sits centrally in the thorax region of the body, but is skewed and twisted to the left. The left side of the heart is also stronger than the right side, because it is responsible for pumping blood throughout the body.

The heart functions as the body's circulatory pump. The heart is responsible for pumping deoxygenated blood through the veins and delivering it to the lungs where the red blood cells are able to get rid of waste (CO_2) and pick up oxygen (O_2). Oxygenated blood is then pumped back into the heart where it is transported through various arteries throughout the body; providing oxygen and nutrients to bodily tissues.

Circulation:

The heart consists of four chambers: the right atrium and right ventricle (which together form the right pump), and the left atrium and left venntricle (the left pump).

Deoxygenated blood (blue) from the lower body flows through the inferior vena cava into right atrium. Deoxygenated blood from the upper body flows through the superior vena cava into the right atrium. The blood then flows through the tricuspid valve into the right ventricle. As the heart contracts, blood flows through the pulmonic valve into the pulmonary artery which branches off into the right and left lungs. After becoming oxygenized in the lungs, the blood (red) flows through the right and left pulmonary veins into the left atrium. Oxygenated blood flows through the mitral valve into the left ventricle where it is then pumped past the aortic valve into the aortic arch. Oxygenated blood flows through the upper body via the three aortic branches. Oxygenated blood flows through the lower body via the decending aorta.

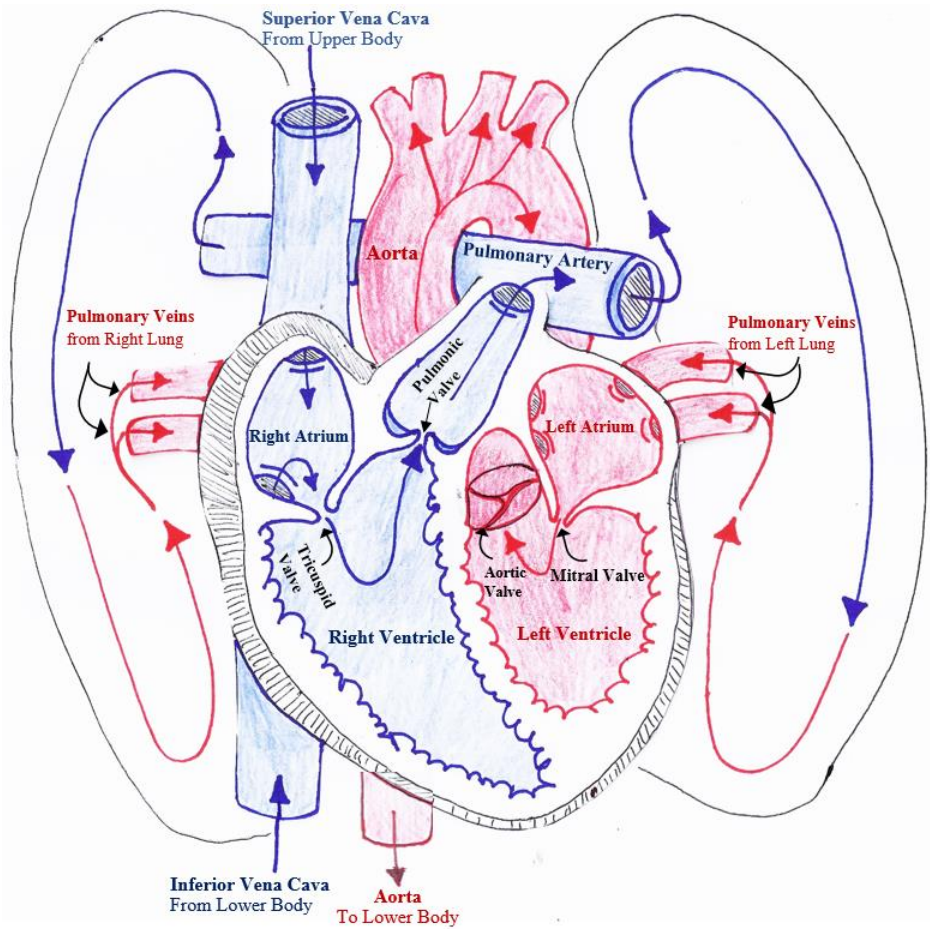


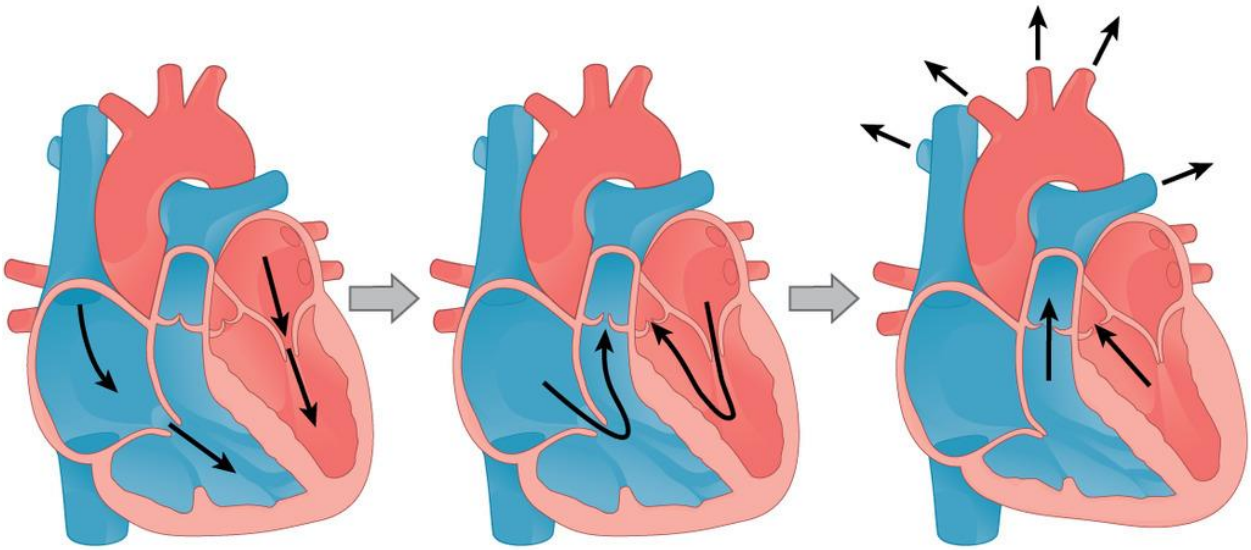
Diagram of the heart with its four chambers, and major veins (red) and arteries (blue) labeled. Red and Blue arrows indicate blood flow.

Heart pumping blood animation: https://commons.wikimedia.org/wiki/File:Latidos.gif#/media/File:Latidos.gif

Cardiac Cycle:

The heart combines two separate pumps within a single organ: one for deoxygenated blood (right), and the other for oxygenated blood (left). Every heartbeat involves the coordinated contraction (systole) and relaxation (diastole) of the heart's four chambers.

These muscular pulses transfer blood from the atria into the lower two ventricles via a system of valves, which inforce forward flow, and from there pump it from the heart through the aorta and pulmonary artery. Known as the cardiac cycle, this process involves five key stages.



(a) Cardiac diastole: all chambers are relaxed, and blood flows into the heart.

(b) Atrial systole, ventricular diastole: atria contract, pushing blood into the ventricles.

(c) Atrial diastole, ventricular systole: after the atria relax, the ventricles contract, pushing blood out of the heart.

Stage 1 Cardiac Diastole: The ventricles are relaxed. High pressure in the atria opens the mitral and tricuspid valves. Blood that has been building up in the atria rapidly flows into the ventricles.

Stage 2 Atrial Systole: The right and left atria contract simultaneously, forcing any remaining blood into the ventricles.

Stage 3 Isovolumic Contraction: The first stage of systole. Ventricles begin to contract; increasing the pressure on the blood within the ventricles and closing the mitral and tricuspid valves. Pressure is not yet great enough to force open the aortic and pulmonary valves.

Stage 4 Ejection: When venticular contraction causes the pressure of the blood within the ventricles to exeed the pressure of the blood within the aorta and pulmonary arteries, the aortic and pulmonary valves are forced open and blood is ejected powerfully from the ventricles.

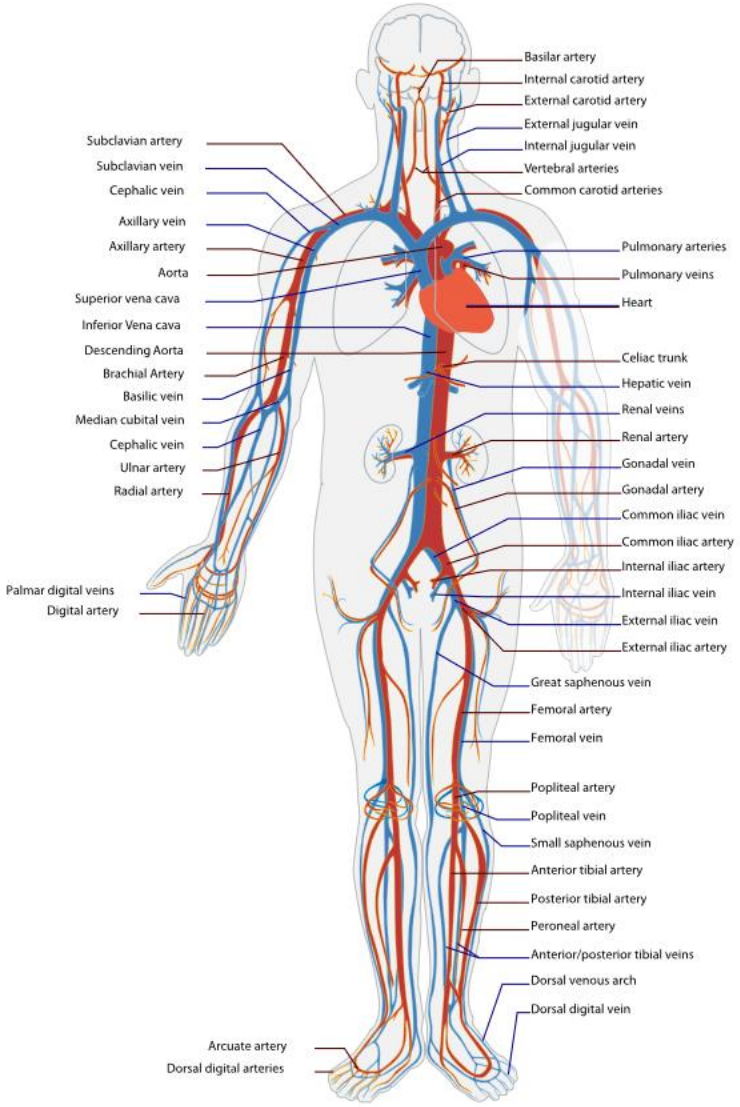
Stage 5 Isolvolumic Relaxation: Ventricular pressure decreases and the pulmonary and aortic valves close. However, pressure in the ventricles is still too high to allow the mitral and tricuspid valves to open.

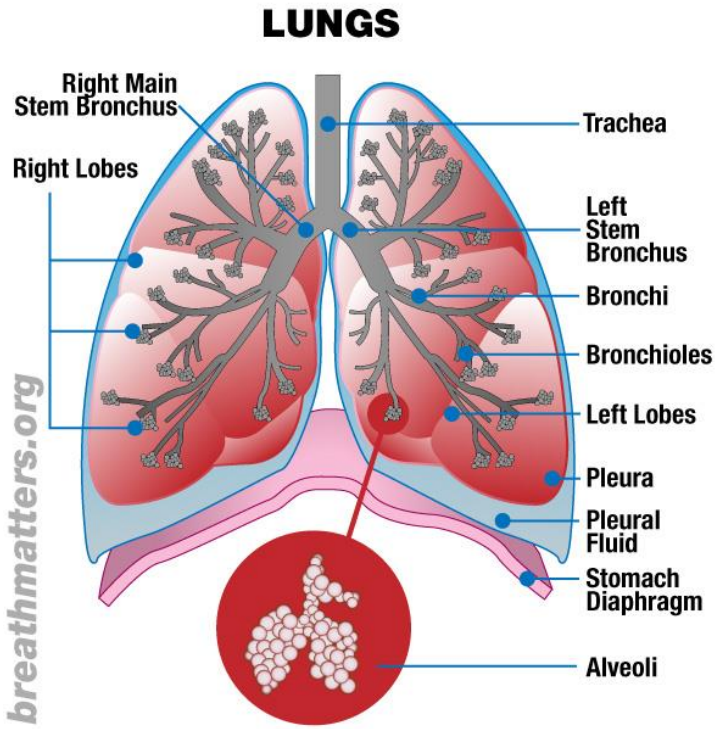
Gas Exchange:

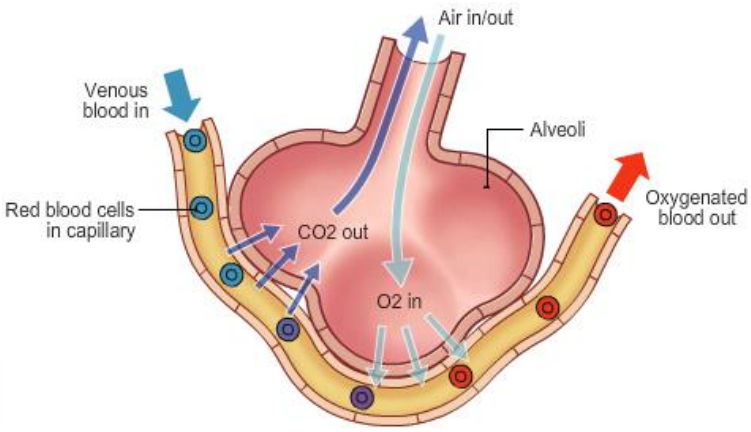
Cells need a continual supply of oxygen that they combine with glucose to produce energy. Carbon dioxide is continually generated as a waste product of this process and is exchanged for oxygen in the lungs.

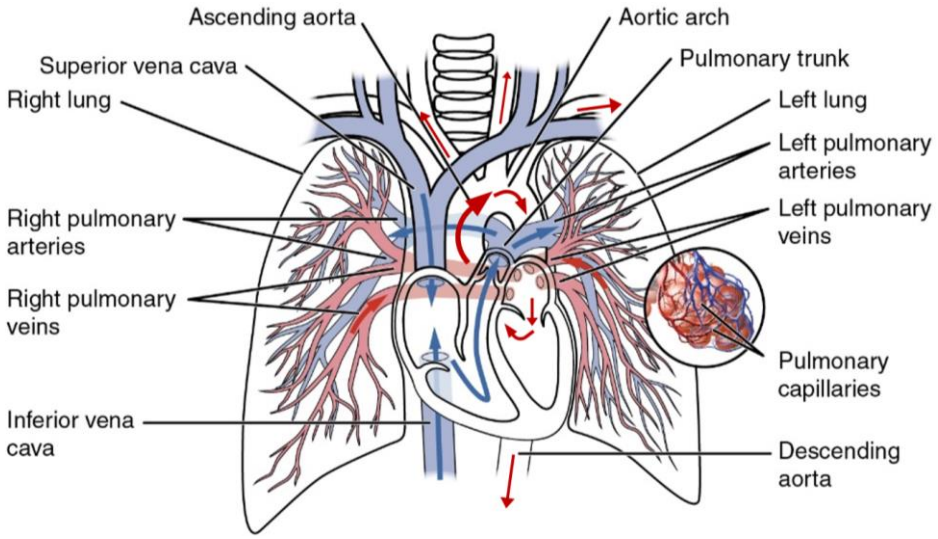
Hemoglobin is a protein found in red blood cells. Hemoglobin binds to oxygen, forming oxyhemoglobin, and holds it within the red blood cell (oxygenating the blood). Through a process known as diffuson; oxygen molecules migrate to the area where oxygen is scarce, while carbon dioxide molecules migrate to the area where carbon dioxide is scarce. When oxygen levels are high, for example in the lungs, oxygen readily binds to hemoglobin. When oxygen levels are low, such as in a working muscle, the oxygen molecules dettach from the hemoglobin and move freely into the working cells. Carbon dioxide then diffuses out of the working cells and into the red blood cells where it is picked up by hemoglobin or dissolved in the plasma.

The respiratory tract acts as a transport system, transporting air to millions of tiny air sacs (alveoli) in the lungs. When deoxygenated blood is pumped into the lungs, it travels through tiny capilaries surrounding the alveoli. As the blood passes over the alveoli; the oxygen in the alveoli diffuses into the red blood cells, and the carbon dioxide from the red blood cells diffuses into the alveoli where it is taken up through the brochioles and exhaled normally.





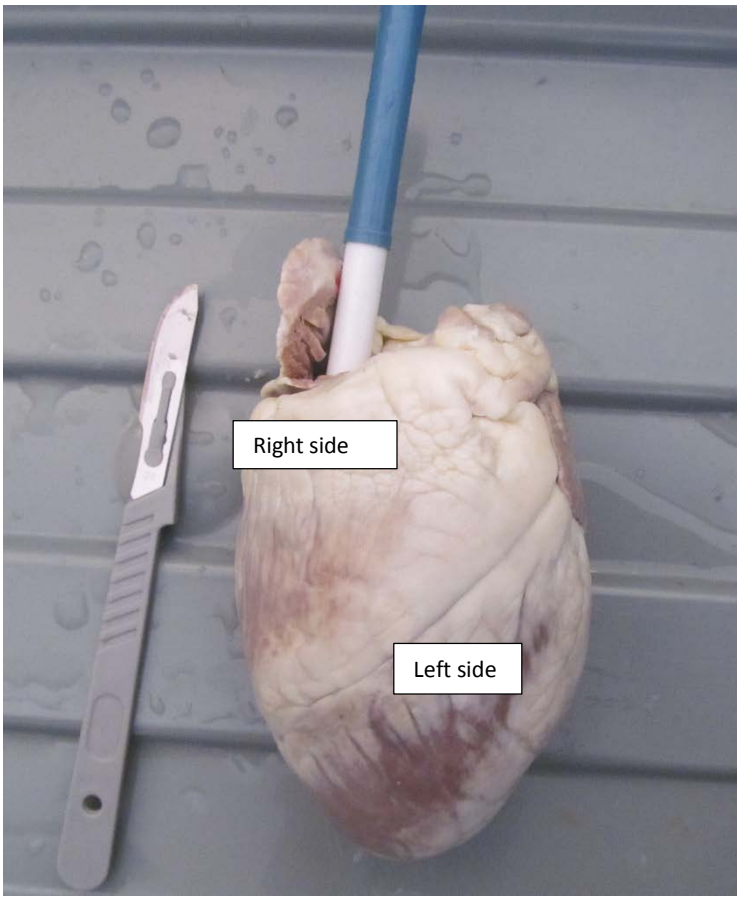



Ascending aorta
Aortic arch
Superior vena cava
Pulmonary trunk
Right lung
Left lung
Left pulmonary arteries
Right pulmonary arteries
Left pulmonary veins
Right pulmonary veins
Pulmonary capillaries
Inferior vena cava
Descending aorta

APPENDIX: LAB PHOTOS

Gray Marker: aorta?

Front side of the heart

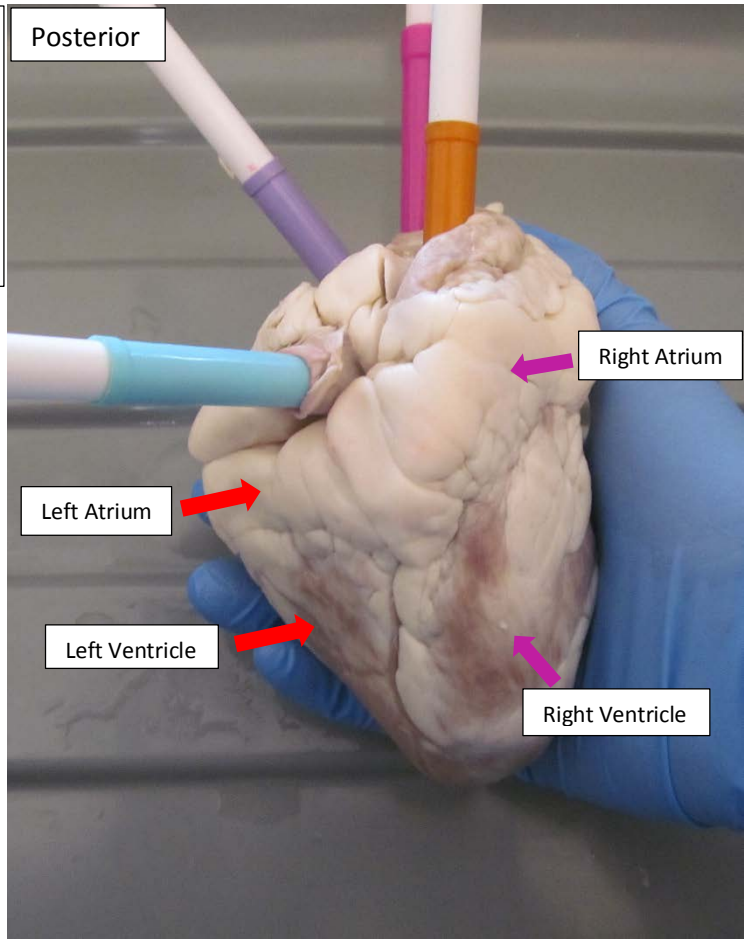


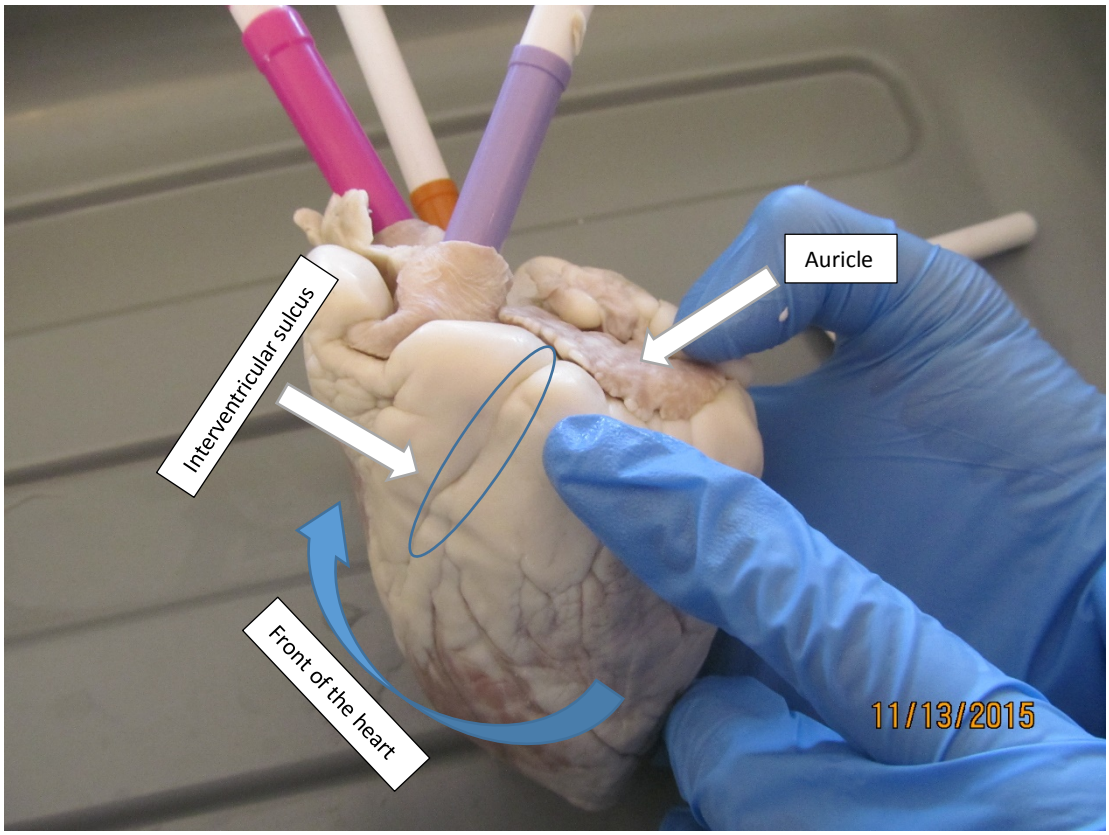
Light Blue Marker: pulmonary vein

Gold Marker: superior vena cava

Pink Marker: brachiocephalic (branching from aorta)

Purple Marker: pulmonary artery




Auricle
Interventricular sulcus
Front of the heart
11/13/2015

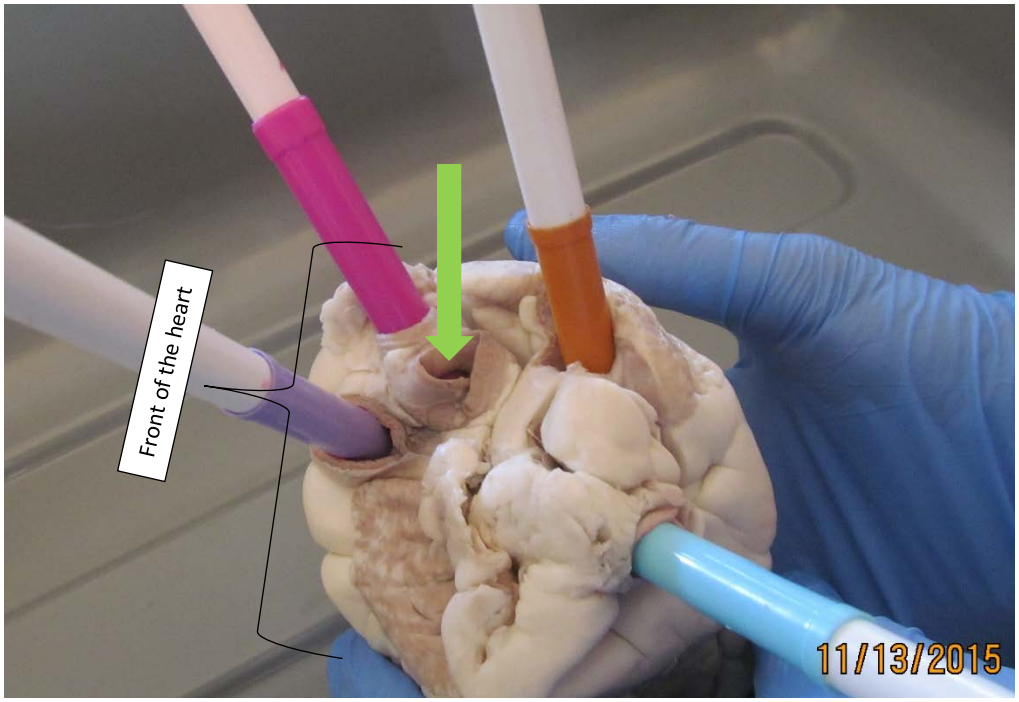
Light Blue Marker: pulmonary vein

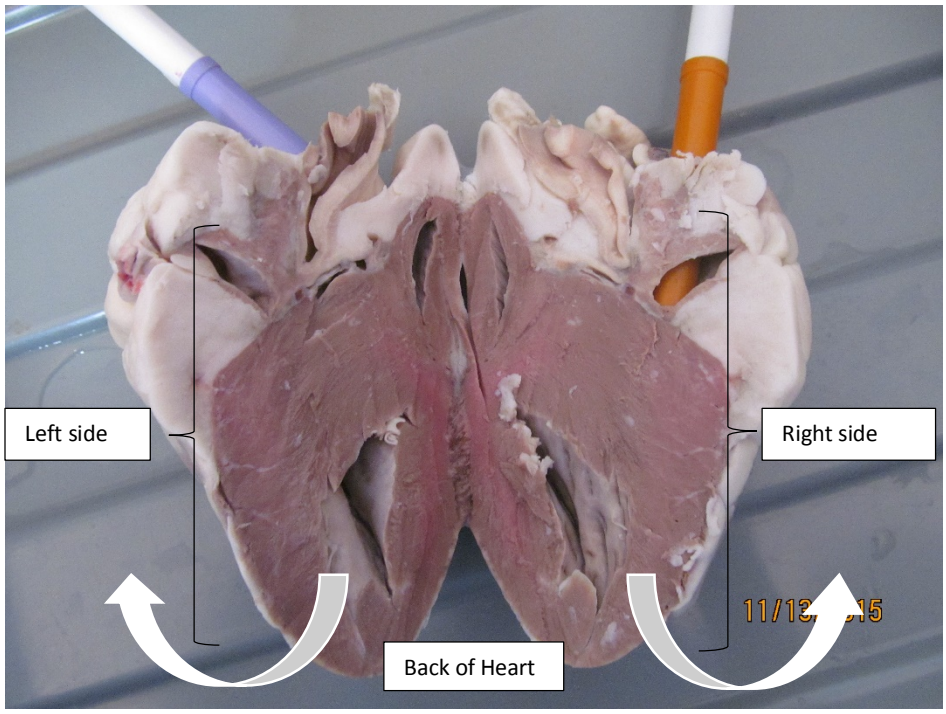
Gold Marker: superior vena cava

Pink Marker: brachiocephalic (branching from aorta)

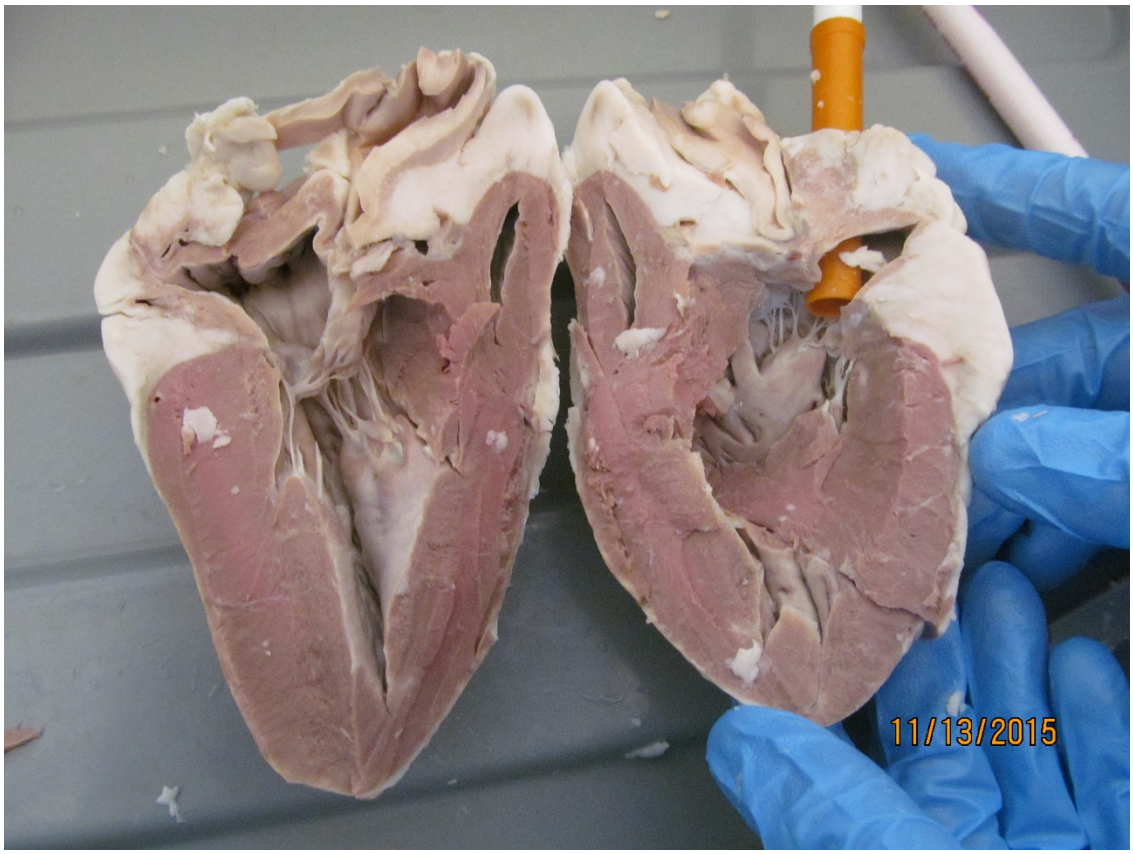
Purple Marker: pulmonary artery

Green Arrow: aorta

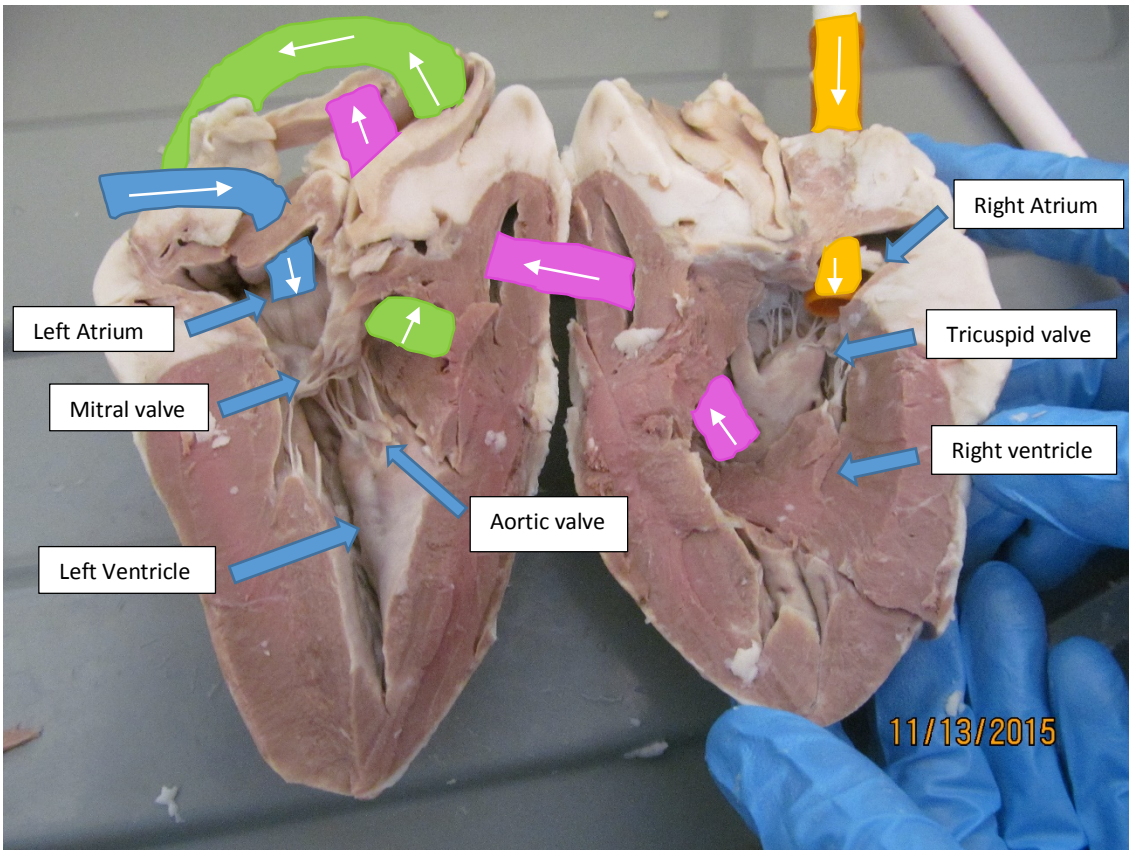




We cut right down the middle of the **back** to expose the right and left sides in separate halves.



Same picture angle as above. With tissue cut away to further expose the chambers.



Light Blue Marker: pulmonary vein

Gold Marker: superior vena cava

Green Marker: Aorta

Purple Marker: pulmonary artery

The Heart – Structure and Function

A lab report by Isabel Kosic

In our last class, we dissected sheep hearts to better understand the structure and function of the biological heart.

Before making any incisions in our sheep heart, we first identified where the veins, arteries, atriums, and ventricles were by just looking at the outside of the sheep heart.

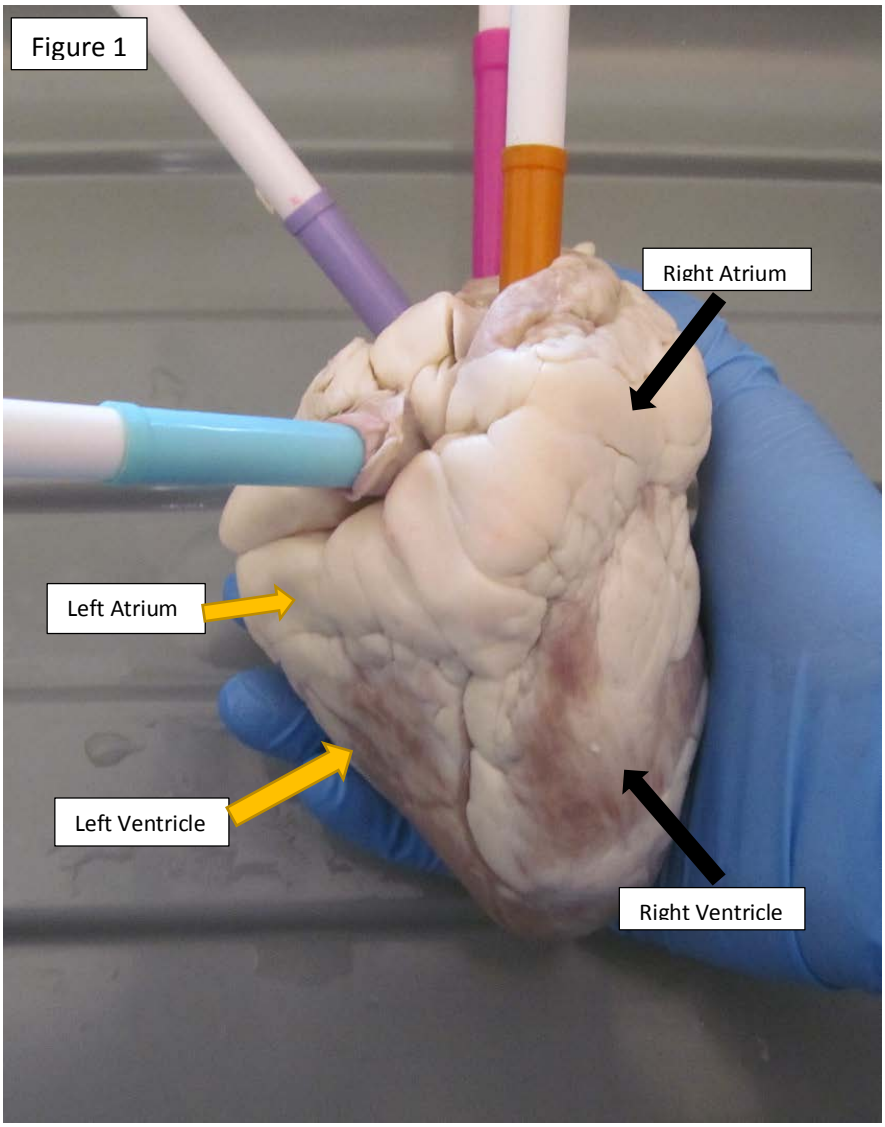


Figure 1: This is a posterior view of the sheep heart. The right and left atriums and ventricles are labeled in the picture. The colored markers in the picture correspond to different veins and arteries. They are connected as follows:

Light blue marker: Pulmonary Vein

Gold marker: Superior Vena Cava

Pink marker: Brachiocephalic (branching from aorta)

Purple marker: Pulmonary Artery

We then cut down the middle of the back of the heart to see the right and left chambers, each on their own half. We removed small amounts of muscle and tissue in order to view the chambers more clearly.

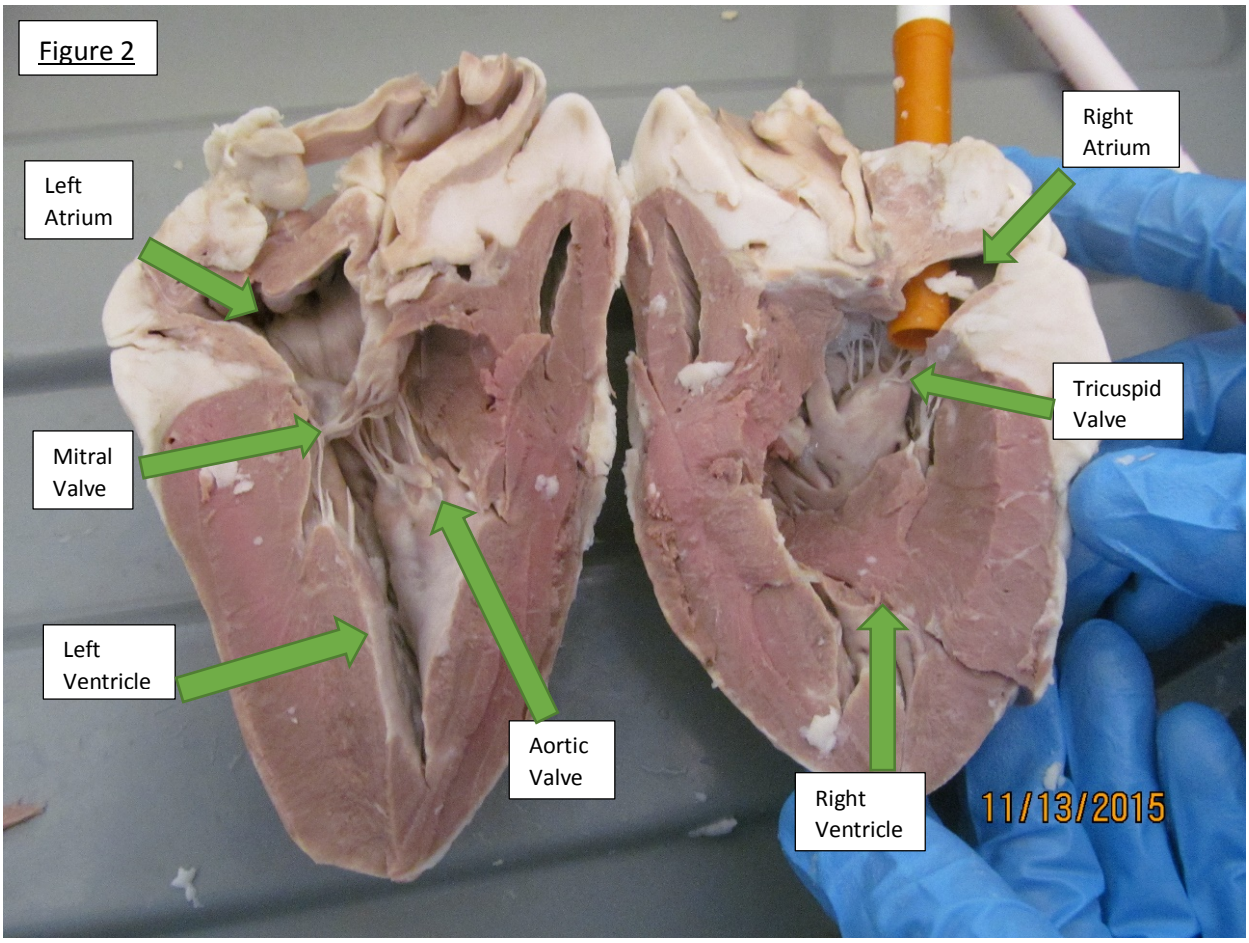


Figure 2: The chambers of the heart are visible in this picture, and most of the valves are visible as well (only the pulmonary valve is not visible, due to the angle). The gold marker shows where the superior vena cava is in the heart.

Here is an explanation on how the heart works, and how the blood flows through the heart and body:

Deoxygenated blood from the legs and torso comes to the heart through the inferior vena cava, while deoxygenated blood from the arms, chest, and head comes to the heart through the superior vena cava. The deoxygenated blood flows into the right atrium, and is then pumped into the right ventricle through the tricuspid valve. The blood is then pumped through the pulmonary valve into the pulmonary arteries, where it is sent to the lungs. When the blood arrives in the lungs, the blood cells trade carbon dioxide (CO_2) for oxygen (O_2). The oxygenated blood is then pumped back to the heart through the pulmonary veins. The blood arrives in the left atrium, and is pumped through the mitral (bicuspid) valve into the left ventricle. The blood is then pumped out of the heart through the aortic valve and into the aorta, which branches out and carries the oxygenated blood throughout the body. Once the blood delivers the oxygen to wherever it is needed, the now deoxygenated blood returns back to the heart, and the cycle starts over again.

The last page of this lab report is a hand-sketched diagram of the heart. Arrows show the direction the blood is flowing in. Main parts are labeled numerically. Here are the labels that correspond with each number marked on the diagram:

1. Superior Vena Cava
2. Inferior Vena Cava
3. Right Atrium
4. Right Ventricle
5. Tricuspid Valve
6. Pulmonary Valve
7. Pulmonary Artery
8. Pulmonary Veins
9. Left Atrium
10. Left Ventricle
11. Mitral (bicuspid) Valve
12. Aortic Valve
13. Aorta

Kai McAlister

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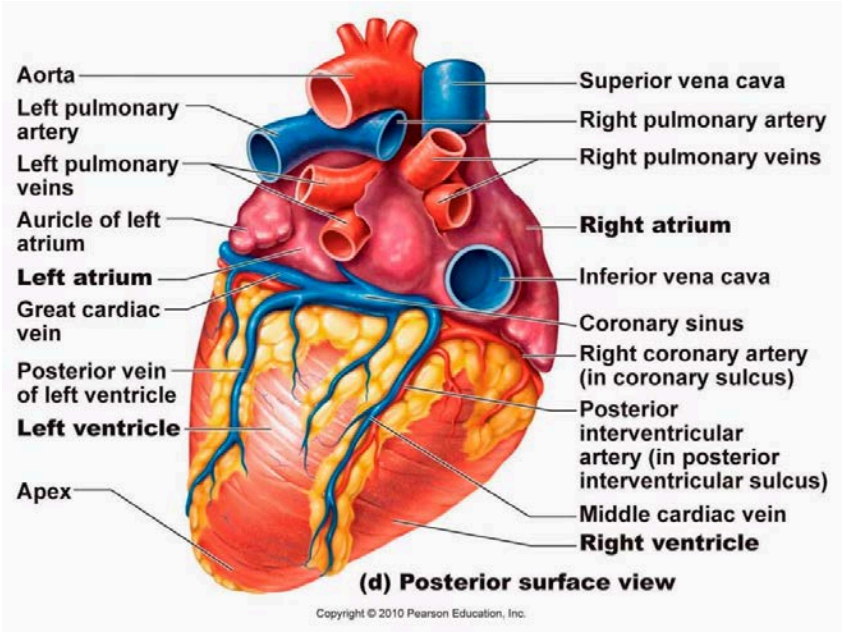
12-01-15

Heart Dissection Lab Write-Up



Perhaps the most archetypal organ in the human body, the heart is indubitably the most popular muscle in the human body. The heart is incessantly depicted as the conduit through which love is felt with its simple and elegant shape that has become a ubiquitously recognized icon. In actuality, the actual shape of the heart – as seen above – does not look at all similar to the stereotypical heart depiction permeating the internet. Today, we will discuss this vital organ and explore how exactly it works.

The rudimentary purpose of the heart is to concentrate and subsequently disseminate blood to all parts of the body. It is a strikingly complex organ that uses muscular contractions to manipulate the blood to the correct location. It has a plethora of various components that are used as vessels through which the blood is sent. We will deal with the Atria, Ventricles, Septum, and Valves.

The atria – plural for “atrium” – are two hollow chambers near the uppermost section of the heart. Individually, the atria are called the left atrium and right atrium, based solely on their position in the heart. The right atrium takes in unoxygenated blood from the veins that have returned from the body, while the left atrium collects oxygenated blood from the arteries that have returned from the lungs.

However, moving to the bottom section of the heart, we find the ventricles which receive blood from the atria. When the heart repeatedly contracts, the right ventricle quickly pushes blood into an artery that leads directly to the lungs; the blood will be oxygenated before it returns to the heart. The left ventricle pushes blood into the body’s blood vessels for circulation through the body. Since the left ventricle must be forceful enough to deliver adequate blood to your entire body, it is the largest and most powerful of the four heart chambers.

The septum is an extremely durable and thick muscular wall that bisects the heart. It separates the left atrium and ventricle from the right atrium and ventricle. Many life-threatening heart defects create holes in the septum, allowing unoxygenated and oxygenated blood to mix together, which ultimately impairs the heart's ability to function and can have fatal consequences if not speedily addressed. These septal defects are almost entirely endemic to infants though they can vary in size and severity. Small holes might never produce symptoms and often require no special treatment. However, large holes can eventually cause damage to the lungs and lead to permanent heart failure. While some of these defects can be corrected with medication, others require open heart surgery.

Finally, we have the valves. Valves separate the various parts of the heart from one another like a retracting wall. They permit blood into areas where it is needed, but prohibit it from entering areas it is not intended to be in. The mitral valve separates the left atrium and the left ventricle, while the tricuspid valve separates the right atrium and the right ventricle. The aortic valve lies between the left ventricle and the aorta, which leads to the body's network of blood vessels, and the pulmonary valve lies between the right ventricle and the pulmonary artery, which leads to the lungs. All of these

valves open and close in response to pressure changes inside the various parts of the heart.

Ben Martin
11-27-15

The heart is a muscular organ which pumps blood through the body using veins and arteries. Your heart is the size of your fist, although small, it is one of the most important muscles in your body. The heart pumps two kinds of blood, oxygenated blood, and deoxygenated blood. The oxygenated blood is pumped around the body to cells that need to replentish their oxygen. The deoxygenated blood takes the carbon dioxide from the cells and brings it to the lungs where the carbon dioxide is exhaled.[1]

The heart is controlled by your brain, but more specifically your heart is controlled by your automated nervous system (ANS)[2]. The ANS controls things that humans can don't normally think of doing such as breathing, digestion, heart rate, and other body functions. The heart is connected to many of nerves which, controlled by the ANS by electrical signals, cause the heart tissue cells to expand and contract in unison. This expanding and contracting is the heart beating which pumps the blood around the body[3].

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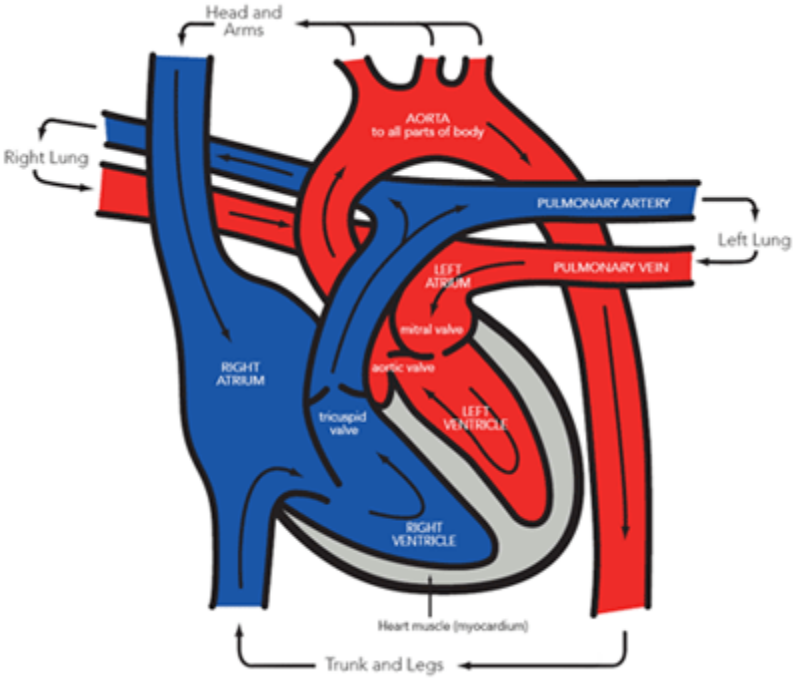
[1] "How the Heart Works", National Heart, Lung, and Blood Institute, http://www.nhlbi.nih.gov/health/health-topics/topics/chd/heartworks 11-27-15
[2] "Heart", Innerbody.com, http://www.innerbody.com/image/card01.html#full-description 11-27-15
[3] "Heart", Innerbody.com, http://www.innerbody.com/image/card01.html#full-description 11-27-15

Ben Martin
11-27-15



In the above diagram, the blood starts its journey around your body as deoxygenated (shown in blue) blood in right atrium. The blood enters the right atrium by the superior and inferior vena cava. Once in the right atrium, the blood is pushed through the tricuspid valve and into the right ventricle. After the blood settles in the right ventricle, the heart contracts, and shoots the blood through the pulmonary semilunar valves and into the pulmonary arteries. The pulmonary arteries lead to the lungs where the deoxygenated blood gives up the carbon dioxide and other waste products, and, in return, it takes oxygen back to the heart. After the blood has been oxygenated, the blood (now red) travels back to the heart through the pulmonary veins and into the left atrium. When the heart contracts, the blood is pushed through the bicuspid valve and into the left ventricle. After the left ventricle, the blood moves through the aortic semilunar valves and into the aorta. The aorta is the largest artery in the

body, and from the aorta the blood is split into smaller arteries which lead all over the body[4]. The heart uses the "cardiac cycle"[5] which is all the actions completed in one heartbeat. The parts of the cardiac cycle are the atrial systole, ventricular systole, and the relaxation phase. The atrial systole phase is when the atria contract and push blood into the ventricles. During the ventricular systole, the ventricles contract and push blood through the aorta. At this time, the atria relax. The relaxation phase explains itself, at this stage, all four chambers of the heart are relaxed as blood refills the ventricles.

Below is a diagram of the heart dissection. It shows the left atrium and ventricle, as well as the bicuspid valve. These parts of the heart contain the oxygenated blood which is pumped through the aorta into the body. Valves are controlled by the beating heart which contracts and expands tissue as the heart is beating[6]. Valves are used so that the blood does not go down into the wrong heart cavity which will result in a decreased blood flow and, if left untreated, can starve the brain of oxygen resulting in brain death.

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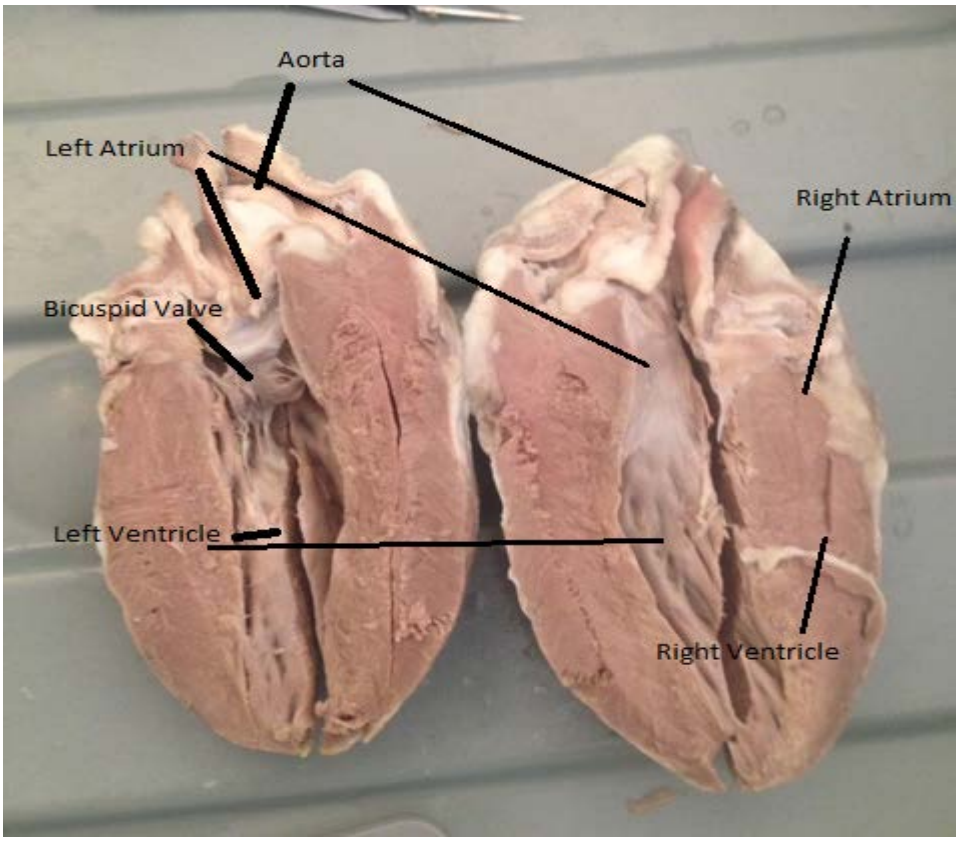
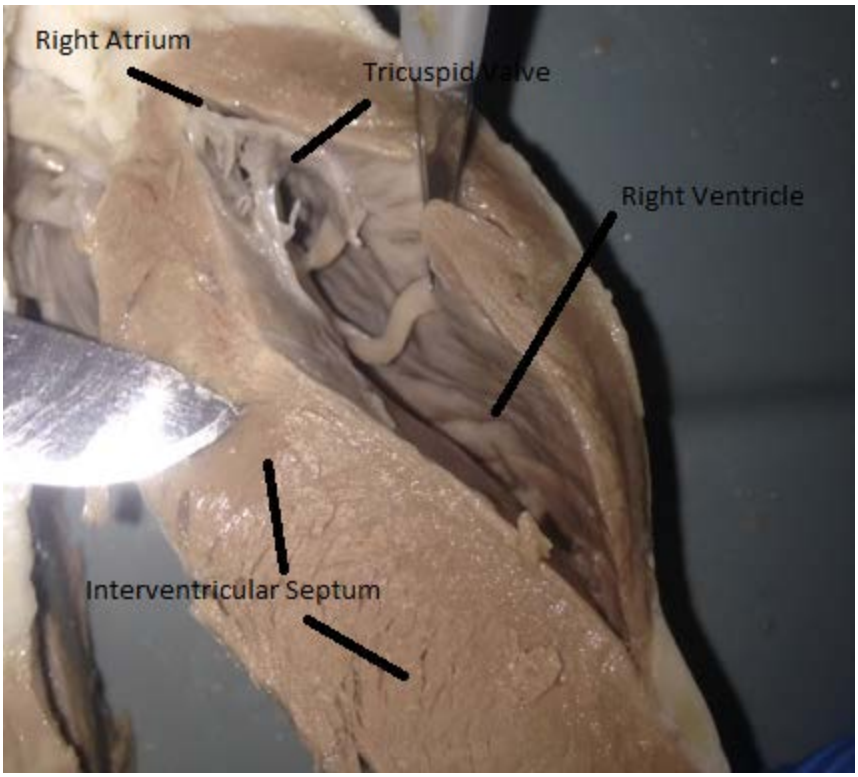
[4] "How the Heart Works", medicinenet.com, http://www.medicinenet.com/heart_how_the_heart_works/article.htm 11-27-15
[5] "Heart", Innerbody.com, http://www.innerbody.com/image/card01.html#full-description 11-27-15
[6] "How Your Heart Works", Saint Jude Medical, https://health.sjm.com/heart-valve-answers/understanding-your-condition/how-your-heart-work 11-27-15

Ben Martin
11-27-15



Above is a diagram of the sheep heart cut in two halves with the major visable parts labeled.

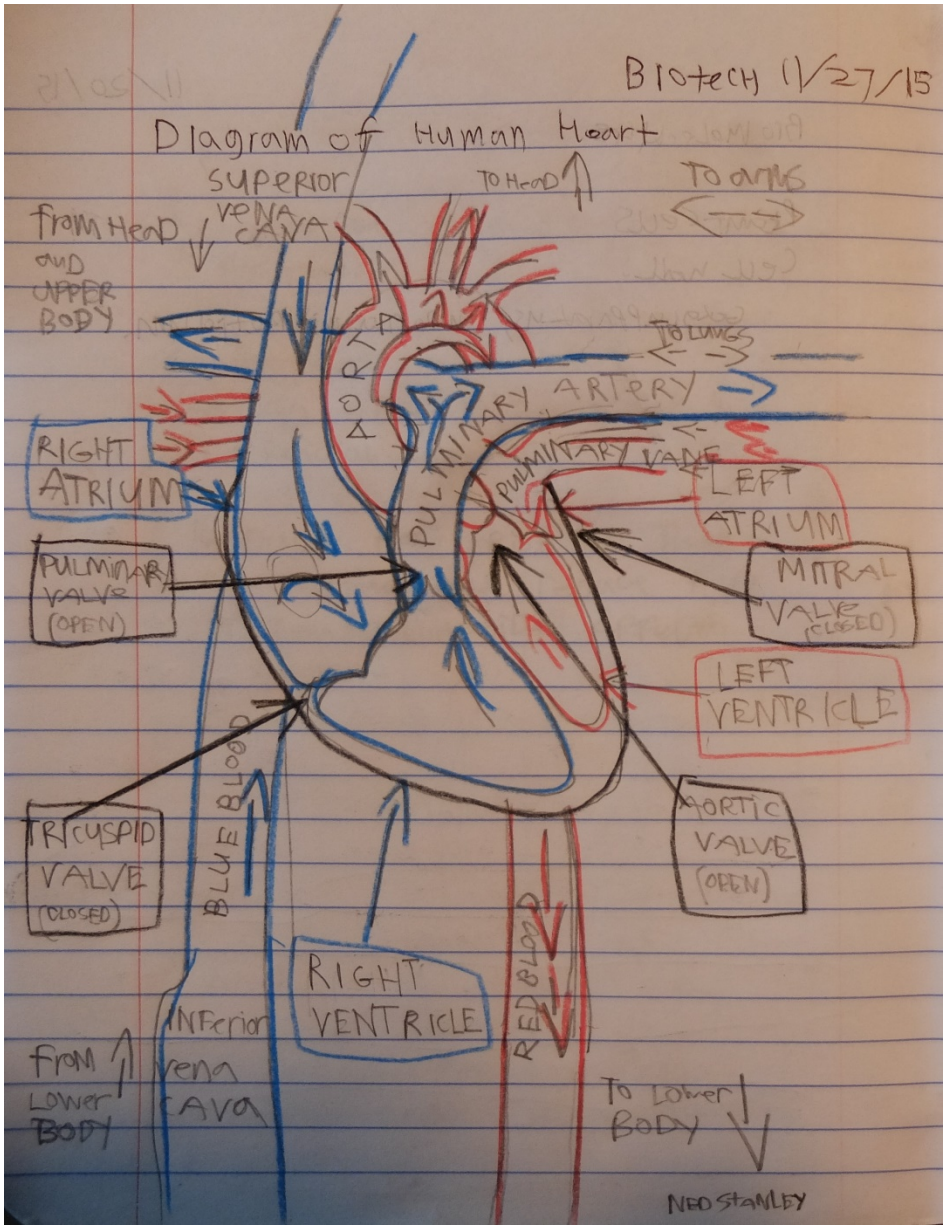
Ben Martin
11-27-15



Above is the right atrium and ventricle. They are seperated from the left atrium and ventricle by the interventricular septum.

Dissection of a Heart

The human heart is divided into four chambers: Right Atrium, Right Ventricle, Left Atrium, and Left Ventricle. Each of the chambers has a corresponding valve that prevents the backflow of blood.



The Tricuspid valve is between the right atrium and right ventricle and prevents back flow out of the heart back out to the body. The pulmonary valve is located at the outlet of the right ventricle and prevents back flow from the lungs to the heart. The Mitral valve is located between the left atrium and the left ventricle and prevents backflow into the lungs from the heart. The aortic valve is located at the outlet of the left ventricle and prevents backflow from the body into the heart. Without these valves, the heart could not circulate blood through the lungs and body.

The heart pumps blood through a series of four chambers. Deoxygenated blood (Blue blood) enters the right atrium through the superior vena cava and the inferior vena cava. The right ventricle relaxes, the pulmonary valve closes and the tricuspid valve opens, letting blood into the right ventricle as it is dilating. Once the right ventricle fills up with blood it squeezes. This causes the tricuspid valve to close from the backflow of blood and the pulmonary valve to open, directing blood to flow to the lungs. Once the right ventricle has finished pumping blood, the pulmonary valve closes from the back flow of blood from the lungs.

After the blood has exchanged carbon dioxide for oxygen in the lungs, it returns to the heart as oxygenated blood (Red Blood). The blood now enters into the left atrium that squeezes causing the mitral valve to open letting blood flow into the left ventricle. Once filled, the left ventricle squeezes, causing the mitral valve to close from the back pressure and the aortic valve to open allowing the ventricle to pump blood to the body.

The two sides of the heart correspond to the two different circulatory systems: the right side of the heart pumps blood to the pulmonary system, while the left side of the heart pumps blood to the systemic system.

When the blood is pumped out of the right side of the heart, it goes to the pulmonary circulatory system. The pulmonary circulatory system consists of the pulmonary arteries and veins as well as the lungs that contain alveoli where blood exchanges carbon dioxide for oxygen. Once the blood has been oxygenated, it returns to the left side of the heart to be pumped to the systemic circulatory system.

The systemic circulatory system consists of large arteries that branch into smaller arteries that branch into capillaries. The blood flows through the capillaries where red blood cells exchange oxygen for carbon dioxide from individual cells, resulting in deoxygenated blood. Once the blood has flowed through the capillaries, it is collected in veins. The veins join together to form larger veins that eventually become either the superior vena cava or the inferior vena cava that returns blood to the right side of the heart where it is then pumped into the pulmonary circulatory system.