The Cardiovascular System

HASPI Medical Anatomy & Physiology 13a

Station Lab Activity

Name(s): _____

Period: _____ Date: _____

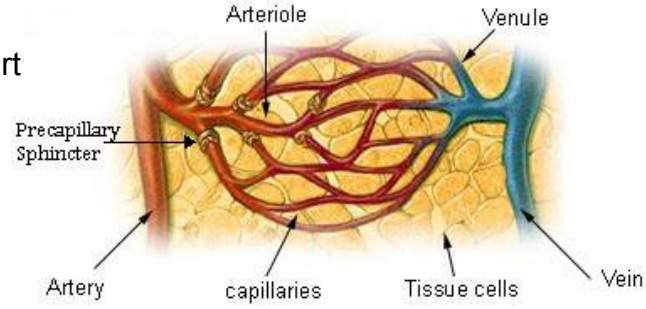
Background

The Cardiovascular System

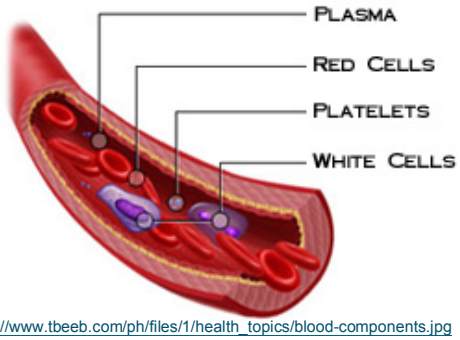
The cardiovascular system is made up of the heart, blood, and blood vessels. It functions as the freeway of your body by carrying oxygen, carbon dioxide, nutrients, waste produces, and even medications to and from organs, tissues, and cells. The blood vessels act as the road or path, the blood is the vehicle that substances travel upon, and the heart is the pump that keeps everything moving. In fact, all of the blood vessels in your body would equal more than 60,000 miles!

The Blood Vessels

The blood vessels travel in one direction, leaving the heart through arteries. Twenty major arteries travel through the body and branch into smaller blood vessels, called arterioles. The arterioles get even smaller and branch into blood vessels that are a single cell thick, called capillaries. Capillaries are the most abundant blood vessels in the bodyand are so small that red blood cells must travel in single file. Because of their thinness, oxygen, carbon dioxide, nutrients, and wastes easily diffuse out of capillaries into the tissues and cells that surround them. The capillaries pass through the tissues of the body, dropping off and picking up substances, and then begin to group together to become venules. Venules eventually join together and form veins, that end up back at the heart to start the path through the body all over again. Veins and venules have specialized valves to prevent blood from flowing backward.



http://0.tqn.com/d/biology/1/0/2/W/microcurculation.jpg



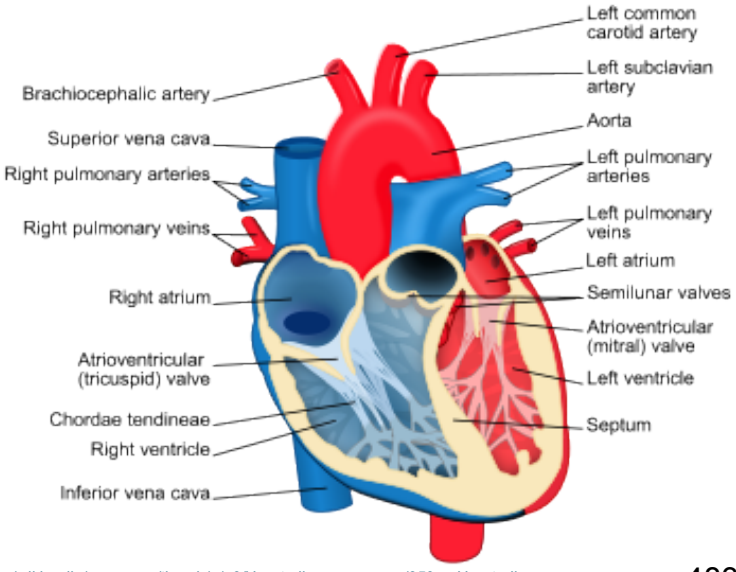
http://www.tbeeb.com/ph/files/1/health_topics/blood-components.jpg

The Blood

A healthy adult contains approximately 5 liters of blood. Blood is a liquid made up primarily of plasma, red blood cells, white blood cells, and platelets. Plasma is mainly water with a variety of dissolved substances and nutrients. Red blood cells function to carry oxygen and carbon dioxide molecules between the lungs and the cells of the body. White blood cells function in immunity, allowing our bodies to recognize and fight off infections. Platelets function to help stop bleeding when a blood vessel is damaged.

The Heart

The heart is one of, if not the most important, organ of the body and will beat more than 3 billion times in an average lifetime. It is made up of strong cardiac muscle tissue that contracts continually for the entire lifetime of an individual. The heart creates its own electrical impulses through cardiac conduction, that keeps the heart beating regularly. The contraction of the heart expels blood out of four chambers within the heart that are the right atrium, right ventricle, left atrium, and left ventricle. The blood is pushed forward out through arteries, and specialized valves prevent the blood from flowing backward.



http://upload.wikimedia.org/wikipedia/commons/thumb/e/e0/Heart_diagram-en.svg/350px-Heart_diagram-en.svg.png

The Path of Blood

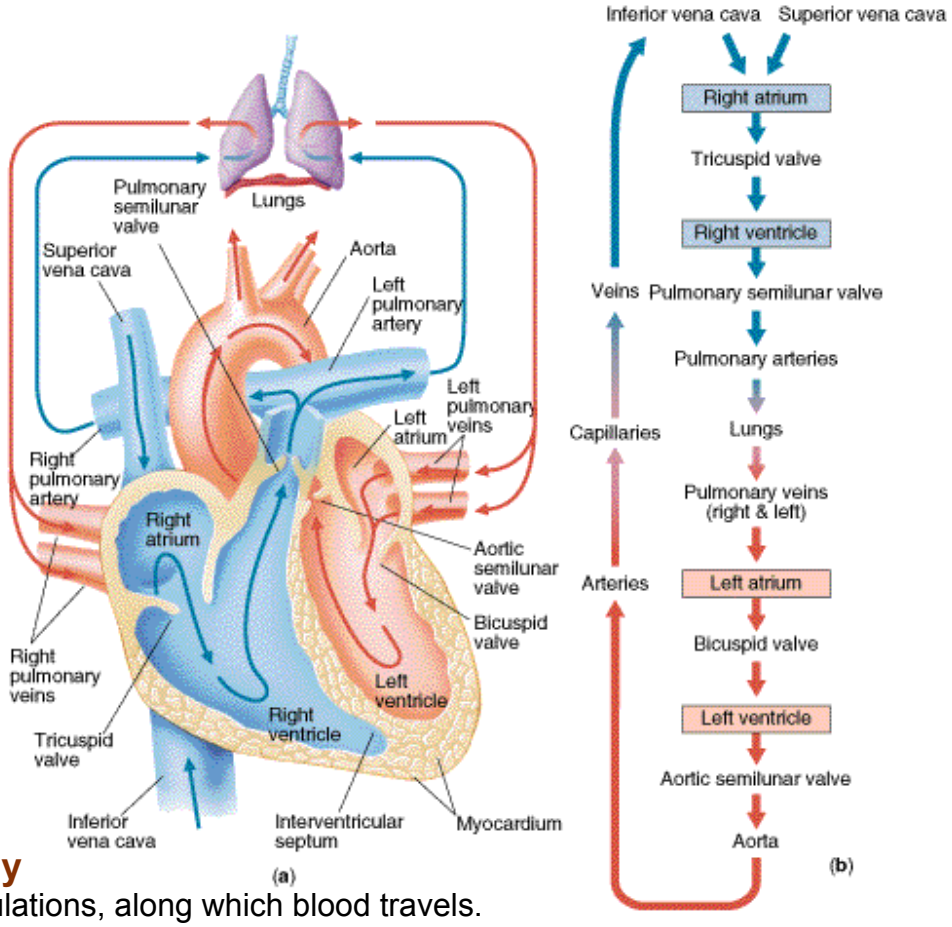
Blood flows through the heart in a one-way path.

1. Blood that is oxygen-poor and carbon dioxide-rich returns to the heart through two large veins – the **superior vena cava** (enters the heart at the top) and **inferior vena cava** (enters the heart at the bottom.)
2. Blood is pumped into the **right atrium** and is then pushed through the **tricuspid valve** into the **right ventricle**.
3. The right ventricle contracts and pushes blood through the **pulmonary semilunar valve** into the right and left **pulmonary arteries**.
4. The pulmonary arteries lead to the **lungs** where the red blood cells will pick up oxygen and release carbon dioxide.
5. Blood that is now oxygen-rich and carbon dioxide-poor returns back to the heart through the right and left **pulmonary veins**.
6. Blood is pumped into the **left atrium** and is then pushed through the **bicuspid valve** (also known as the mitral valve) into the **left ventricle**.
7. The left ventricle contracts and pushes blood through the **aortic semilunar valve** into the **aorta**.
8. The aorta branches out into smaller arteries that lead to the rest of the body.

To Summarize:

- Superior & Inferior Vena Cava
- Right Atrium
- Tricuspid Valve
- Right Ventricle
- Pulmonary Valve
- Pulmonary Arteries
- LUNGS
- Pulmonary Veins
- Left Atrium
- Bicuspid or Mitral Valve
- Left Ventricle
- Aortic Valve
- Aorta

http://circulatorysystemlesson.wikispaces.com/file/view/BloodFlowPhysiology.gif/84430933/BloodFlowPhysiology.gif



Circulation Through the Body

There are three main paths, or circulations, along which blood travels.

Pulmonary Circulation – Blood is pumped from the heart to the lungs through pulmonary arteries where it picks up oxygen and releases carbon dioxide. The blood then returns to the heart through pulmonary veins.

Systemic Circulation – Blood is pumped from the heart through arteries to the rest of the body and then returns to the heart through veins.

Coronary Circulation – Arteries and veins connected to the aorta provide blood to the actual heart muscle.

Cardiovascular Disorders

A healthy cardiovascular system is crucial for overall health. A variety of abnormalities caused by disease or disorders can affect the ability of the heart, blood, and blood vessels to circulate important substances around the body. The following table summarizes only a few common disorders. Prevalence and mortality is based on annual numbers from 2009 in the U.S.

Cardiovascular Disorder	Description	Symptoms	Prevalence	Annual Mortality Rate
Heart Disease	A collection of disorders that affect the function of the heart	Chest pain, palpitations, shortness of breath, fatigue	26.5 million	597,689
Hemophilia	Blood does not clot normally	Uncontrollable bleeding	97,000	78
Leukemia	Cancer of the blood cells	Fever, headaches, bruising, bone and joint pain, swollen lymph nodes, infections	1,012,533	53,010
Anemia	Lack of healthy red blood cells in circulation	Fatigue, headaches, lack of focus, shortness of breath	9% of females 4% of males	4,852
Abdominal Aortic Aneurysm	Rupture of the aorta extending into the abdomen	Sudden and severe chest and abdominal pain	176,913	15,806
Cerebral Aneurysm	Rupture of a blood vessel in the brain	Vision issues, confusion, headache, weakness, nausea	30,000	12,000
Stroke	Lack of blood and oxygen to a portion of the brain	Change in senses, confusion, muscle weakness, numbness	6.2 million	129,476
Hypertension	High blood pressure	Asymptomatic	31.9% of population	26,634

Diagnostic Tests for Cardiovascular Disorders

There are many tests that can be performed to assess and treat cardiovascular disorders. The following list summarizes a few common procedures.

http://a.abcnews.com/images/Health/ocp_Heart_III_ScreeningDiag_080122_mn.jpg

- **Pulse & Heart Rate** – These are basic tests used in nearly all physical examinations to determine whether the heart rate is normal and whether the heartbeat is regular.
- **Complete Blood Cell Count** – A complete blood cell count measures the number of red blood cells, white blood cells, and platelets in a patient's blood sample. Complete blood cell count results can be used to pinpoint a diagnosis, such as anemia, infection, or bleeding disorders.
- **Echocardiogram** – An ultrasound of the heart is taken to show a detailed image of the heart and its valves.
- **Electrocardiography (EKG or ECG)** – A test that measures and records the electrical activity of the heart using electrodes. It can be used to determine if the heart rhythm is normal.
- **Cardiac Catheterization** – Also known as a coronary angiogram; involves placing a small catheter through a blood vessel in the arm or leg to the heart. A dye is injected through the catheter and a specialized x-ray is used to view the heart to determine whether coronary arteries are blocked, valves are not opening/closing correctly, and whether the chambers are contracting sufficiently.
- **Blood Pressure** – A device called a sphygmomanometer is used to measure a patient's blood pressure. High blood pressure can lead to heart disease and is an important measure of the stress put on the heart.

Gandelman, G. 2012. Cardiovascular System. Medline Plus, National Institutes of Health, U.S. National Library of Medicine. www.nlm.nih.gov.

WebMD. 2013. Heart Disease Health Center. WebMd. www.webmd.com.

Materials

Station 1: Anatomy posters (4)
Station 2: Stethoscope, timer
Station 3: Histology posters (4)
Station 4: Sphygmomanometer, stethoscope
Station 5: Disease posters (5)
Station 6: Ruler, calculator

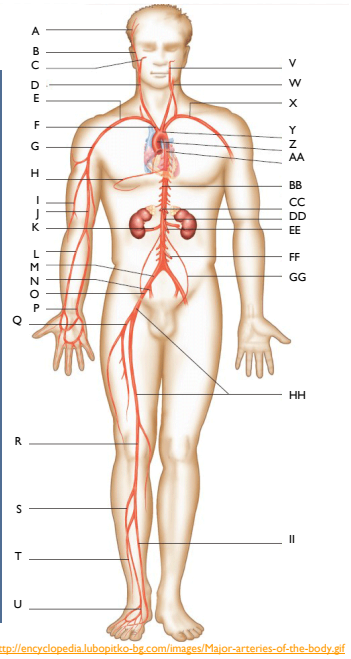
Procedure

This is a station lab activity. There are 6 stations set up around the classroom. Each station will take approximately 10-15 minutes.

Station 1: The Cardiovascular System

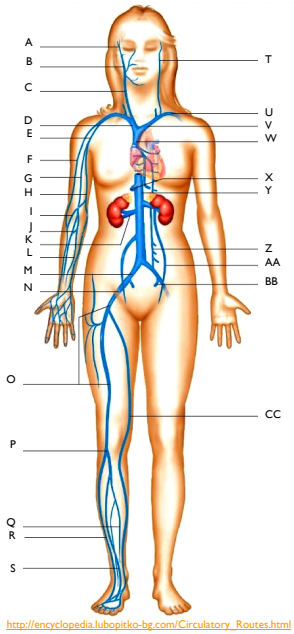
Major Arteries – Using the "Major Arteries" chart, identify the arteries labeled A-II in **Table 1** below. If there are any that you cannot identify, use a textbook or online resource. A smaller version of this chart is included here for later review.

Table 1. Arteries	L	X
A	M	Y
B	N	Z
C	O	AA
D	P	BB
E	Q	CC
F	R	DD
G	S	EE
H	T	FF
I	U	GG
J	V	HH
K	W	II



http://encyclopedia.lubopitko-bg.com/images/Major-arteries-of-the-body.gif

Major Veins – Using the "Major Veins" chart, identify the veins labeled A-CC in **Table 2** below. If there are any that you cannot identify, use a textbook or online resource. A smaller version of this chart is included here for later review.

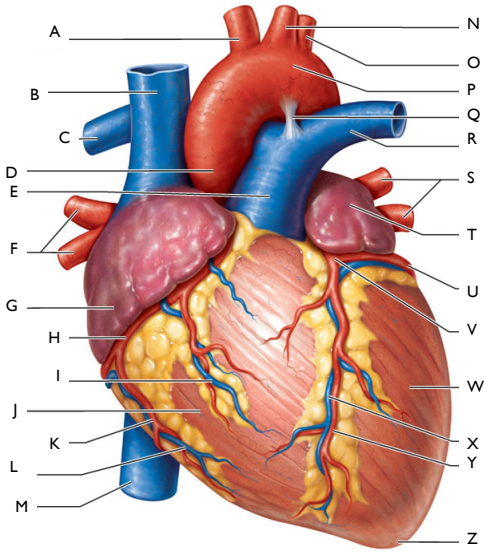


http://encyclopedia.lubopitko-bg.com/Circulatory_Routes.html

Table 2. Veins	J	T
A	K	U
B	L	V
C	M	W
D	N	X
E	O	Y
F	P	Z
G	Q	AA
H	R	BB
I	S	CC

The Exterior Heart – Using the "Exterior Heart" chart, identify the structures labeled A-Z in **Table 3** below. If there are any that you cannot identify, use a textbook or online resource. A smaller version of this chart is included here for later review.

Table 3: The Exterior Heart	
A	N
B	O
C	P
D	Q
E	R
F	S
G	T
H	U
I	V
J	W
K	X
L	Y
M	Z



http://antranik.org/wp-content/uploads/2011/12/gross-anatomy-of-the-heart-anterior-view.jpg

The Interior Heart – Using the "Interior Heart" chart, identify the structures labeled A-Y in **Table 4** below. If there are any that you cannot identify, use a textbook or online resource. A smaller version of this chart is included here for later review.

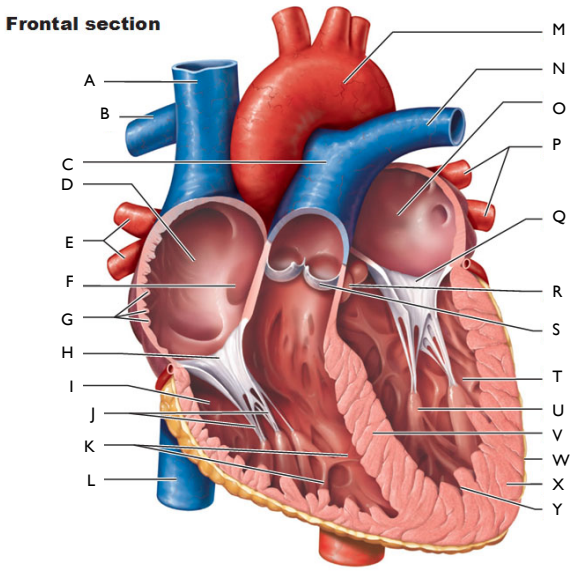


Table 4: The Interior Heart	
A	N
B	O
C	P
D	Q
E	R
F	S
G	T
H	U
I	V
J	W
K	X
L	Y
M	

Station 2: Heart Sounds & Pulse

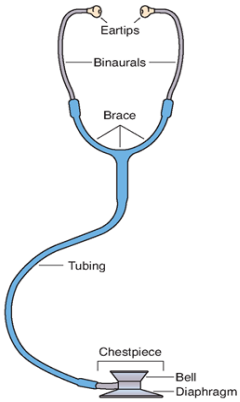
The sounds created by the heart are caused by the heart valves opening/closing. Normally, there are two sounds heard when listening to the heart. The first sound is caused by the atrioventricular (AV) valves closing and the semilunar (SL) valves opening. The second sound is caused by the SL valves closing and the AV valves opening. The pulse is just an extension of the heartbeat as blood is pumped into arteries throughout the body. Larger arteries closer to the heart have a stronger pulse, allowing us to feel it through the skin and determine the heart rate. Follow the directions below to listen to the heart and find pulse points on your partner.

Directions

✔when complete

Listening to the Heart

Step 1 The heart will sound different depending on the part of the chest you auscultate (listen to.) The figure below shows the location on the chest to auscultate each of the valves of the heart.

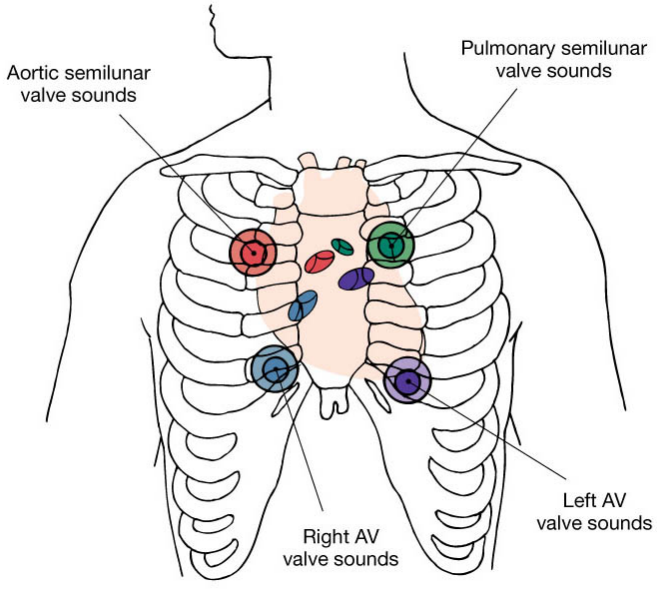


Step 2 The stethoscope has two important parts:

- The **chest piece** is the round, flat portion that will be placed on your partner to listen and amplify sound
- The **ear tips** fit into the ears and should face slightly forward to funnel the sound from the chest piece into the ear canal

Step 3 Use the stethoscope to listen to your partner's heart in each of the locations on the figure below. Just as if you were a healthcare worker, BE AWARE of where you are placing the stethoscope especially on your female classmates. Ask your partner if he or she would like to hold the chest piece of the stethoscope on parts of the chest that may be uncomfortable.

Step 4 Describe in detail how the heart sounds in each part of the heart in Table 5.



http://iupucbio2.iupui.edu/anatomy/images/Chapt21/FG21_08.jpg

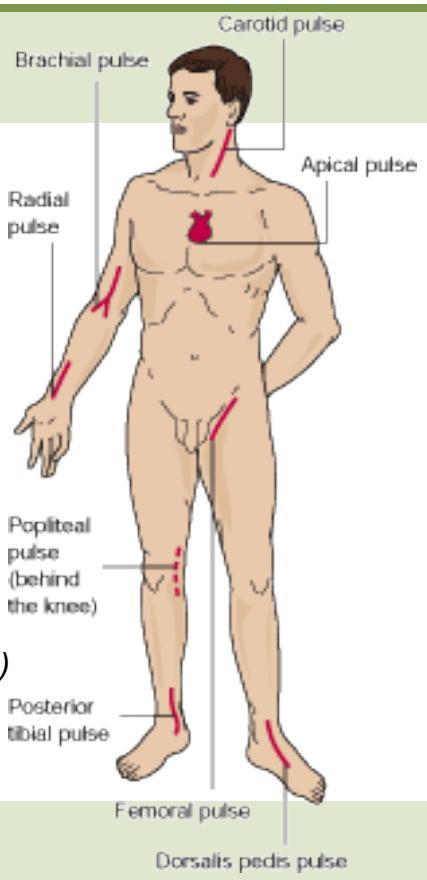
Table 5. Heart Sounds *(describe how each sounds)*	
Aortic semilunar valve	
Right AV valve	
Pulmonary semilunar valve	
Left AV valve	

Locating Pulse Points

Step 5 The pulse is actually the arteries expanding in rhythm with the contraction of the heart. The pulse can be taken at a variety of locations on the body.

Step 6 There are seven common pulse points. Take the pulse at each of the following 6 sites by counting the number of beats in 15 seconds. Multiply this number by 4 to determine the beats per minute (BPM). The location of each pulse point can be found in the image to the right. If you are having trouble locating the pulse, you can use the stethoscope on the location.

- Radial pulse *(thumb side of the wrist)*
- Brachial pulse *(inner elbow)*
- Carotid pulse *(neck)*
- Popliteal pulse *(behind the knee)*
- Posterior tibial pulse *(behind the ankle bone)*
- Dorsalis pedis pulse *(top of the foot)*



http://wps.prenhall.com/wps/media/objects/504/517114/fg11_00500.gif

Step 7 Record the beats and BPM for each pulse point in the list above in Table 6.

Table 6. Pulse Points

Pulse Area	Beats in 15 s	Beats Per Minute (BPM)
Radial		
Brachial		
Carotid		
Popliteal		
Posterior tibial		
Dorsalis pedis		

Station 3: Cardiovascular System Histology

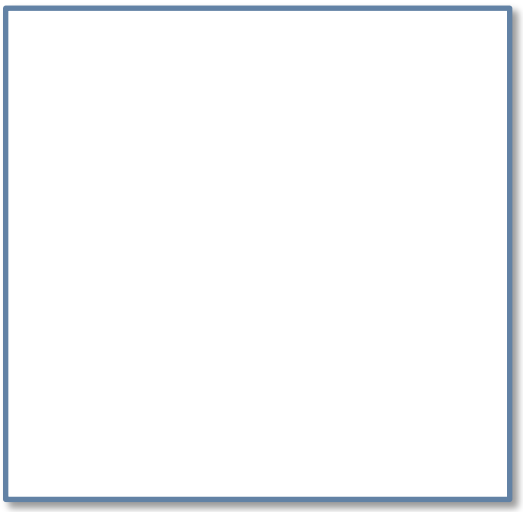
The cell and tissue structure of cardiovascular organs are suited for the functions they perform. Redraw and label Image B from the posters below. Image A on each chart is for reference!

Blood

Using colored pens/pencils, draw the histology Image B from the "Blood" chart in the space below. Using Image A as a reference, label your drawing with the RBCs, neutrophils, lymphocytes, and platelets.

Cardiac Muscle

Using colored pens/pencils, draw the histology Image B from the "Cardiac Muscle" chart in the space below. Using Image A as a reference, label your drawing with the muscle cell nucleus, intercalated disc, endothelial cell nucleus, and capillary.

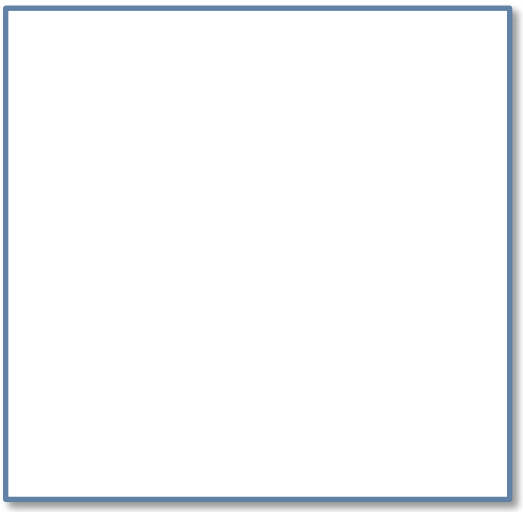


The Heart Wall

Using colored pens/pencils, draw the histology Image B from the "Heart Wall" chart in the space below. Using Image A as a reference, label your drawing with the atrial wall, epicardium, myocardium, and endocardium.

Arteries & Veins

Using colored pens/pencils, draw the histology Image B from the "Arteries & Veins" chart in the space below. Using Image A as a reference, label your drawing with the artery lumen, vein lumen, nerve, adipose tissue, adventitia, and media.



Station 4: Blood Pressure

As your heart contracts it pushes blood out into the arteries of the body. The force created by the "pulse" of blood flowing through the artery is called the blood pressure. When blood pressure is high, it means the heart is working harder to push blood through the blood vessels. A normal healthy adult blood pressure for an adult is 120/80. The top number is the pressure on the arteries when the heart contracts and is called the systolic blood pressure. The bottom number is the pressure on the arteries when the heart relaxes and is known as the diastolic blood pressure.

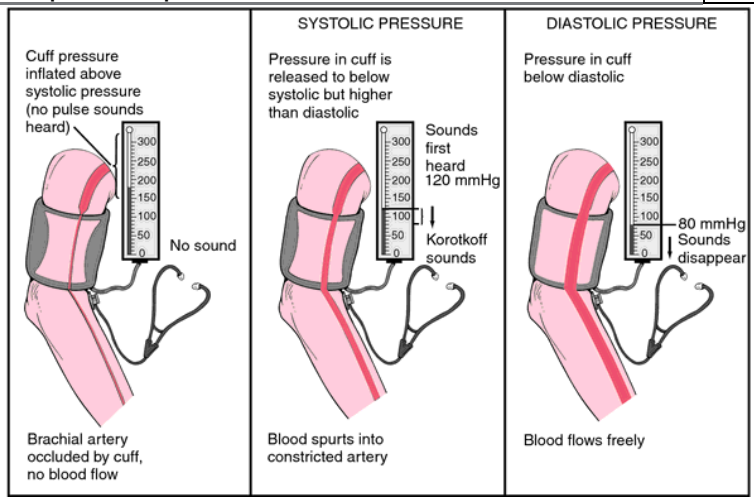
Directions

		✔when complete
Step 1	Have your partner sit and place his or her forearm on a desk or table. Make sure the blood pressure cuff is completely deflated, and secure it around your partner's upper arm so it does not slide down, but is not too tight.	
Step 2	Have your partner hold the pressure gauge, clip it on the cuff, or place it on the table so it is easily visible.	
Step 3	Place the ear tips of the stethoscope in your ears and the chest piece of the stethoscope at the crease of the elbow, just under the cuff so it will be held in place.	
Step 4	If you are right-handed hold the pump in the palm of your left hand so you are easily able to tighten and loosen the valve on top of the pump with your fingers.	
Step 5	Squeeze the pump and watch the pressure gauge. Increase the pressure to around 150 mmHg or until you are no longer able to hear your partner's pulse through the stethoscope. DO NOT INFLATE TOO TIGHT! (If the cuff is not inflating, make sure the valve is closed on the pump.)	
Step 6	At this point you have cut off circulation at the elbow. Slightly open the valve to allow the air out of the cuff SLOWLY. Watch the pressure gauge as it drops and listen carefully with the stethoscope for when the pulse returns. This takes a lot of practice so you may need to reinflate the cuff and try a few times.	
Step 7	The number on the pressure gauge when the pulse returns is the systolic blood pressure. Record this number in Table 7.	
Step 8	Continue to let air out of the cuff slowly, watch the pressure gauge, and listen for when the pulse can no longer be heard through the stethoscope.	
Step 9	The number on the pressure gauge when the pulse disappears is the diastolic blood pressure. Record this number in Table 7.	
Step 10	Completely release all of the air out of the blood pressure cuff and remove it from your partner. Exchange roles and repeat steps 1-9.	

http://www.wholefoodsmagazine.com/sites/default/files/images/articles/2011/Feb/BloodPressure.jpg

Table 7. Blood Pressure

Systolic Blood Pressure	Diastolic Blood Pressure



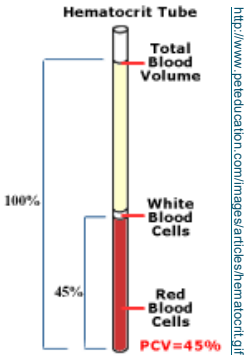
http://img2.tfd.com/mk/B/X2604-B-25.png

Station 5: Cardiovascular Disease

Using the "Cardiovascular Disease" charts, complete the following table. List ONLY THREE Causes or Risk Factors, Symptoms, and Treatment Options for each disease.

Myocardial Infarction (Heart Attack)			
Description	Causes or Risk Factors (3)	Symptoms (3)	Treatment Options (3)
In what part of the U.S. did the most myocardial infarctions occur in 2005?			
Peripheral Artery Disease (PAD)			
Description	Causes or Risk Factors (3)	Symptoms (3)	Treatment Options (3)
What age group has the largest prevalence of PAD? Do more men or women suffer from PAD?			
Cerebrovascular Accident (Stroke)			
Description	Causes or Risk Factors (3)	Symptoms (3)	Treatment Options (3)
What is the most common long-lasting disability of individuals who have experienced a stroke?			
Endocarditis & Myocarditis			
Description	Causes or Risk Factors (3)	Symptoms (3)	Treatment Options (3)
Which bacteria type causes the most cases of endocarditis & myocarditis?			
Congenital Heart Disease			
Description	Causes or Risk Factors (3)	Symptoms (3)	Treatment Options (3)
What is the most common type of congenital heart disorder?			

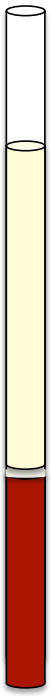
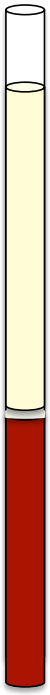
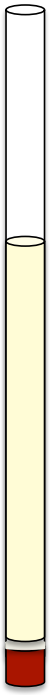
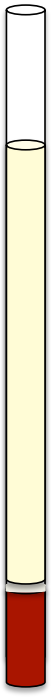
Station 6: Hematocrit



The hematocrit, or packed cell volume (PCV), is the percentage of the blood that is made up of red blood cells. To determine this percentage, special hematocrit capillary tubes are used. A blood sample is collected in the capillary tube and centrifuged, which causes the red blood cells, white blood cells, platelets, and plasma to separate. The bottom layer is made up of red blood cells. A thin layer of white blood cells and platelets sits just above the red blood cells, and the plasma is at the top of the tube. The hematocrit test provides a quick evaluation of an individual's cell status. Follow the directions to determine the hematocrit levels for five patients.

Directions

		✔when complete
Step 1	Use the ruler to measure the total height of ALL of the blood in each column A-E below. Record this measurement in mm for the "Total Volume" below each patient sample.	
Step 2	Use the ruler to measure the height of the red blood cells (RBCs) in each column. Record this measurement in mm for the "RBC Volume" below each patient sample.	
Step 3	Use the following equation to determine the hematocrit percentage for each patient. Record the "Hematocrit" percentage below each patient sample. $$\frac{\text{RBC Volume (mm)}}{\text{Total Volume (mm)}} \times 100 = \text{Hematocrit (\%)}$$	
Step 4	A normal adult male will have a hematocrit of 42-54% while a normal adult female will have a hematocrit of 38-46%. Determine whether each patient's hematocrit level is normal, high, or low and record below each patient sample.	

Patient A	Patient B	Patient C	Patient D	Patient E
				
Total Volume = _____	Total Volume = _____	Total Volume = _____	Total Volume = _____	Total Volume = _____
RBC Volume = _____	RBC Volume = _____	RBC Volume = _____	RBC Volume = _____	RBC Volume = _____
Hematocrit = _____ %	Hematocrit = _____ %	Hematocrit = _____ %	Hematocrit = _____ %	Hematocrit = _____ %

Analysis Questions - *on a separate sheet of paper complete the following*

Station 1

1. Which arteries leave directly from the aorta?
2. Which veins lead directly back into the superior and inferior vena cava?
3. Which arteries and veins are crucial to supplying the heart with oxygen?
4. Which valves separate the atria from the ventricles?
5. What structure separates the right and left ventricles?

Station 2

6. What are you actually hearing when you listen to the heartbeat?
7. What is the pulse?
8. How can the pulse be felt at different parts of the body?
9. Which pulse point had the strongest pulse? The weakest pulse? Why do you think this happened?

Station 3

10. What type of cell is most abundant in blood tissue?
11. What is the purpose of intercalated discs in cardiac muscle?
12. How is the cellular structure of arteries versus veins different?

Station 4

13. What is blood pressure and how is it measured?
14. Why is high blood pressure a health concern?

Station 5

15. What were the common causes & risk factors found between the majority of the cardiovascular disorders?
16. What were the common symptoms found between the majority of the cardiovascular disorders?

Station 6

17. What is hematocrit?
18. How can it be used to diagnose a health problem?
19. Which patient's had abnormal hematocrit percentages?

Review Questions - *on a separate sheet of paper complete the following*

1. How do the heart, blood, and blood vessels work together to perform the function of the cardiovascular system?
2. Explain the difference between arteries, veins, arterioles, and venules.
3. Why are substances able to diffuse through the capillaries?
4. How much blood does a healthy adult body normally contain?
5. What components make up blood?
6. What is the function of red blood cells, white blood cells, and platelets?
7. Why is the heart an important organ?
8. What is cardiac conduction?
9. What are the four chambers of the heart?
10. Outline the path of blood through the heart. This can be written out step-by-step or in an illustration.
11. What is the difference between pulmonary, systemic, and coronary circulation?
12. From the table in the background section, what cardiovascular disorder was the most prevalent in 2009? Least prevalent? Hypothesize why.
13. What cardiovascular disorder had the highest mortality rate? The lowest mortality rate?
14. Choose two of the common diagnostic procedures and summarize their uses.