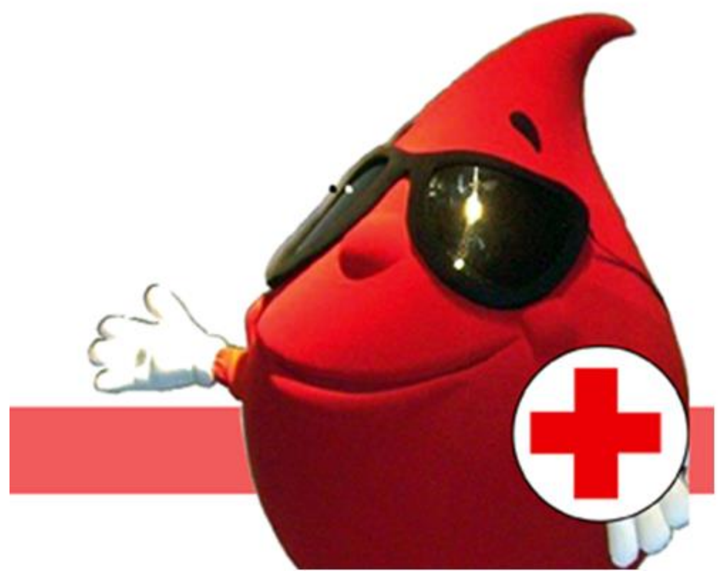
Circulation

Blood and Blood Types

Mrs. Kornelsen



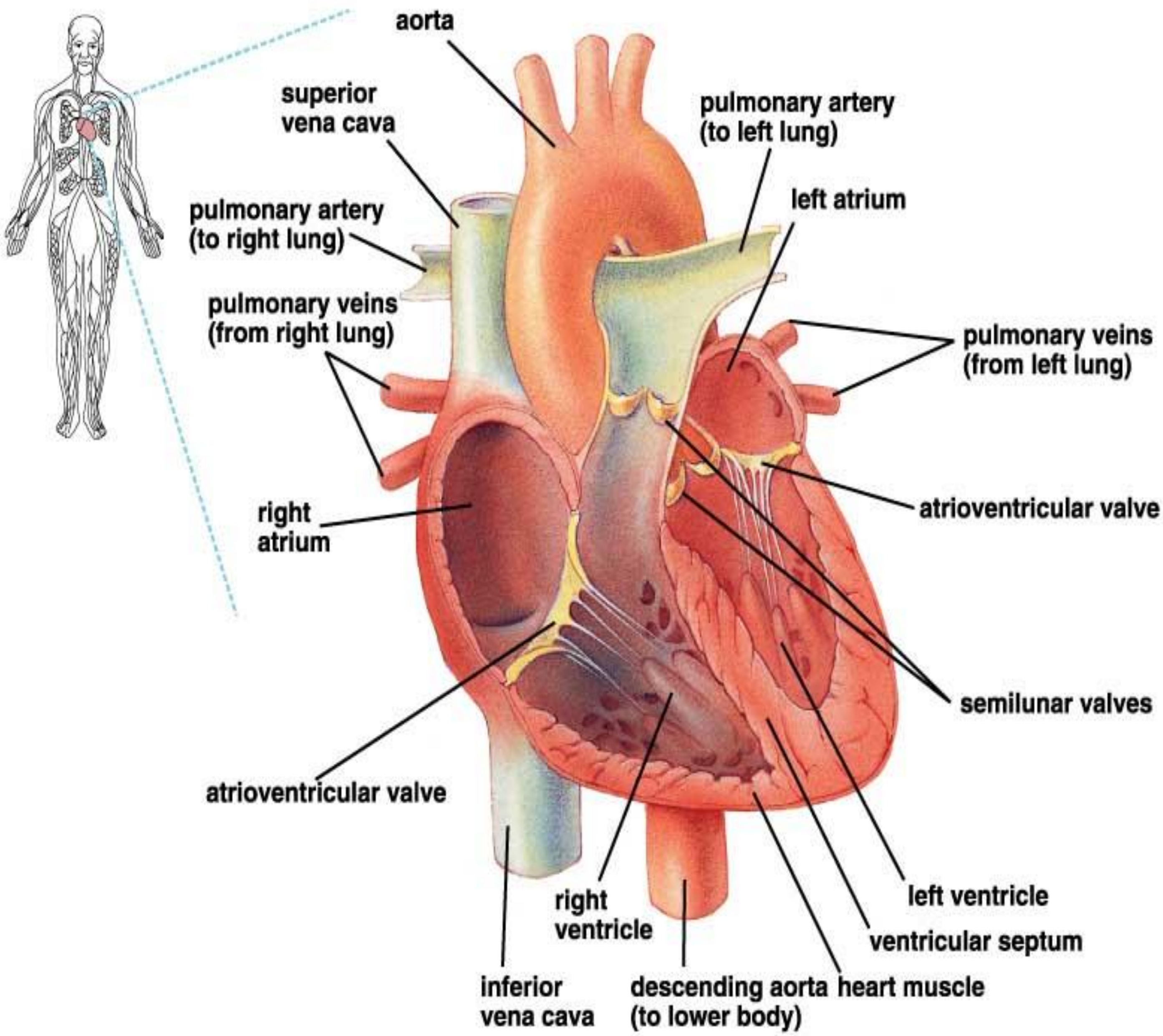
Learning checklist – Circulation

Learning increases when you have a goal to work towards. Use this checklist as guide to track how well you are grasping the material. In the center column, rate your understand of the topic from 1-5 with 1 being the lowest and 5 being the highest. Be sure to write down any questions you have about the topic in the last column so that you know what you have yet to learn.

Outcomes	Understanding	Questions?
Design and execute an experiment to investigate an aspect of the transportation or respiratory system		
Compare the characteristics of blood components in terms of appearance, origin, numbers, relative size and function in the body. Include: plasma, erythrocytes (red blood cells), leukocytes (white blood cells), and thrombocytes (platelets)		
Select and use scientific equipment appropriately and safely. *Examples: microscopes, dissection equipment, prepared slides…*		
Record, organize, and display data and observations using an appropriate format. Include: Biological drawings.		
Compare and contrast the characteristics of different blood groups. Include: ABO, Rh factor		
Predict the physiological consequences of blood transfusions involving different blood groups.		
Describe the blood donation process and investigate related issues. *Examples: compatible blood groups, screening procedure, frequency of donation, use of donated blood products, blood borne*		

diseases…		
Compare the structure and function of blood vessels. *Examples: diameter, elasticity, muscle layers, valves, what they transport…*		
Identify the materials transported between cells and capillaries. Include: carbon dioxide, oxygen, hormones, nutrients and nitrogenous wastes		
Explain the meaning of blood pressure readings and identify the normal range. Include: given as a ratio of systolic over diastolic		
Identify factors which affect blood pressure or cardiac function and describe their effects. *Examples: Factors: exercise, caffeine, nicotine, shock, betablockers, diuretics, hormones, stress; Effects: low blood pressure, high blood pressure, increased heart rate…*		
Explain how transport systems help to maintain homeostasis in the body. Include: transport nutrients, oxygen, carbon dioxide, wastes; help maintain fluid balance; regulate body temperature; and assist in the defence of the body against invading organisms		
Demonstrate work habits that ensure personal safety, the safety of others, and consideration of the environment.		

* Remember each unit’s connection to wellness and homeostasis.


aorta
superior vena cava
pulmonary artery (to left lung)
left atrium
pulmonary artery (to right lung)
pulmonary veins (from right lung)
pulmonary veins (from left lung)
right atrium
atrioventricular valve
semilunar valves
atrioventricular valve
left ventricle
right ventricle
ventricular septum
inferior vena cava
descending aorta (to lower body)
heart muscle

Introduction to the Circulatory System

Blood is the most commonly tested _______________ in the human body.

From as little as one teaspoon of blood, many different types of information can be obtained about your health.

Blood is considered to be the "life stream" as it contains different types of cells that perform many different functions. It also contains many dissolved substances that are being transported throughout the body.

One of the major functions of your blood is _________________. Inside your body, there is an amazing protection mechanism called the immune system. It is designed to defend you against millions of bacteria, microbes, viruses, toxins and parasites that would love to invade your body.

Circulatory System Basics:

The circulatory system is made up of three key components

1) Fluid - _________________
2) Channels - ______________
3) A Pump - ______________

Circulatory System Functions

1)
2)
3)
4)
5)
6)

Blood and Blood Components:

Blood transports

____

___________________________.

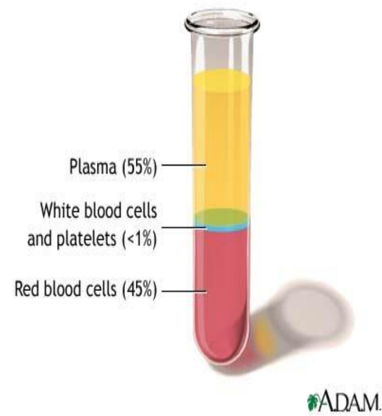
Blood has 2 major components:

A) ________________________

> 55-60%blood volume

B) ____

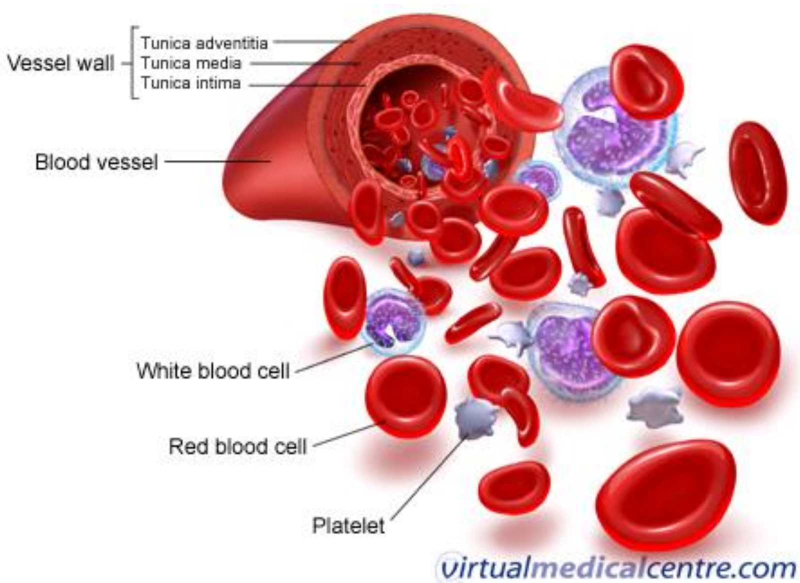
40-45% blood volume



Blood Components

Red blood cells	Carry oxygen to all parts of the body
White blood cells	Fight infection
Platelets	Clot your blood when injured
Plasma	Clear liquid: 90% water

Elements of blood



Blood cells are made in the ___________________. The bone marrow is the soft, spongy tissue found in the center of the large bones. All cells made in the bone marrow start out as a single kind of cell called a ____________________. Depending on what type of cell the body needs, a stem cell can become one of three major types of blood cells: a red cell, a white cell, or a cell that makes platelets.

1) Plasma:

This fluid is made up of 90% water

Dissolved in the plasma are proteins, hormones and nutrients such as:

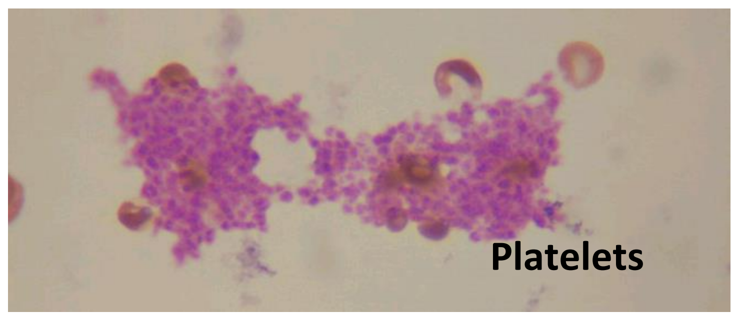
- ______________________________________
- _____________________________________
- ____________________________________
- _____________________________________

The blood proteins are of four types:

- ________________ - made in the liver and is important in maintaining blood pressure.
- ________________ - used in the body's defense against disease.
- ________________ - necessary for blood clotting.
- ________________ - necessary for blood clotting.

2) Platelets (Thrombocytes)

- They are pieces of large cells called __________________________________ from the ____________________________.
- These cells remain in the bone marrow and pinch off membrane enclosed chunks of their cytoplasm (platelets)
- Like RBCs they ________________________. Their life span is about _________________.
- There are 250 000/mm^3 of blood



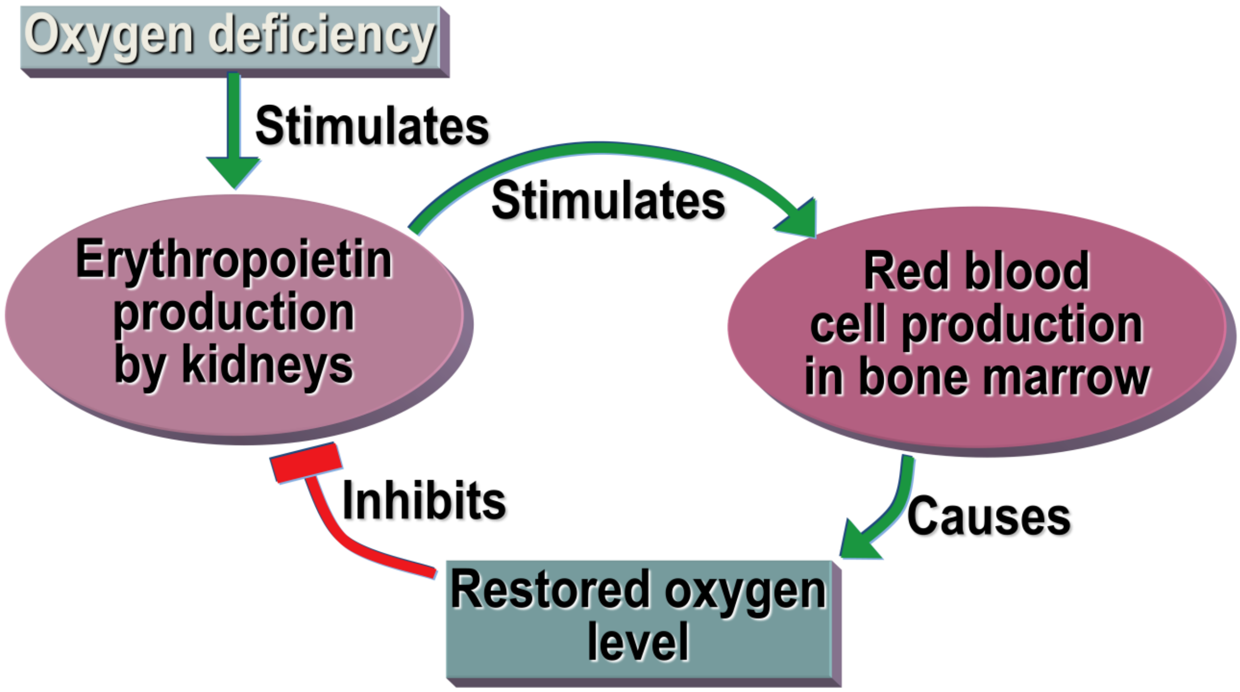
If the number of platelets is too low, excessive ______________ can occur. However, if the number of platelets is too high, blood clots can form (_________________), which may obstruct blood vessels and result in such events as a ____ or the blockage of blood vessels to other parts of the body, such as the extremities of the arms or legs.

3) Red Blood Cells (Erythrocytes) – RBCs

- Red blood cells ______________________________. They are the most abundant cells in the blood. A cubic millimetre of blood contains 5 million.
- During its _____________ life span, an RBC makes about 75,000 round trips between the lungs and tissues.
- RBCs make up:
  - 99% of all blood cells
  - 40% of total blood volume in females
- 45% of total blood volume in males

RBCs and Hemoglobin

When there is a deficiency of ___________________ in the blood, a condition known as ____________ results. Anemia is characterized by low energy levels. The shortage of hemoglobin in the bloodstream can result from the production of too few red blood cells, excessive loss of blood through physical injury or internal bleeding. It may also be caused a dietary deficiency of _______________ or genetic disorders such as ________________________.



Sickle- Cell Anemia – Find out what it is

My Notes	Class Notes

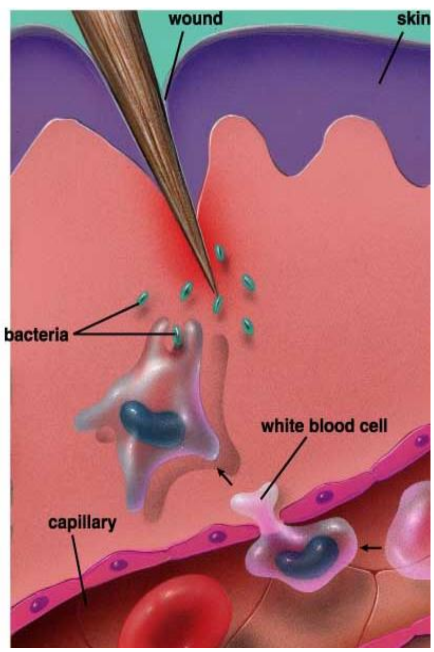
Hematocrit

http://www.medicine.mcgill.ca/physio/vlabonline/bloodlab/hemat2.htm

My Notes	Class Notes

4) White Blood Cells (Leukocytes) - WBCs

- WBCs are the mobile units of the body's immune system.
- There are five different types of leukocytes, which together make up less than 1% of all blood cells.
- An average WBC count is 7000/mm^3 (1 WBC for every 700 RBCs)



1) Compare and contrast the structure, function and origin of erythrocytes, leukocytes and platelets.

2) Explain why blood in arteries is a bright red colour while blood in veins is a bluish colour.

3) Fill in the Blood Components chart

*Quiz on Blood Components

Blood Components

	Red blood cells	White blood cells	Platelets	Plasma
Can also be called…				
Creative representation				
Origin				**Composition:**
Life span				
Number (% in blood)				
Color				
Relative size				
Function				
Other notes:				
Appearance: drawing				

Blood Testing for Disorders:

Red Blood Cell (RBC) **level**
Red blood cells (also called erythrocytes) have the important job of carrying oxygen from your lungs to all the parts of your body. When you do not have enough red blood cells, you develop a condition called *anemia.* When severe, anemia can cause symptoms of weakness, easy fatigue, dizziness, pounding in your head, heart palpitations, and shortness of breath.

Hemoglobin is the oxygen carrying protein that gives red blood cells their red color. Hemoglobin allows red blood cells to carry fresh oxygen to the body's cells and to transport carbon dioxide waste back to the lungs where it is exhaled. Hemoglobin is measured in grams per deciliter.

A normal HBG is different between the sexes: 14 - 18 gms/dL for men and 12 - 16 gms/dL for women.

Red Blood Cell
Another measurement of red blood cells is the Hematocrit which measures the amount ofspace that RBCs take up in the blood. This simple test is done by placing fresh unclotted blood in a narrow centrifuge tube, which is spun rapidly, forcing the red blood cells to the bottom of the tube and displacing the plasma to the top. The HCT is reported as a percentage of red blood cells to the total blood volume. A normal HCT is different between the sexes: 42 - 52% for men and 37 - 48% for women.

White Blood Cell (WBC) count and Differential
White blood cells (also called leukocytes) are your body's mobile defense system against infections. Like a SWAT team, white blood cells travel in the bloodstream to areas of infection and destroy harmful bacteria. A normal WBC count is 4.8 - 10.8 thousand cells per cubic millimeter, but varies from day to day depending upon the circumstances. The WBC count can be temporarily decreased when the body defends itself against a viral infection such as the common cold.

Platelet (PLT) count
Platelets (also called thrombocytes) are the cells that help stop bleeding. When an injury occurs, free-floating platelets quickly clump together to form clotted blood to stop a hemorrhage. Platelets are made in the bone marrow and last about 8 - 10 days in the bloodstream before being replaced. Platelet counts increase during strenuous activity and in certain conditions called myeloproliferative disorders, infections, inflammation, cancers, and when the spleen has been removed. Platelet counts decrease just before menstruation. They are measured in thousands per cubic millimeter. Normal values range from 150,000 to 400,000 per microliter.

Plasma: The Importance of Plasma
Is a clear liquid that is 90 percent water, and it is an essential ingredient for human survival. The water of the plasma is freely exchangeable with that of body cells and other extra cellular fluids and is available to maintain the normal state of hydration of all tissues.

Besides water, plasma also contains dissolved salts and minerals like calcium, sodium, magnesium, and potassium. Microbefighting antibodies travel to the battlefields of disease by hitching a ride in the plasma. Fatty substances (lipids) are also present in plasma in suspension and in solution.

Review Questions:

1. What is hemoglobin made of? What is its function?

2. How can you have a deficiency in hemoglobin?

3. Describe the purpose of the following:

a) WBC count:

b) RBC count:

c) PLT count:

4. What is a CBC?

5. What is a hematocrit?

Blood Clotting

What I think happens when a blood clot forms:	What really happens when a blood clot forms:

Blood Clotting

- Clotting = the solidification of the blood at the site of an injured blood vessel.
- Calcium and vitamin K are needed for proper blood clotting

Steps in the Formation of a Blood Clot: (Process involves > 30 different substances)

1. Injured blood vessel allows blood to flow from the wound.

2. Platelets encounter injured blood vessel and stick to it to form a 'plug' to prevent excessive blood loss.

3. Platelets rupture and release thromboplastin (enzyme), which initiates a series of controlled reactions.

4. Thromboplastin converts prothrombin (plasma protein) into thrombin (enzyme)

5. Thrombin converts fibrinogen (soluble plasma protein) into fibrin (insoluble threads which wrap around damaged area and form clot)

Platelets send out projections that grip one another and contract pulling damaged ends together to promote healing

6. Clot stops bleeding and hardens
    - Mitosis produces new cells to replace damaged cells
    - Plasmin (enzyme) dissolves fibrin clot when healing is finished

Note: A dry clot exposed to air is called a **scab.**

What Prevents Clots Inside Vessels?

1) Smooth inner lining of vessels
2) Anti-coagulants (heparin – circulates in blood and prevents clotting in intact vessels by interfering with conversion of fibrinogen to fibrin)

Clotting Problems

1) Hemophilia
   a. Genetic (hereditary) disease
   b. Body not producing clotting factors
   c. Injections can be given for missing factor

2) Low platelet number in blood
3) Low vitamin K intake
   a. Synthesizes prothrombin

4) Thrombus
   a. Blood clot that seals a blood vessel

5) Embolus
   a. A dislodged blood clot
   b. May travel in bloodstream and lodge in vital organs
      i. Coronary embolism = heart attack
      ii. Pulmonary embolism = blood clot in one of the blood vessels to your lungs

Activity:

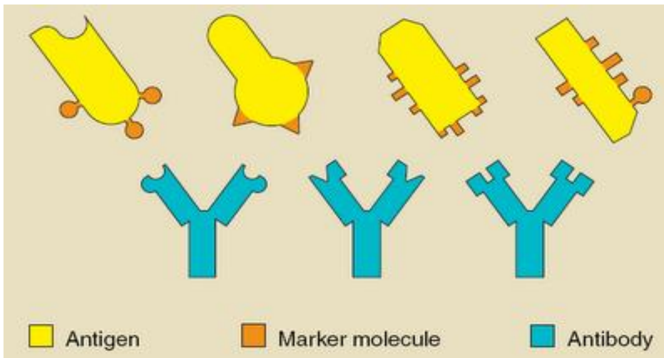
1) Make a figurative representation about the process of blood clotting

2) Why doesn't blood clot in your blood?

3) Why is low vitamin K intake a problem with Blood clotting?

Blood Typing

- ✖ ________________– a complex molecule, normally a protein of polysaccharide (sugar), that stimulates the production of a specific antibody
- ✖ ________________ – a protein, produced by cells of the immune system, that combines with a specific antigen and normally facilitates the destruction of the antigen

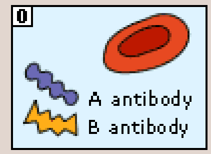
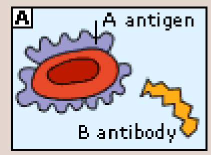
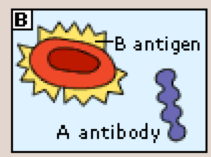


http://www.youtube.com/watch?v=lrYlZJiuf18

The Discovery

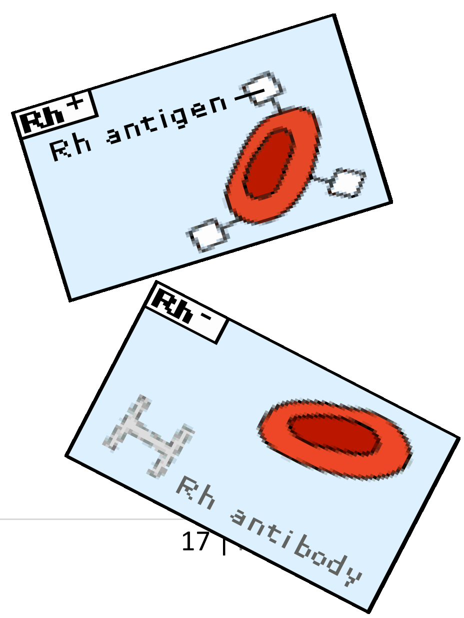
In 1901, ______________________ demonstrated the existence of blood group __________ _______ on human red blood cells as well as ________________ directed against those antigens in human sera (plasma). Blood was collected from members of his laboratory staff. He then separated the ______________________ from the serum, and then studied the results of mixing serum and red blood cells from different individuals. He discovered that some sera could ______________________ or clump the red blood cells of some individuals but not others. He realized that individuals could be grouped.

Group A individuals had an ______________, called A, on their red blood cells and _________________ to another antigen, called B, in their serum. Group B individuals had _____________________- on their red blood cells and antibodies to __________________ in their sera. A third group, called group O, had neither A nor B on their red blood cells but had both anti-A and anti-B in their sera. Some time later, individuals were described who had both A and B antigens on their red blood cells but no antibodies to A or B in their sera. This group was called AB. The table below summarizes his findings.

Blood Group	Antigen on RBC	Antibody in Serum	Diagram
			
			
			
			

<u>Rh Factor</u>

During the 1940's, scientists discovered another antigen on red blood cells. They called this antigen the ________________________ because the investigations used to discover this antigen involved the ________________________.



Many people have the _______________________ on the red blood cell's surface. Those who have it are called ________. Those who haven't are called __________. A person with Rh- blood ____________ have Rh antibodies naturally in the blood plasma (as one can have A or B antibodies, for instance). But a person with Rh- blood can develop Rh antibodies in the blood plasma if he or she __________________ _____________________________, whose Rh antigens can trigger the production of ________________ _________________. A person with Rh+ blood can receive blood from a person with Rh- blood without any problems.

- See notes on Erythroblastosis Fetalis

<u>Canadian Blood Services</u>

✖ Canadian Blood Services is the agency in Canada responsible for collecting blood donations. Blood and blood products are a critical part of everyday medical care, such as major surgeries and other medical procedures. Specifically:

✖ ______________________ can be used to help accident victims, surgical patients and people with anemia
________________ can be used to treat leukemia and cancer patients
________________ is effective in treating patients suffering from burns or shock

✖ __________________________________ are a critical element of:

- Organ transplants
- Cancer therapy
- Heart surgery
- Treatment for anemia
- Treatment for blood disorders
- Resuscitation of trauma victims
- Caring for premature infants

✖ Every minute of every day, someone in Canada needs blood. Much of the blood that is transfused every year is done under emergency or trauma situations. Hundreds of thousands of people each year receive blood components or blood products following accidents, during surgery or for cancer treatments, burn therapy, hemophilia and other blood-related diseases.

- ✖ The average amount of blood in one person is ____________________. There are approximately 450 mL of blood in a unit On average, 4.6 units of blood are required per patient Each year CBS collects approximately 800,000 units of whole blood Each year CBS collects almost 38,000 units of plasma Each year CBS collects approximately 18,000 units of platelets

Blood and Forensic Science

- ✖ Blood types can be used in crime scene forensics where investigators will examine blood samples and attempt to match these samples with suspects. In most cases, the blood will be used to obtain DNA for analysis. However, blood type forensics can be used in court as evidence to convict or prove innocence.

  Blood typing can also be used in legal situations involving identification or disputed paternity. In paternity cases a comparison of the blood types of mother, child, and alleged father may be used to exclude a man as the possible parent of a child. For example, a child with the blood type AB whose mother is type A could not have a father whose blood type is A or O. The father must have blood type B.

Blood Group Questions

1. How are blood groups related to antigens and antibodies?

2. Discuss Karl Lansteiner's contribution to current knowledge of blood groups.

3. Explain why erythroblastosis fetalis usually only involves the second or third pregnancy but not the first.

4. Summarize blood compatibilities involving the ABO and Rh blood groups.

5. Differentiate between a universal donor and a universal recipient.

6. Identify and describe situations where knowledge of blood types might be used.

Article - Blood Doping

Another drug war

The quest for better athletics through chemicals goes back a long time. In 1972, before steroids were banned, 68 percent of Olympic athletes admitted using them. During the 1970s and '80s, East Germany's huge doping program produced legions of highly successful, but oddly mannish female swimmers and track stars. In 1976, the year the Olympics started drug testing, East Germany bagged 11 of 13 women's swimming medals.

After the Berlin Wall fell, some East German sports doctors moved to China. In the 1994 Rome Olympics, Chinese women swimmers accepted 12 gold medals at ceremonies while onlookers protested by waving syringes. Twenty seven Chinese women have flunked drug tests since 1990, more than the total from all other nations.

One way to look at the problem is to gripe about "tainted athletes." On the positive side, the rise of doping is a sign of progress. As medicine identifies the molecular basis for health and disease, it presents athletes with new ways to improve their performance -- some legal, some not.

The tip of the hypodermic?

Many of the most popular new compounds are identical to natural chemicals made by the body --- making sure detection difficult or impossible. It was one of those undetectable drugs, erythropoetin or EPO, that caused the latest stink in Europe. Biker Marco Pantani, AKA the Pirate, was close to winning the Giro d'Italia, a multi-day race in his native Italy, when he failed a test intended to catch users of EPO.

EPO is a genetically-engineered version of a natural hormone made by the kidney that stimulates bone marrow to make red blood cells. synthetic EPO is sold as a rescue medicine for treating anemia in end-stage kidney disease, when production of EPO declines.

Because red blood cells carry oxygen to the muscles, and because bikers need a huge amount of oxygen during their arduous sport, raising the number of red blood cells can -- theoretically -- improve performance. Here's a description of the origin of synthetic EPO.

In the past, bike racers tried to increase the number of red blood cells by removing their own blood, storing it, and transfusing it back just before a race. Nowadays, this gory process of "blood doping" has been replaced by genetic engineering. Athletes simply inject EPO, which causes the body to make the cells.

Since EPO is a naturally occurring hormone, testing for it would detect anyone, not very helpful for identifying doped athletes. Unable to measure EPO itself, the mandarins of international cycling at Union Cycliste Internationale (UCI) rely on a surrogate test that measures the density of cells in the blood. Blood, as you'll recall, is composed of cells -- mainly red, but also white -- and serum and other liquids that help the cells flow. A study from the 1980s, before synthetic EPO, showed that bike racers' blood averaged a cellular content of 43 percent, so the UCI decreed that anybody with a level above 50 percent would be disqualified for taking EPO.

It wasn't me, babe

On June 5, 1999, Pantani, with a cellular content of 52 percent, was ejected from the Giro d'Italia. In a June 11 report in VeloNews, the great cyclist defended his record: "'I am a clean rider,' the 29-year-old Italian told a much-awaited press conference. 'My conscience is clear. I have nothing to do with doping. I am one of the few riders in the world who doesn't have a personal trainer. I don't need doping to win races, I need hill climbs.'"

Whether Pantani, whose trademark is breaking away from the pack on a hill, is telling the truth or not, it's true that detecting EPO is tricky, since training at high altitude also increases the number of red blood cells.

EPO is not the only genetically engineered compound that could help cyclists and other endurance athletes on the market. Growth hormone, which stimulates the growth of bones and muscle, became so popular that some athletes took to calling the 1996 Atlanta Olympics the "Growth Hormone Games." Like EPO, growth hormone cannot be reliably detected in abusers. Growth hormone can cause carpal tunnel syndrome and swelling in adults who are normally deficient in the hormone; the effects of the hormone on people with normal natural levels are not known.

If EPO and growth hormone are the wave of the future, anabolic steroids are the wave of the present.

<u>Questions</u>

1. What is the issue discussed in this article?

2. What does EPO stand for? What is EPO's role in your body?

3. How do you think athletic organizations can try to control EPO injections?

4. How does erythropoietin contribute to homeostasis in our body – specifically our blood?

5. What do you think the prefix "erythro-" stands for? Consider the words we have learned with this prefix so far.

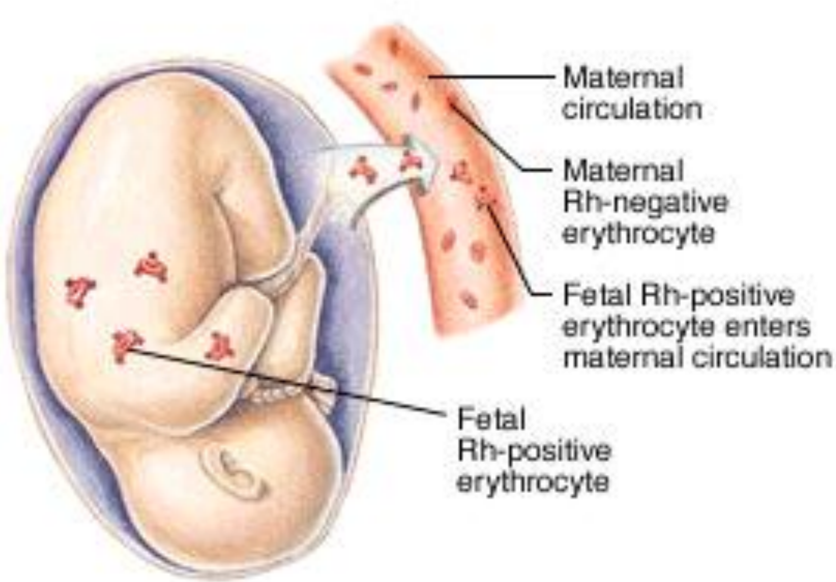
DID YOU KNOW? - Erythroblastosis fetalis

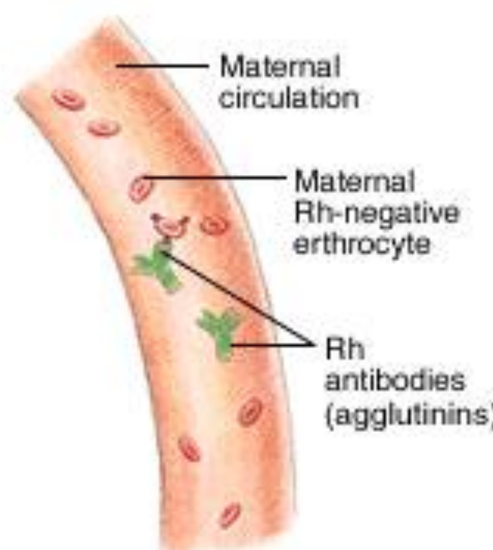
Erythroblastosis fetalis is a blood disease of a newborn infant caused by blood group incompatibility between mother and child. With an Rh-negative mother and an Rh-positive father, the possibility exists that the fetus will be Rh positive. Blood mixing during pregnancy permits fetal red blood cells to enter the maternal circulation, causing the mother to start to produce antibodies against the Rh antigen from the fetus.

Maternal antibodies pass through the placenta into the fetus, where an excessive destruction of fetal red blood cells occurs. When this destruction begins during pregnancy, stillbirth may result.

There is little danger of damage to the fetus during the first pregnancy because not enough antibodies have been produced by the mother. However, by the second pregnancy, sufficient antibodies will have accumulated in the mother's bloodstream to cause increasing danger.

The formation of maternal anti-Rh antibodies has been largely prevented in Canada by the injection of human immune globulin into the mother within 72 hours after delivery. This globulin contains antibodies against the Rh-positive fetal red blood cells, destroying them before the maternal bloodstream reacts by producing its own anti-Rh antibodies. Thus during the next pregnancy there will be few, if any, antibodies in the maternal bloodstream to destroy the fetal Rh-positive blood cells.





Blood Transfusion Case Studies

Station #1 Quinn has been extremely tired lately and really unable to do very much physical labour. As her doctor you diagnose her with anemia and suggest a blood transfusion. Quinn is O^+. She has a sister who is B^+ and a brother who is O^-. Who can donate blood to Quinn?	Station #2 Lester just went through a difficult surgery. His hemoglobin count is low and therefore you recommend a blood transfusion. Lester's blood type is B^-. As Lester's doctor what blood type(s) could you give Lester?

Station #3 Meagan was in a car accident and due to an injury to her spleen she was bleeding internally. You as her doctor were able to control the internal bleeding but must replace the blood with a transfusion. Meagan is A^-. What blood type(s) could you give to Meagan?	Station #4 Reagan is AB^+ and is suffering form severe heart disease. As her doctor you suggest to Reagan that she have a blood transfusion to increase the oxygen flow throughout her body. What blood type(s) could you give to Reagan?

Station #5 Gilles has a cancer that has affected his ability to produce enough red blood cells. As his doctor you want Gilles who is AB^- to have a blood transfusion. What blood type(s) could you give to Gilles?	Station #6 Donald is being prepared for a long heart surgery. However, his hemoglobin count is too low. As his doctor you recommend a blood transfusion before surgery. Donald is A^+. As Donald's doctor what blood type can Donald be given?

Station #7 Reg has hemophelia and needs clotting factors found in plasma. Reg is AB^-. As Reg's doctor from what blood type(s) can Reg receive the plasma/clotting factor from?	Station #8 Stacey has sickle cell anemia and requires a blood transfusion to help transport more oxygen to her tissues. She has O^- blood. From what blood type(s) could Stacey receive a transfusion

Station #9 Hilda has breast cancer and undergoes chemotherapy. The chemo has affected her red blood cell count and she needs a transfusion. Hilda is B^+. As her doctor what blood type(s) could you use for Hilda's transfusion?	Station #10 Bill has an immunodifficiency disorder that weakens his body's ability ot fight off infection. As his doctor you suggest a blood transfusion. Bill is A^+. What blood type(s) could you give Bill?

Blood Vessels

Blood Vessels

Blood vessels are the channels through which blood is distributed to body tissues. The vessels make up two closed systems of tubes that begin and end at the heart. One system, the **pulmonary system**, transports blood from the heart to the lungs and back to the heart. The other system, the **systemic system**, carries blood from the heart to the tissues in all parts of the body and then returns the blood to the heart. Based on their structure and function, blood vessels are classified as arteries, arterioles, capillaries, veins or venules.

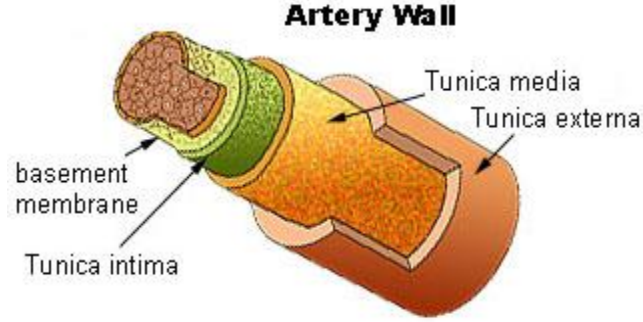
Arteries

Arteries are blood vessels which carry blood away from the heart to various parts of the body. The large arteries branch many times to form smaller and smaller arteries. The smallest arteries are called **arterioles**. The **aorta**, the largest artery in the human body, is about 25 mm in diameter. Arterioles on the other hand are only about 0.2 mm in diameter.

Artery walls are thick, strong and muscular and made of three tissue layers. The innermost layer is an epithelial tissue called **endothelium**, a smooth, thin sheet of tightly packed cells. The thick middle layer of the artery is made of elastic fibers and muscle fibers. In large arteries the middle layer is made mostly of elastic fibers. These fibers allow the large arteries to accommodate surges of blood pumped by the heart. The thick elastic walls stretch with the changing blood flow. This property of elasticity means that they can expand to accept a volume of blood, and then contract and squeeze back to their original size after the pressure is released. A good way to think of them is like a balloon. When you blow into the balloon, it inflates to hold the air. When you release the opening, the balloon squeezes the air back out.

As the arteries get smaller, the blood pressure gets less and the need for elastic fibers in the middle section diminishes. This layer becomes mostly muscle fibers that contract, changing the size of the arterial channel, regulating the pressure and amount of blood that enters the capillaries. The artery's outer layer is made of fibrous, connective tissue, nerves, and tiny blood vessels that nourish the artery's walls.

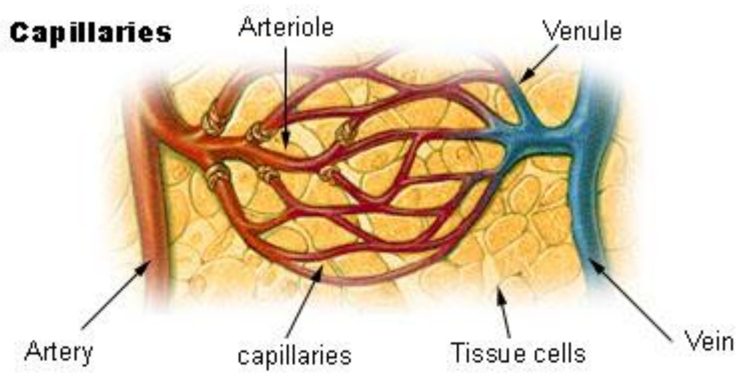
The diagram below illustrates the structure of arteries.



Capillaries

The two outermost layers of the arteries disappear as the arterioles branch into a network of capillaries. The capillaries have very thin walls, composed of a single layer of **endothelial** cells. The average diameter of a capillary is 7/1000 mm (7 µm), just wide enough to let red blood cells pass through single file.

Capillaries are really more like a web than a branched tube. It is in the capillaries that the exchange between the blood and the cells of the body takes place. Here the blood gives up its oxygen and takes on carbon dioxide. In the special capillaries of the kidneys, the blood gives up many waste products in the formation of urine. Capillary beds are also the sites where white blood cells are able to leave the blood and defend the body against harmful invaders. The diagram below illustrates a capillary bed.



There are approximately 100 000 km of capillaries in an adult. Because these minute capillaries are so numerous, (about 10 billion) they present a huge surface area to the tissue. More than 800 square meters of surface area allows for a great deal of exchange between the blood and the tissues. Tissues are so permeated with capillaries that rarely are any cells more than one cell layer away from a capillary. This is necessary to allow for the diffusion of materials between the body cells and the walls of the capillaries. The walls of capillaries are only one cell thick. Substances in the blood and substances in body tissue are exchanged only across the capillary endothelium.

Capillary networks serve nearly all of the living tissue of the body, their concentration in the tissue depending on the local need for exchange of materials. Muscles, which are called upon frequently to move the body, and the kidneys, which must remove waste products constantly, require great quantities of food and oxygen and are well supplied with capillaries. On the other hand, the cornea of the eye, a very inactive tissue, has none.

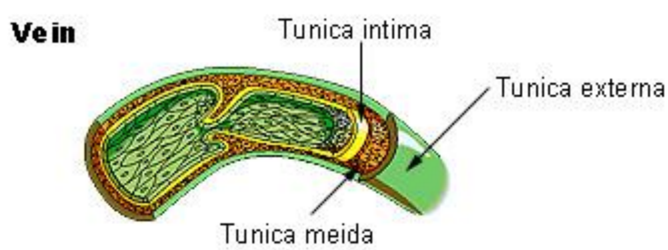
Veins

Veins are blood vessels which carry blood to the heart to from various parts of the body. Capillaries reunite to form venules, which join to form larger and larger veins, having progressively thicker layers of muscle and elastic fibers, and connective tissue. The structure of a vein is similar to that of an artery, except that the middle section, containing muscle and elastic fiber, is thinner because there is very little blood pressure in it. Because the walls of the veins are thinner and less rigid than arteries, veins can hold more blood. Almost 70 percent of the total blood volume is in the veins at any given time.

Although the blood is forced into the arteries under pressure, by the time it reaches the veins, this pressure is very low. Blood pressure in the veins is less than 1/10 of the pressure in the aorta. Therefore, another mechanism must be present for getting blood back to the heart.

The veins depend largely on the pressure exerted on them by the surrounding tissues to return the blood to the heart. Most veins, particularly in the arms and legs, have one-way **valves** that prevent the backflow of blood into the capillaries. While standing, a person unconsciously contracts muscles in his legs to force blood through the leg veins. When blood is not being forced forward in the vein, the valve closes to prevent blood from flowing backward.

The diagram below illustrates the structure of veins.



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Veins, like other blood vessels are subject to problems. Large volumes of blood tend to stretch the veins. In most cases, the elastic tissue allows them to return to their original shape. However, if the pooling of the blood occurs over long periods of time, the valves become damaged. Without the proper functioning of the valves, gravity carries the blood toward the feet and greater pooling occurs. Surface veins become larger and begin to bulge. This disorder is known as **varicose veins**. Varicose veins are usually associated with lifestyle. Prolonged standing, especially with restricted movement increases the pooling of blood.

Comparing Vessels

	Artery	Vein	Capillary
Direction of Flow			
Inner Wall			
Smooth Muscle			
Gas & Nutrient Exchange			
Blood Pressure			
Valves Present			
Fluid Moved by			
Oxygen Content			
Carbon Dioxide Content			

Know Your Blood Pressure by Heart Quiz

What do you know about blood pressure? Take this short quiz by circling either "T" for TRUE or "F" for FALSE for each of the following statements about blood pressure.

Check your answers on the reverse.

1. Blood pressure begins with a heart beat.	T	F
2. Blood pressure stays the same all day, every day.	T	F
3. Blood pressure helps the blood flow to all parts of the body	T	F
4. A blood pressure reading has two numbers.	T	F
5. You can tell what your blood pressure is by the way you feel.	T	F
6. A healthy person could have a blood pressure of around 120/80.	T	F
7. Blood pressure should be checked every five years.	T	F
8. You can only tell what your blood pressure is by having it measured.	T	F
9. Being overweight can lower blood pressure.	T	F
10. Eating large amounts of food high in salt (sodium) can cause blood pressure to rise.	T	F
11. Regular exercise will help keep your blood pressure healthy.	T	F
12. Only a relaxed and easy-going person can have normal blood pressure.	T	F

Answers to Blood Pressure Quiz

1. TRUE. When the heart beats it pushes through the arteries and veins. Blood pressure is created by the force (pressure) of the blood pushing against the walls of the blood vessels, as it flows through them.
2. FALSE. Blood pressure changes moment to moment and day to day. It is usually lowest when we sleep and gradually rises throughout the day. Changes in activity, posture and emotions cause changes in blood pressure.
3. TRUE. Everyone has blood pressure. It is not an illness or an abnormal condition. Blood pressure keeps us healthy by helping the blood flow to all parts of the body.
4. TRUE. Systolic pressure (the first or larger number) refers to the highest pressure in the arteries. It occurs every time the heart beats. Diastolic pressure (the second or a smaller number) refers to the lowest pressure in the arteries. It occurs when the heart is relaxing between beats.
5. FALSE. You cannot tell your blood pressure by the way you feel.
6. TRUE. The normal range of blood pressure is up to 140 for the systolic pressure (the first or larger number), and up to 90 for the diastolic pressure (the second or smaller number).
7. FALSE. The Royal Collage of Family Physicians in Canada recommends that a healthy person should have her or his blood pressure checked every two years. If you are pregnant, your blood pressure should be checked more often.
8. TRUE. The only way to tell your blood pressure is to have it checked. Always have your blood pressure checked by someone who can refer you for medical care if needed.
9. FALSE. Being overweight can lead to an unhealthy blood pressure.
10. TRUE. Using less salt has proven to be a useful of treatment for some Individuals with high blood pressure. Most Canadians eat more salt than necessary, so using less salt makes good sense.
11. TRUE. Regular exercise, three times a week for 20 to 30 minutes at a time, can help keep your blood pressure healthy.
12. FALSE. Blood pressure is not necessarily higher in anxious, overactive people than it is in easy going, relaxed people.

Score
0-3 Poor. Lots of room for improvement
4-7 Fair. You need to improve your score.
8-10 Good. But you can still do better.
11-12 Excellent. But aren't you curious to know more?

From Heart and Stroke Foundation "Know Your Blood Pressure by Heart" handout.

Blood Pressure

___________________ is defined as the force of blood against the walls of arteries. The blood must reach the hands and feet, the brain, and every other part of the body in order to nourish those cells. In order the reach every extremity, it must be pumped out of the heart under considerable pressure. The highest pressure occurs in the aorta, the large vessel that carries oxygenated blood away from the heart. As the blood passes into smaller vessels and the distance from the heart becomes greater, the pressure becomes reduced.

The pressure in any artery varies as a result of two major factors.

1. ________________

- _________________. The volume blood pumped with each beat of the heart will affect blood pressure in the arteries. If as a result of some injury a person has lost a lot of blood, the pressure in the system drops because of the decrease in volume.
- _________________. The faster the heart pumps blood, the greater the pressure which is built up. The pressure falls as the heart rate decreases, especially during rest or sleep.

2. ____________________

- ____________ - When the arteries dilate (become bigger in diameter), the volume of the vessels increases and the pressure falls. If the arteries constrict (become smaller in diameter), pressure is built up because of the extra resistance to blood flow.
- _____________ - . The walls of the artery must be flexible and elastic. They must be able to expand as a surge of blood is forced out of the heart, and then relax after the surge has passed. If they cannot stretch this way they are described as hardened. Hardened arteries lead to increased blood pressure.

Measuring Blood Pressure

Two different pressures are measured and compared in a blood pressure reading.

__________________________ is the amount of pressure the blood exerts on the walls of the arteries when the _______________. ______________________ is the amount of pressure the blood exerts on the walls of the arteries when the _____________________.

The pressure of the blood pressing against the arterial walls can be measured using a device called a __________________________**.** To measure blood pressure, an inflatable rubber cuff is wrapped around the upper arm. As air is pumped into the cuff, the cuff presses on the arteries of the arm. When the pressure in the cuff is high enough, the blood flow through the arteries ceases. A ______________________is placed over one of the arteries in the elbow, and the air in the cuff is gradually released. At first, the person listening through the stethoscope hears no sound. Then, a sharp tapping sound is heard. This sound is made by the blood spurting through a narrow opening in the compressed artery. The pressure reading just as this sound is heard is the systolic pressure. As more air is released from the cuff, the sound becomes muffled and then stops as the cuff ceases to press on the artery. The pressure reading just as the sound stops is the diastolic pressure.

Blood pressure is measured in millimeters of mercury (mm Hg). It is expressed as a ratio of systolic pressure to diastolic pressure. A reading of 120/70 means that the person's systolic pressure is 120 mm Hg and the diastolic pressure is 70 mm Hg. It is expressed verbally as "120 over 70."

Normal blood pressure is less than 130 mm Hg systolic and less than 85 mm Hg diastolic. Optimal blood pressure is less than 120 mm Hg systolic and less than 80 mm Hg diastolic. A typical reading for a healthy adult is 120/70. Readings for children and adolescents may be slightly higher.

A physician can infer much about a person's health by taking a blood pressure reading.

Hypertension:

High blood pressure or **hypertension** is defined in an adult as a blood pressure greater than or equal to 140 mm Hg systolic pressure or greater than or equal to 90 mm Hg diastolic pressure. High blood pressure directly increases the risk of coronary heart disease (which can lead to heart attack) and stroke, especially along with other risk factors.

High blood pressure can occur in children or adults, but it's more common among people over age 35. It's particularly prevalent in middle-aged and elderly people, obese people, heavy drinkers and women who are taking birth control pills. It may run in families, but many people with a strong family history of high blood pressure never have it. People with diabetes mellitus, gout or kidney disease are more likely to have hypertension.

The diastolic pressure is particularly important and a reading above 90 is considered high. This means that even when the heart is at rest, the pressure in the arteries is too high, and this may lead to blood vessel damage in the heart, brain or kidneys.

Blood pressure is normally controlled by nerves that have their center in the brain. If the blood pressure in certain vessels increases, the brain sends nerve impulses to the heart and to the blood vessels, causing the heart rate to slow and the blood vessels to widen. As a result the blood pressure decreases. If the blood pressure becomes too low, the brain sends impulses that cause the heart rate to increase and the blood vessels to narrow, increasing the blood pressure. This is another case of homeostasis—maintaining a constant internal environment. If this regulatory mechanism cannot bring the blood pressure to normal levels, a condition known as hypertension is evident and medical assistance is required.

The factors causing hypertension are not well understood. In 90% of the cases of hypertension, the cause is unknown. It is well documented that hypertension is more common in societies in which salt consumption is high. Hypertension is also a much greater problem among obese (over-weight) people. There is a strong heredity influence, as hypertension tends to "run in families." The current view is that excessive salt intake and obesity trigger hypertension only when an underlying genetic predisposition is present. Drugs such as nicotine and caffeine can also increase blood pressure as they are categorized as stimulants. Stimulants increase heart rate and therefore increase blood pressure. People with high blood pressure are encouraged to reduce coffee consumption and quit smoking.

Risk Factors You Can Control

- Smoking
- Physical Inactivity
- Obesity
- Diet (Salt Intake)
- Diabetes
- Stress

Risk Factors You Can't Control

- Age
- Ethnicity (South Asians, First Nations/Aboriginal Peoples or Inuit and people of African decent are at increased risk)
- Family history

The goal of treatment is to reduce the diastolic blood pressure to less than 90 mm Hg. Treatment consists of a combination of no-added-salt diet, weight loss if the person is over-weight, and drug medication. The excess fluid that sodium (salt) holds in the body may also put an added burden on the heart and "waterlog" the blood vessels, causing them to contract or narrow more easily. The blood vessels then take less diluted blood to the organs of the body than the quantity of normal blood that is required, depriving the cells of some oxygen and nutrients that they need. For this reason, low-sodium diets are used in treating mild to moderately severe hypertension. However, in individuals with severe hypertension, salt restriction must be severe.

When the demand for blood in various parts of the body is high (e.g. during exercise), the heart must pump faster, increasing the blood pressure in the vessels. Fatty tissue requires a lot of blood to feed it. Therefore, another way to reduce blood pressure and the stress on the heart is to lose weight. In addition to possibly lowering blood pressure and reducing weight, a low-fat, low-cholesterol diet may also help delay the beginning of arteriosclerosis. Medications called diuretics, which help rid the body of excess salt and therefore, of excess water, are often prescribed by the doctor in the treatment of hypertension.

Blood Pressure in Capillaries and Veins

Blood pressure in the Capillaries

The pressure of arterial blood is significantly reduced when the blood enters the capillaries. Capillaries are tiny vessels with a diameter just about that of a red blood cell (7 µm). Although the diameter of a single capillary is quite small, the number of capillaries supplied by a single arteriole is so great that the total area available for the flow of blood is increased. Therefore, the pressure of the blood as it enters the capillaries decreases.

Blood pressure in the veins

When blood leaves the capillaries and enters the venules and veins, little pressure remains to force it along. Blood in the veins below the heart is helped back up to the heart by the muscle pump. This is simply the squeezing effect of contracting muscles on the veins running through them. One-way flow to the heart is achieved by valves within the veins.

Blood Pressure Questions:

1. a) What is blood pressure?

   b) List and describe two major factors that affect blood pressure.

2. a) Differentiate between systolic and diastolic blood pressure.

   b) How is blood pressure measured?

   c) What are "normal" blood pressure measurements?

   d) What effect does exercise have on blood pressure?

3. a) Define hypertension.

   b) What are some of the possible side effects of hypertension?

   c) Discuss the causes, risk factors and treatment of hypertension.

4. Define Artheriosclerosis. This is not in your notes. You are responsible to find this information on your own at home. We will discuss it next day.

Major Systemic Arteries and Veins

All systemic arteries are branches, either directly or indirectly, from the **aorta**. The aorta ascends from the left ventricle, curves to the left, and descends through the thorax and abdomen. This geography divides the aorta into three portions: ascending aorta, aortic arch, and descending aorta.

After blood delivers oxygen to the tissues and picks up carbon dioxide, it returns to the heart through a system of veins. The capillaries, where gas exchange occurs, merge into venules and these converge to form larger and larger veins until the blood reaches either the **superior vena cava** or **inferior vena cava**, which drain into the right atrium.

The Heart

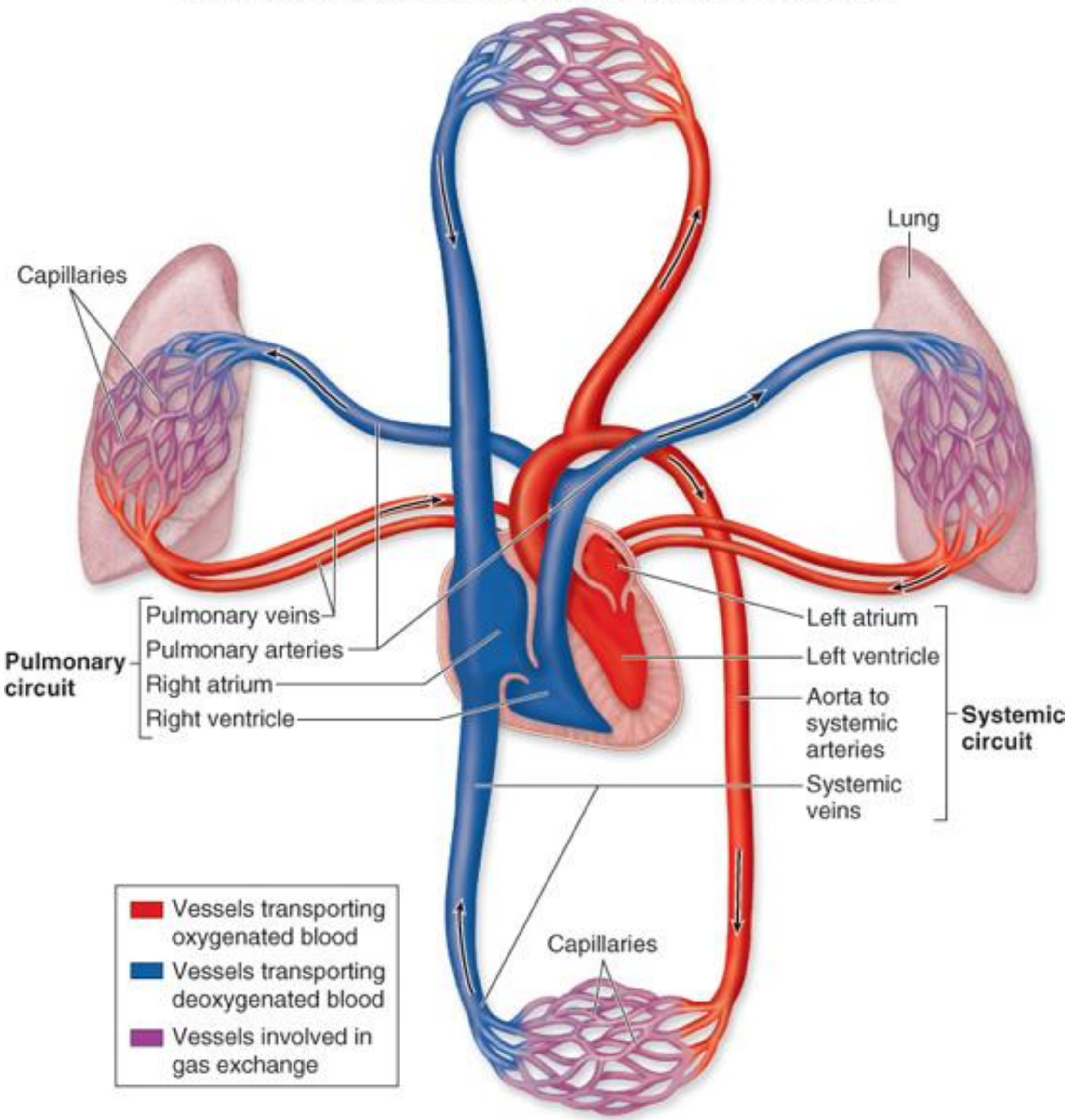
While most of the hollow organs of the body do have muscular layers, the heart is almost entirely muscle. Unlike most of the other hollow organs, whose muscle layers are composed of smooth muscle, the heart is composed of **cardiac muscle** called the **myocardium**. The heart is surrounded by a fluid-filled membrane called the **pericardium**. The **pericardial** fluid bathes the heart, preventing friction between its outer wall and the membrane.

The human heart is really two pumps working side by side. A thick wall of muscle, called the **septum**, separates the heart's right and left sides. Each side is divided into two chambers: the atrium and the ventricle. The upper chambers, the **left atrium** and **right atrium**, collect blood returning to the heart through veins. The thin muscles of their walls push blood a short distance into the lower chambers, the **left ventricle** and **right ventricle**. The thick, muscular walls of the ventricles contract forcefully, pushing blood out of the heart to the lungs and body through arteries.

The heart is responsible for pumping the blood to every cell in the body. It is also responsible for pumping blood to the lungs, where the blood gives up carbon dioxide and takes on oxygen. The heart is able to pump blood to both regions efficiently because there are really two separate circulatory circuits with the heart as the common link. Some even refer to the heart as two separate hearts, a right heart (pulmonary system) and left heart (systemic system).

In the pulmonary system, blood leaves the heart through the **pulmonary trunk** which branches into the left and right **pulmonary arteries**, goes to the lungs, and returns to the heart through the left and right **pulmonary veins**. In the systemic system, blood leaves the heart through the **aorta**, goes to all the organs of the body through the systemic arteries, and then returns to the heart through the systemic veins.

Arteries carry blood away from the heart and veins carry blood toward the heart. Most of the time, arteries carry oxygenated blood and veins carry deoxygenated blood. However, there is an exception. The pulmonary arteries leaving the right ventricle for the lungs carry deoxygenated blood and the pulmonary veins carry oxygenated blood. The diagram below illustrates this relationship.



Blood from any body tissue other than the lungs returns to the heart through either of two veins: **superior vena cava** and **inferior vena cava**. The former drains blood from the arms, head, and upper part of the body; the latter drains the lower part of the body and legs. The blood in these veins, called deoxygenated blood, has low oxygen content and high carbon dioxide content. It passes from the superior vena cava and the inferior vena cava into the right atrium of the heart. A contraction of the right atrium forces blood into the lower chamber, the right ventricle.

Two valves regulate the flow of blood between the atria and ventricles. These valves, commonly called the **atrioventricular (AV) valves**, consist of three flaps of tissue that together form a more or less funnel-shaped arrangement, the narrow end extending into the ventricle. The pressure of the blood in the atrium forces the valve open, but when pressure develops in the ventricle, the pressure pushes the flaps against each other, effectively closing the opening. The **tricuspid valve** regulates blood flow between the right atrium and right ventricle. The **mitral valve** lets oxygen-rich blood from your lungs pass from the left atrium into the left ventricle.

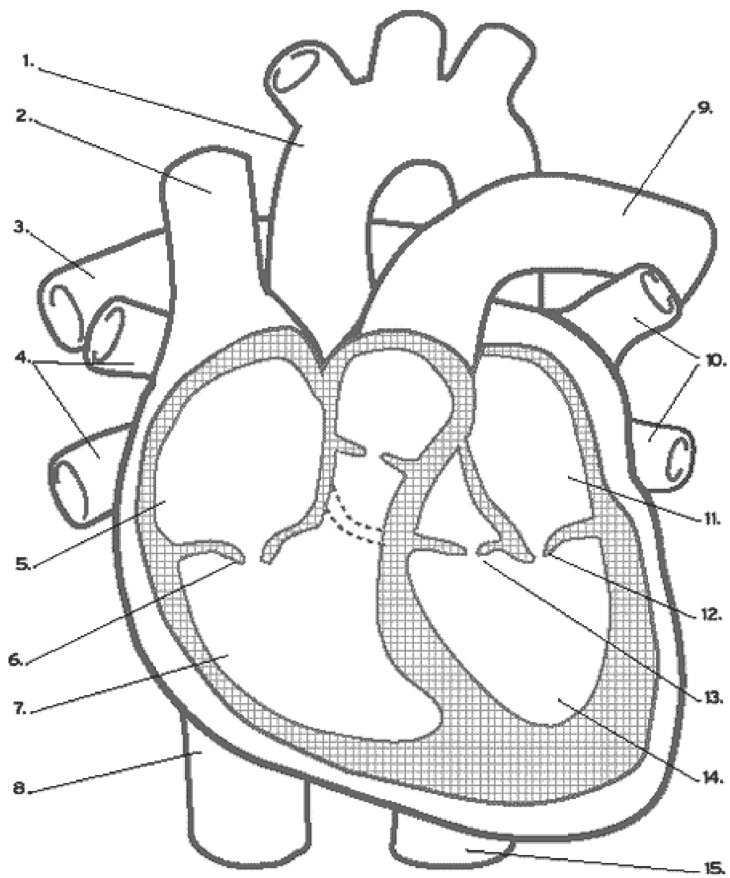
Two valves regulate the flow of blood between the ventricles and the major vessels leaving those ventricles. These valves are commonly known as semilunar valves. The contraction of the right ventricle can force blood out only through the pulmonary trunk, the only artery departing from the right ventricle. Another valve, the **pulmonary valve**, between the right ventricle and the pulmonary trunk prevents backflow of blood. The pulmonary trunk branches into the two pulmonary arteries, each of which serves a different lung. In the capillaries of the lungs, deoxygenated blood releases the carbon dioxide it received from the body tissues and receives a fresh supply of oxygen.

After passing through the lungs, oxygenated blood returns to the heart by way of the pulmonary veins, which enter the left atrium. Contraction of this chamber forces blood into the left ventricle. The mitral valve between the left atrium and the left ventricle prevents the backflow into the left atrium. Contraction of the left ventricle forces blood into the aorta, the largest artery of the body. The **aortic** valve prevents backflow into the left ventricle from the aorta when the ventricle relaxes.

The branches of the aorta carry oxygenated blood to all parts of the body except the lungs. In the brain, a muscle, a gland, or some other organ, the oxygenated blood becomes deoxygenated blood as it releases its oxygen and accepts carbon dioxide from the tissues.

The Heart Questions

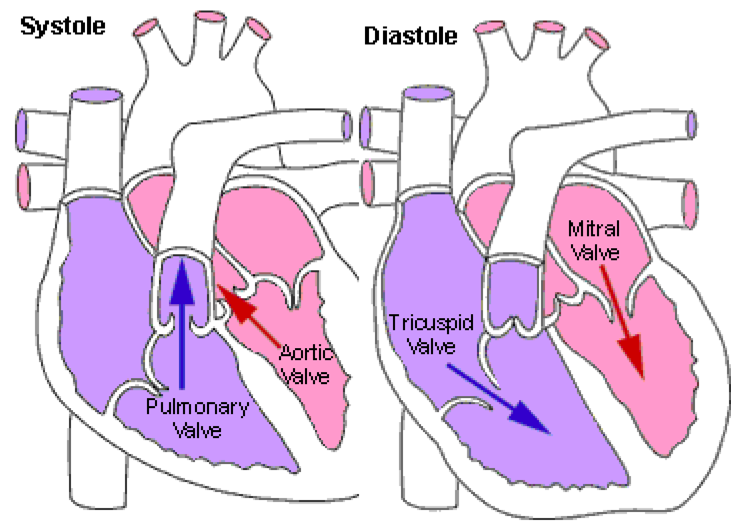
1. List 5 ways that the human circulatory system contributes to homeostasis.
2. Compare and contrast the structure and function of arteries, capillaries and veins.
3. Why is it necessary to have 100 000 km of capillaries in your body?
4. Differentiate between the pulmonary and systemic circulatory systems.
5. Name and give the function of the four valves found in the heart
6. Using the following diagram of the heart, label the major structures and trace the flow of blood using arrows. Use the colors blue and red to distinguish between deoxygenated and oxygenated blood.



The Heartbeat

A heartbeat is a two-part pumping action that takes approximately one second. The contraction of the heart and its anatomy cause the distinctive sounds heard when listening to the heart with a stethoscope. The **"lubb-dubb"** sound is the sound of the valves in the heart closing. When the ventricles begin to contract, the blood is forced back against the AV valves between the atria and the ventricles, causing the valves to close. This is the "lubb" sound, and signals the beginning of ventricular contraction, known as **systole**. The "dubb" is the sound of the valves closing between the ventricles and their arteries, and signals the beginning of ventricular relaxation, known as **diastole**.

After blood moves into the pulmonary artery and the aorta, the ventricles relax, and the pulmonary and aortic valves close. The lower pressure in the ventricles causes the tricuspid and mitral valves to open, and the cycle begins again. This series of contractions is repeated over and over again, increasing during times of exertion and decreasing while you are at rest.



Your heart does not work alone, though. Your brain tracks the conditions around you—climate, stress, and your level of physical activity—and adjusts your cardiovascular system to meet those needs.

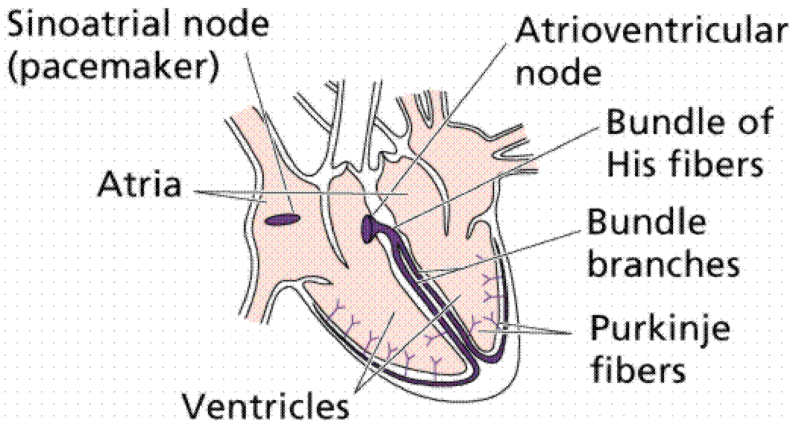
Control of Heartbeat

The contraction of the heart muscles of the atria and ventricles is initiated by a mass of specialized cells known as the **sinoatrial node (SA node)**. The SA node is located in the posterior wall of the right atrium, near the entrance of the superior vena cava. The SA node is called the **pacemaker** because it produces the impulse that starts each heartbeat.

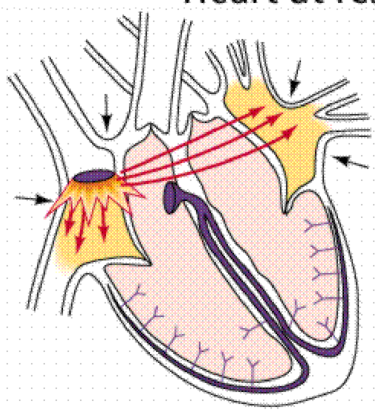
When the SA node "fires", the nerve impulse spreads quickly over both atria, causing the atrial muscles to contract. The impulse then reaches a second node of tissue, the **atrioventricular node (AV node)**, located in the septum between the ventricles but in contact with the lower portion of the right atrium. The stimulation of the AV node causes nerve impulses to be sent down the bundle of nerve fibers, known as the **Bundle of His**. The Bundle of His branches into a pair of nerve fibers through the septum and circling around the base of each ventricle. The impulse started in the SA node and picked up by the AV node reaches the muscles of the ventricles and causes them to contract.

The heart has special muscle fibers called **Purkinje fibers** that conduct impulses five times more rapidly than surrounding cells. The Purkinje fibers form a pathway for conduction of the impulse that ensures that the heart muscle cells contract in the most efficient pattern.

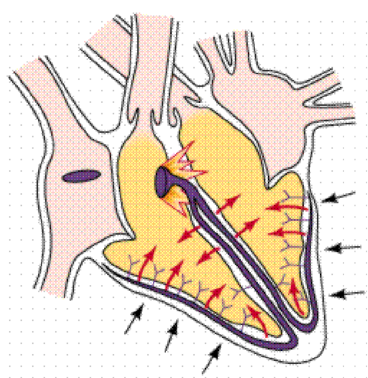
The following diagrams illustrate the sequence of events involved in a heart contraction.



Heart at rest



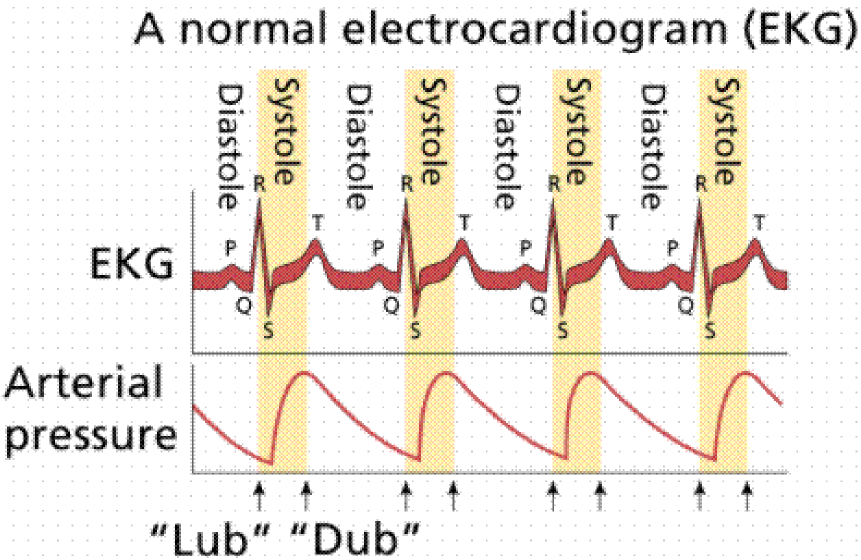
Sinoatrial node fires, action potentials spread through atria which contract



Atrioventricular node fires, sending impulses along conducting fibers; ventricles contract

A physician listening carefully to the heart with a **stethoscope** can detect if the valves are closing completely or not. Instead of a distinctive valve sound, the physician may hear a swishing sound if they are letting blood flow backward. When the swishing is heard tells the physician where the leaky valve is located. This condition is known as a heart **murmur**.

An **electrocardiograph** is an instrument that is used to measure electrical activity in the heart. It measures changes in electrical potential across the heart and can detect the contraction pulses that pass over the surface of the heart. The resulting record is called an **electrocardiogram (ECG or EKG)**. The EKG shows three slow, negative changes, known as P, R, and T. Positive deflections are the Q and S waves. The P wave represents the contraction impulse of the atria, the T wave the ventricular contraction. EKGs are useful in diagnosing heart abnormalities.



The SA node sends electrical impulses at a certain rate, but your heart rate may still change depending on physical demands, stress, or hormonal factors. For example, when you run to catch a bus, the increased activity in your muscles produces a faster rate of cellular respiration. This leads to an increase in the amount of carbon dioxide in your blood. The medulla oblongata detects this increase and sends impulses along the nervous system causing the release of a hormone called **noradrenaline**. When noradrenaline reaches the SA node, it makes the node fire more rapidly. Once you have boarded the bus, your heart gradually slows to a resting rate due to an increase in blood pressure. This response is detected by special blood pressure receptors located in the walls of the aorta and carotid arteries that send messages to the medulla oblongata.

Physical activity is not the only trigger for an increased heart rate. Your nervous system releases another hormone called **adrenaline** when you are nervous, angry, excited or after a sudden shock or sharp pain. All of these conditions produce what is called the "flight or fight" response – a physiological change that prepares the body for anticipated activity. This response increases heart rate, increasing blood flow to the muscles.

The Control of Heartbeat Questions

1. What causes the characteristic "lubb-dubb" heart sounds?

2. Describe the structures involved and the sequence of events involved in a heart contraction.

3. What is an ECG? Why are they useful?

4. Why do some people require an artificial pacemaker?

5. Describe the conditions that would cause the release of noradrenaline and adrenaline and their resulting effects of on heart rate.

6. How are heart rate and stroke volume related to fitness?

7. Explain the changes in pulse rate during exercise.

Artheriosclerosis

Atherosclerosis is a form of arteriosclerosis, a general term for the thickening and hardening of the arteries. Atherosclerosis comes from two Greek words: athero (meaning gruel or paste) and sclerosis (hardness). In atherosclerosis, the walls of the arteries have a build-up of **plaque**, a combination of cholesterol, cellular waste products, calcium and fibrin (a clotting material in the blood). Plaque rupture can trigger the formation of a blood clot.

Atherosclerosis affects large and medium-sized arteries. The type of artery involved and the location of the plaque varies with each person. Researchers are still trying to determine why plaque is "patchy" (i.e., why it doesn't occur consistently throughout the artery but is found only in certain locations). Atherosclerosis is a slow, progressive disease that may start as early as childhood. People's susceptibility to atherosclerosis varies with their genetic make-up and their lifestyles.

The causes of atherosclerosis are complex and still not entirely understood. Blood vessels have a thin lining composed of endothelial cells. Many scientists think atherosclerosis begins when this inner lining becomes damaged. The blood vessel wall reacts to this injury by stimulating various types of cells to grow and reproduce. The result is a progressive thickening of the blood vessel wall.

Risk factors for atherosclerosis include:

- High levels of LDL cholesterol and triglycerides in the blood;
- Lipoprotein oxidation, the process whereby cholesterol is modified by elements called "free radicals" and becomes more damaging to the blood vessels;
- High blood pressure;
- Smoking. Cigarette smoke greatly aggravates and speeds up the growth of atherosclerosis in the coronary arteries;
- Genetics. There appears to be a strong genetic component to atherosclerosis.

A person with atherosclerosis may remain symptom-free until the disease is far enough advanced to block a significant portion of some important blood vessel. If the blockage occurs in a coronary artery (one which supplies the heart muscle), the result is **angina**. Angina (angina pectoris is the full medical term) is chest pain. It is sometimes described as "pressure" or "discomfort" rather than pain; it may also radiate to the throat, jaw, back, or arms. Angina usually follows a predictable pattern. Pain generally occurs at about the same point when exercising and/or under emotional stress. The pain usually comes on with activity and/or emotional stress and goes away with rest and/or nitroglycerin within three to five minutes. Angina is a warning signal. It is the heart muscle's way of telling the body that it is being forced to work too hard and needs to slow down.

Atherosclerosis can cause a **heart attack** or **myocardial infarction** in one of two ways. First, it can block coronary arteries to such an extent that little or no blood can get through to the heart. Second, rupture of plaque can trigger the formation of blood clots, which may then block a coronary artery.

Circulation and Blood Types Review

1. List the following in the correct order of blood flow:
- Vena cava, left atrium, right ventricle, right atrium, left ventricle, pulmonary artery, pulmonary vein, tricuspid valve, aortic valve, mitral valve, pulmonary valve, aorta

2. List 5 ways that the human circulatory system contributes to homeostasis.

i.
ii.
iii.
iv.
v.

3. Explain how the structure of arteries, capillaries and veins are related to their function.
4. What are varicose veins?
5. What are the differences between the atria and the ventricles?
6. Where are the valves in the heart located, what are they called and what is their function?
7. Be able to label the heart diagram with the following:
   - Aorta
   - Pulmonary Artery
   - Pulmonary Vein
   - Superior and Inferior Vena Cava
   - Tricuspid Valve (Atrioventricular Valve)
   - Mitral Valve
   - Pulmonary Valve (Semi-Lunar Valve)
   - Aortic Valve (Semi-Lunar Valve)
   - Left and Right Atria
   - Left and Right Ventricle
   - Septum

8. Describe the difference between systemic and pulmonary circulation.
9. Describe what happens during systole and diastole phases of the heartbeat cycle.
10. What causes the “lub-dub” sound of the heartbeat?
11. Explain how a heartbeat spreads out over the heart. Be specific. (Include sinoatrial node, atrioventricular node, Bundle of His, and Purkinje fibers)

12. Compare and contrast the structure and function of veins and arteries:

	Similarities	Differences
Veins		
Arteries		

13. How does blood clot? Explain the process including all of the following words:

- Fibrinogen
- Prothromin
- Fibrin
- Thrombin
- Platelets
- Plasmin
- Thromboplastin

14. Describe how the absence of Vitamin K inhibits blood clotting
15. What does plasma contain (be sure in include the different proteins)
16. What is erythropoietin (EPO)? What is the debate surrounding synthetic EPO
17. What is Erythroblastosis fetalis?
18. How come the second pregnancy is more dangerous for the baby if the mother is Rh-negative and the father is Rh-positive?

19. Fill in the Following Charts:

	Red Blood Cells	White Blood Cells	Platelets
Another name			
Origin			
Life Span			
Function			

Blood Group	Antigen on RBC	Antibody in Serum	Can Receive from	Can Donate to
A-				
A+				
B-				
B+				
AB+				
AB-				
O+				
O-				

	Location	Function
Mitral Valve		
Tricuspid Valve		
Aortic Valve		
Pericardium		
Myocardium		
Pulmonary Artery		
Pulmonary Vein		
Aorta		
Sinoatrial Node		

Atrioventricular Node		
Bundle of His		

20. What is hemoglobin and where is it found?
21. What is a hematocrit? What is the purpose of a hematocrit?
22. What is a Complete Blood Count (CBC)
23. How were blood types discovered?
24. What is the function of the pericardium?
25. Fill in the following chart on hormones relating to the circulatory system:

Hormone	What causes it's release?	What does it do?
Noradrenaline		
Erythropoeitin		
Adrenalin		

26. What is an ECG? Why are they useful?
27. What are the rules of drawing a proper biological drawing?
28. What does the pacemaker do? Why would a person need one?
29. What are the different components of blood? What is the function of each?
30. Can a person with Type A- blood receive from a person with type O- blood? Why or why not? (Be specific – include antigens and antibodies)
31. Can a person with Type B+ blood receive from a person with Type A- blood?
32. Describe the following disorders:
    i) Hemophilia
    ii) Sickle Cell Anemia
    iii) Anemia
    iv) Pulmonary Embolism
    v) Coronary Embolism
33. What are the five functions of the circulatory system?
34. What blood group is the universal donor? Universal Recipient?