CHAPTER VI

Blood & The Cardiovascular System: Our Transportation System

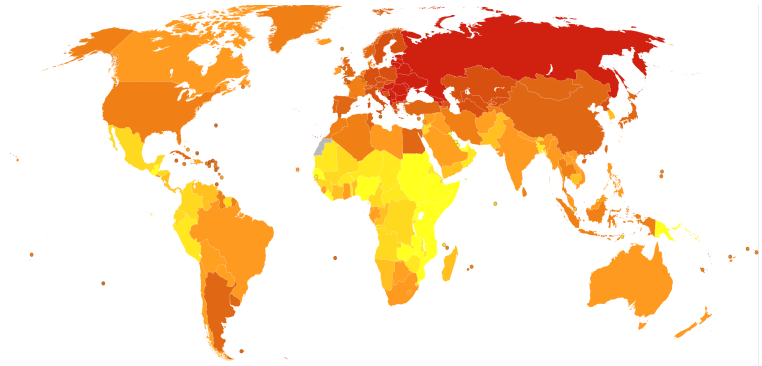
LEARNING OBJECTIVES

By the end of this class you should be able to:

- Define and understand the term "cardiovascular disease" (CVD)
- Provide examples of causes and consequences of CVD
- List and describe the components of the cardiovascular system
- Define systemic and pulmonary circuits, list the different types of blood vessels and provide their functions
- Describe the basic anatomy of the heart
- Explain the steps involved in the heart cycle and describe the structures involved
- Understand the diagnostic relevance of basic cardiac examinations (ECGs, blood pressure measurement, pulse) and the procedures associated to them.
- List functions and components of the blood
- Understand and discuss blood groups and blood typing

Introduction

Cardiovascular disease (CVD) is a class of diseases that involve the heart or blood vessels and is the leading cause of death globally. This is true in all areas of the world except Africa. In 2008, 30% of all global death was attributed to cardiovascular diseases. Most cardiovascular disease affects older adults. The average age of death from coronary artery disease in the developed world is around 80 while it is around 68 in the developing world. Diagnosis of disease typically occurs seven to ten years earlier in men as compared to women and the underlying mechanisms vary depending on the disease. Coronary artery disease, stroke, and peripheral artery disease involve atherosclerosis (the build-up of fat and other material in blood vessels). This may be caused by high blood pressure, smoking, diabetes mellitus, lack of exercise, obesity, high blood cholesterol, poor diet, and excessive alcohol consumption, among others. High blood pressure is estimated to account for approximately 13% of CVD deaths, while tobacco accounts for 9%, diabetes 6%, lack of exercise 6% and obesity 5%. Rheumatic heart disease may follow untreated strep throat. It is estimated that up to 90% of CVD may be preventable. Prevention of CVD involves improving risk factors through: healthy eating, exercise, avoidance of tobacco smoke and limiting alcohol intake. Treating risk factors, such as high blood pressure, blood lipids and diabetes is also beneficial. Treating people who have strep throat with antibiotics can decrease the risk of rheumatic heart disease. The use of aspirin in people, who are otherwise healthy, is of unclear benefit.



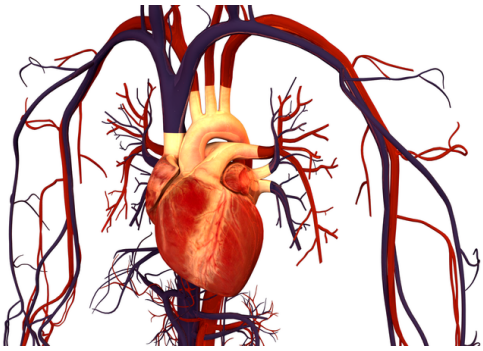
Cardiovascular Diseases Deaths Per Million Persons In 2012. 318–925 926–1,148 1,149–1,294 1,295–1,449 1,450–1,802 1,803–2,098 2,099–2,624 2,625–3,203 3,204–5,271 5,272–10233 (credit: Chris55, CC BY-SA 4.0)

Activity 1. Critical Thinking & Discussion

In your opinion, what could account for the different CVD-related deaths across the world? How can you explain the difference in the average age of death from coronary artery disease between developed countries (about 80 years old) and developing countries (about 68 years old)?

The Components of Our Circulatory System

Our circulatory system is a network of vessels—the arteries, veins, and capillaries—and a pump, the heart. As in all other vertebrate organisms (*i.e.* animals with a backbone) this is a **closed-loop system**, in which the blood is largely separated from the body's other extracellular fluid compartment, the interstitial fluid, which is the fluid bathing the cells. Blood circulates inside blood vessels and circulates **unidirectionally** from the heart around one of two circulatory routes, then returns to the heart again; this is a closed circulatory system.

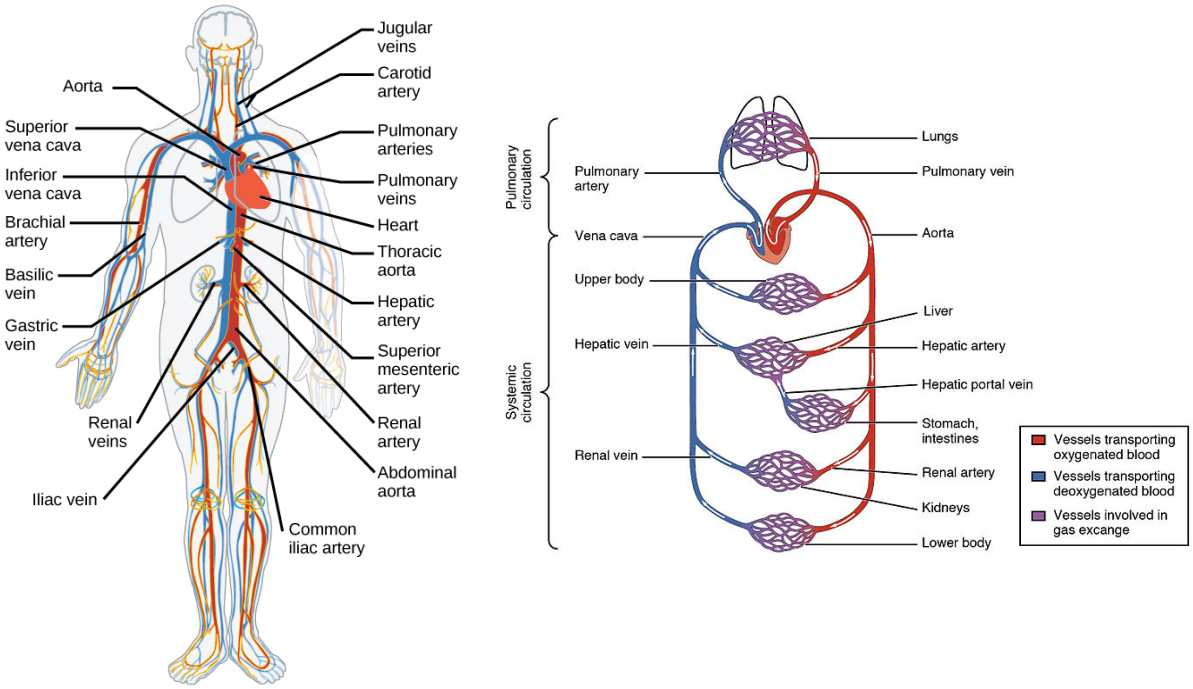


3D Human Heart and Circulatory System
(credit: Brian Brandenburg, CC BY-SA 3.0).

Blood Vessels

The blood from the heart is carried through the body by a complex network of blood vessels. **Arteries** take blood away from the heart. The main artery of the systemic circulation is the aorta; it branches into major arteries that take blood to different limbs and organs. The aorta and arteries near the heart have heavy but elastic walls that respond to and smooth out the pressure differences caused by the beating heart. Arteries farther away from the heart have more muscle tissue in their walls that can constrict to affect flow rates of blood. The major arteries diverge into minor arteries, and then smaller vessels called **arterioles**, to reach more deeply into the muscles and organs of the body.

Arterioles diverge into **capillary beds**. Capillary beds contain a large number, 10's to 100's of capillaries that branch among the cells of the body. Capillaries are narrow-diameter tubes that can fit single red blood cells and are the sites for the exchange of nutrients, waste, and oxygen with tissues at the cellular level. Fluid also leaks from the blood into the interstitial space from the capillaries. The capillaries converge again into **venules** that connect to minor **veins** that finally connect to major veins. Veins are blood vessels that bring blood high in carbon dioxide back to the heart. Veins are not as thick-walled as arteries, since pressure is lower, and they have valves along their length that prevent backflow of blood away from the heart. The major veins drain blood from the same organs and limbs that the major arteries supply.

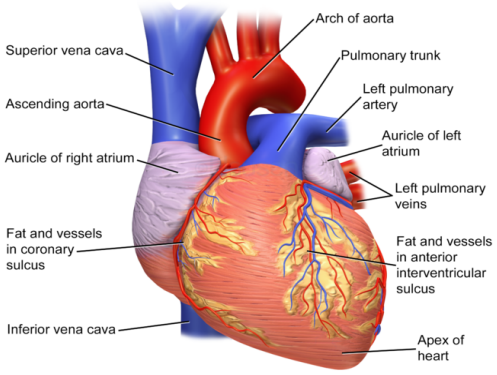


Blood Vessels and Circulation. Left: The arteries of the body, indicated in red, start at the aortic arch and branch to supply the organs and muscles of the body with oxygenated blood. The veins of the body, indicated in blue, return blood to the heart. The pulmonary arteries are blue to reflect the fact that they are deoxygenated, and the pulmonary veins are red to reflect that they are oxygenated (credit: CNX OpenStax, CC BY-SA 4.0) Right: The pulmonary circuit moves blood from the right side of the heart to the lungs and back to the heart. The systemic circuit moves blood from the left side of the heart to the head and body and returns it to the right side of the heart to repeat the cycle. The arrows indicate the direction of blood flow, and the colors show the relative levels of oxygen concentration.
(credit: OpenStax College, CC BY-SA 3.0).

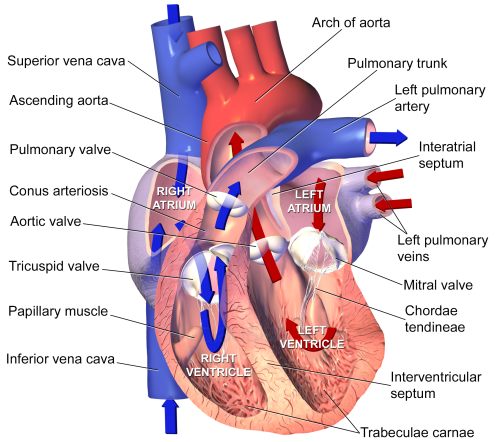
The Heart

(1) Anatomy

The heart is located between the lungs in the middle of the chest (thoracic cavity). It is an **asymmetrical muscle** as a result of the distance blood must travel in the **pulmonary** (lungs) and **systemic** (the rest of the body) **circuits**. Since the right side of the heart sends blood to the pulmonary circuit it is smaller than the left side which must send blood out to the whole body in the systemic circuit. In humans, the heart is about the size of a clenched fist; it is divided into **four chambers**: two **atria** and two **ventricles**. There is one atrium and one ventricle on the right side and one atrium and one ventricle on the left side. The atria are the chambers that receive blood, and the ventricles are the chambers that pump blood. The right atrium receives deoxygenated blood from the **superior vena cava**, which drains blood from the jugular vein that comes from the brain and from the veins that come from the arms, as well as from the inferior vena cava which drains blood from the veins that come from the lower organs and the legs. In addition, the right atrium receives blood from the coronary sinus which drains deoxygenated blood from the heart itself. This deoxygenated blood then passes to the right ventricle through the **atrioventricular valve** or the **tricuspid valve**, a flap of connective tissue that opens in only one direction to prevent the backflow of blood. The valve separating the chambers on the left side of the heart valve is called the **bicuspid or mitral valve**. After it is filled, the right ventricle pumps the blood through the **pulmonary arteries**, bypassing the **semilunar valve (or pulmonic valve)** to the lungs for re-oxygenation. After blood passes through the pulmonary arteries, the right semilunar valves close preventing the blood from flowing backwards into the right ventricle. The left atrium then receives the oxygen-rich blood from the lungs via the **pulmonary veins**. This blood passes through the bicuspid valve or mitral valve (the atrioventricular valve on the left side of the heart) to the left ventricle where the blood is pumped out through the **aorta,** the major artery of the body, taking oxygenated blood to the organs and muscles of the body. Once blood is pumped out of the left ventricle and into the aorta, the **aortic semilunar valve** (or aortic valve) closes preventing blood from flowing backward into the left ventricle. This pattern of pumping is referred to as **double circulation** and is found in all mammals.



Superficial Heart Anatomy (Anterior)



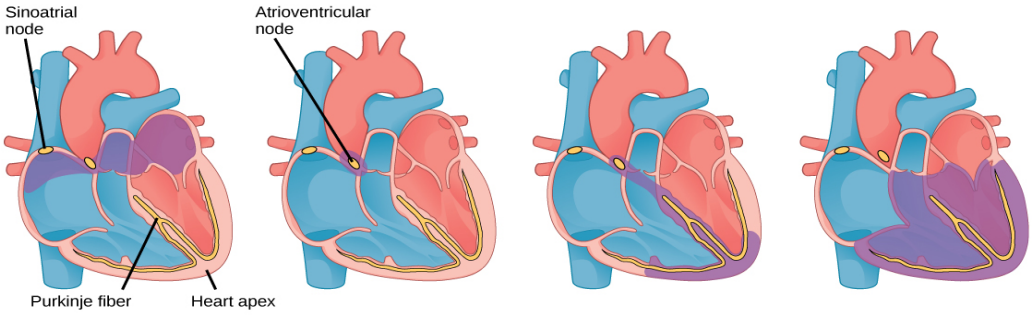
Sectional Anatomy of the Heart

Human Heart Anatomy. (credit: Blausen Medical Communications, Inc., CC BY 3.0).

(2) The Cardiac Cycle, Blood Pressure and Pulse

The main purpose of the heart is to pump blood through the body; it does so in a repeating sequence called the **cardiac cycle**. The cardiac cycle is the flow of blood through the heart coordinated by **electrochemical signals** that cause the heart muscle to contract and relax. In each cardiac cycle, a sequence of contractions pushes out the blood, pumping it through the body; this is followed by a relaxation phase, where the heart fills with blood. These two phases are called the **systole** (contraction) and **diastole** (relaxation), respectively. During systole, when new blood is entering the arteries, the artery walls stretch to accommodate the increase of pressure of the extra blood; during diastole, the walls return to normal because of their elastic properties. The blood pressure of the systole phase and the diastole phase, graphed in gives the two pressure readings for blood pressure. For example, 120/80 indicates a reading of 120 mm Hg (millimeter of mercury) during the systole and 80 mm Hg during diastole. The signal for contraction begins at a location on the outside of the right atrium. It is triggered by a nervous structure referred to as the heart **"pacemaker",** the **sinoatrial (SA) node** which sets the cadiac rhythm. The electrochemical signal moves from there across the atria causing them to contract. The contraction of the atria forces blood through the valves into the ventricles. Closing of these valves caused by the contraction of the ventricles produces a "lub" sound. After reaching another nervous structure, the **atrioventricular (AV) node**, the signal has, by this time, passed down the walls of the heart, through a point between the right atrium and right ventricle. The signal then causes the ventricles to contract. The ventricles contract together forcing blood into the aorta and the pulmonary arteries. Closing of the valves to these arteries caused by blood being drawn back toward the heart during ventricular relaxation produces a monosyllabic "dub" sound. By careful placement of surface electrodes on the body, it is possible to

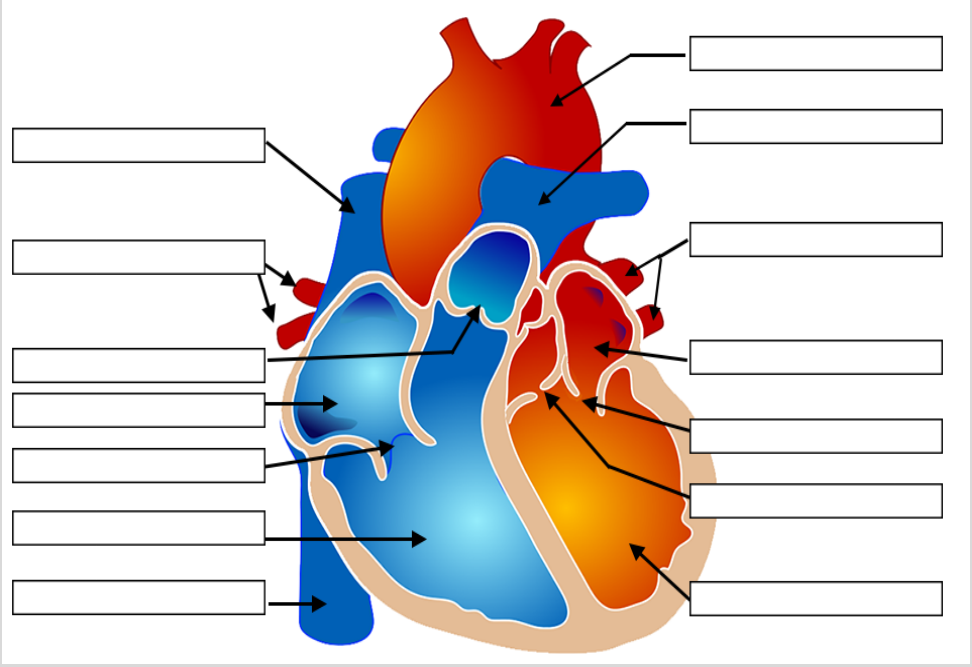
record the complex, compound electrical signal of the heart. This tracing of the electrical signal is the **electrocardiogram (ECG),** also commonly abbreviated EKG (K coming kardiology, from the German term for cardiology). Careful analysis of the ECG reveals a detailed picture of both normal and abnormal heart function, and is an indispensable clinical diagnostic tool. After blood is ejected from the heart, elastic fibers in the arteries help maintain a high-pressure gradient as they expand to accommodate the blood, then recoil. This expansion and recoiling effect, known as the **pulse**, can be palpated manually or measured electronically. Although the effect diminishes over distance from the heart, elements of the systolic and diastolic components of the pulse are still evident down to the level of the arterioles.



The Heart Cycle. The beating of the heart is regulated by an electrical impulse that causes the characteristic reading of an ECG. The signal is initiated at the sinoatrial valve. The signal then (a) spreads to the atria, causing them to contract. The signal is (b) delayed at the atrioventricular node before it is passed on to the (c) heart apex. The delay allows the atria to relax before the (d) ventricles contract. The final part of the ECG cycle prepares the heart for the next beat (credit: CNX OpenStax, CC BY-SA 4.0).

Activity 2. Heart Anatomy

Label the heart illustration below



(credit: Biology Corner, CC BY-NC-SA 4.0)

Activity 3. Heart Beat, Pulse and Blood Pressure Measurement

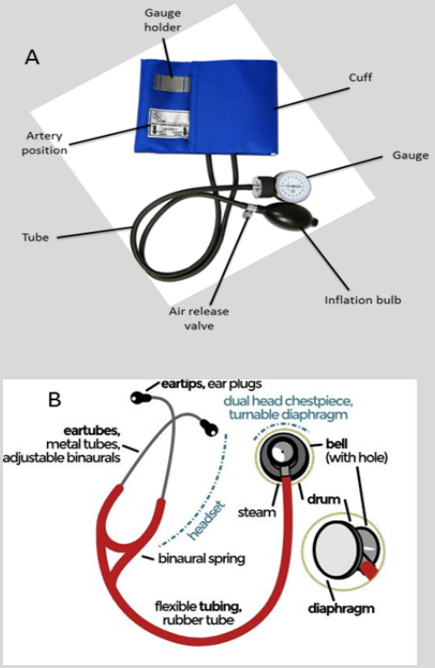
3.1 - Work in groups to listen to each other's heart using a **stethoscope** as demonstrated by your instructor.

a. What do the heart sound "Lub" and "Dub" correspond to?

b. Which one is the loudest?

Blood pressure is one of the critical parameters measured on virtually every patient in every healthcare setting. The technique used today was developed more than 100 years ago by a pioneering Russian physician, Dr. Nikolai Korotkoff. Turbulent blood flow through the vessels can be heard as a soft ticking while measuring blood pressure; these sounds are known as Korotkoff sounds. The technique of measuring blood pressure requires the use of a **sphygmomanometer** (a blood pressure cuff attached to a measuring device) and a stethoscope. The technique is as follows:

- *An inflatable cuff is wrapped tightly around the patient's arm at about the level of the heart.*
- *The rubber pump is squeezed to inject air into the cuff, raising pressure around the artery and temporarily cutting off blood flow into the patient's arm.*
- *The clinician places the stethoscope on the patient's antecubital region and, while gradually allowing air within the cuff to escape, listens for the Korotkoff sounds.*



Blood Pressure Measurement Instruments. (A) Sphygmomanometer (B) Stethoscope (credit: Prof. Alcendor, CC BY-NC-SA 4.0)

3.2 - Work in groups to feel each other's pulse and measure your blood pressure using the stethoscopes and blood pressure monitors provided to you, i) at rest and ii) after exercise (a few jumping jacks and/or running in place for 1 minute).

a. Record your values. Are the values the same at rest and after exercise? How do you explain the results you obtained?

b. Why are taking a patient's pulse and blood pressure diagnostic tools? What can they reveal?

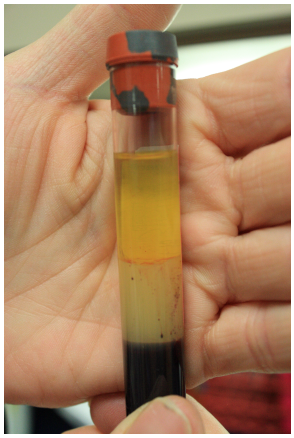
Blood

Blood is important for regulation of the body's systems and homeostasis. Blood helps maintain homeostasis by stabilizing pH, temperature, osmotic pressure, and by eliminating excess heat. Blood supports growth by distributing nutrients and hormones, and by removing waste. Blood plays a protective role by transporting clotting factors and platelets to prevent blood loss and transporting the disease-fighting agents or white blood cells to sites of infection.

(1) Plasma and Serum

The liquid component of blood is called **plasma**, and it is separated by spinning or centrifuging the blood at high rotations (3000 rpm or higher). The blood cells and platelets are separated by centrifugal forces to the bottom of a specimen tube. The upper liquid layer, the plasma, consists of 90 percent water along with various substances required for maintaining the body's pH, osmotic load, and for protecting the body. The plasma also contains the coagulation (clotting) factors and antibodies. The plasma component of blood without the coagulation factors is called the **serum**. Serum is similar to interstitial fluid in which the correct composition of key ions acting as electrolytes is essential for normal functioning of muscles and nerves. Other components in the serum include proteins that assist with maintaining pH and osmotic balance while giving viscosity to the blood. The serum also contains antibodies, specialized proteins that are important for defense against viruses and bacteria. Lipids, including cholesterol, are also transported in the serum, along with various other substances including nutrients, hormones, metabolic waste, plus external substances, such as, drugs, viruses, and bacteria.

Human serum albumin is the most abundant protein in human blood plasma and is synthesized in the liver. Albumin, which constitutes about half of the blood serum protein, transports hormones and fatty acids, buffers pH, and maintains osmotic pressures. Immunoglobin is a protein antibody produced in the mucosal lining and plays an important role in antibody mediated immunity.

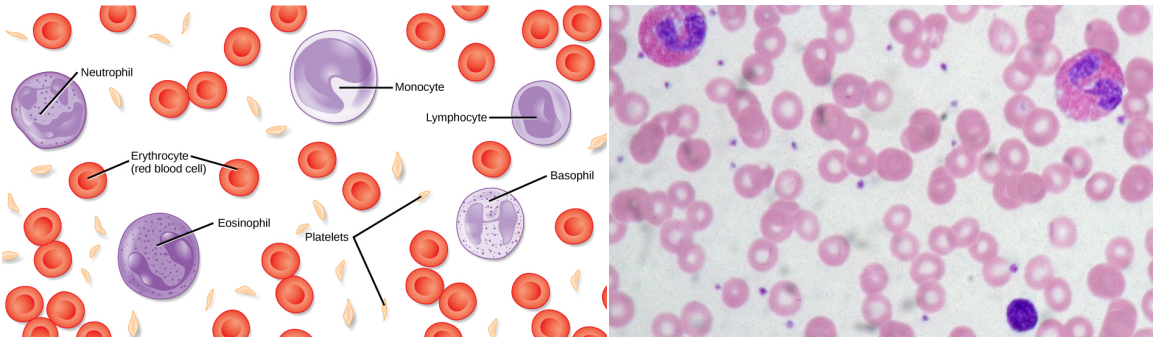


Serum. A blood vial after centrifugation to separate blood cells (bottom) from serum (top) (credit: Wheeler Cowperthwaite, CC BY-SA 2.0).

(2) Red Blood Cells

Red blood cells (RBC), or **erythrocytes** (erythro- = "red"; -cyte = "cell"), are specialized cells that circulate through the body delivering oxygen to cells; they are formed from stem cells in the bone marrow. Like all mammals, our red blood cells are small biconcave cells that at maturity do not contain a nucleus or mitochondria and are only 7–8 μm in size.

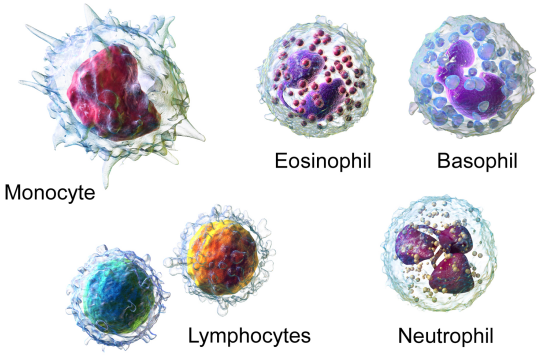
The red coloring of blood comes from the iron-containing protein **hemoglobin**. The principle job of this protein is to carry oxygen, but it also transports carbon dioxide as well. Hemoglobin is packed into red blood cells at a rate of about 250 million molecules of hemoglobin per cell. Each hemoglobin molecule binds four oxygen molecules so that each red blood cell carries one billion molecules of oxygen. There are approximately 25 trillion red blood cells in the five liters of blood in the human body, which could carry up to 25 sextillion (25×10^{21}) molecules of oxygen in the body at any time. Red blood cells have an average life span of 120 days, at which time they are broken down and recycled in the liver and spleen by phagocytic macrophages, a type of white blood cell. The small size and large surface area of red blood cells allows for rapid diffusion of oxygen and carbon dioxide across the plasma membrane. In the lungs, carbon dioxide is released and oxygen is taken in by the blood. In the tissues, oxygen is released from the blood and carbon dioxide is bound for transport back to the lungs.



Blood. Diagram (left; credit: CNX OpenStax CC BY 4.0) and photomicrograph (right; credit: Ed Uthman CC BY 2.0) of a blood smear. Basophils, eosinophils, lymphocytes, macrophages, monocytes and neutrophils are all leukocytes (white blood cells).

(3) White Blood Cells

White blood cells (WBC), also called **leukocytes** (leuko = white), make up approximately one percent by volume of the cells in blood. The role of white blood cells is very different than that of red blood cells: they are primarily involved in the **immune response** to identify and target pathogens, such as invading bacteria, viruses, and other foreign organisms. White blood cells are formed continually; some only live for hours or days, but some live for years. The morphology of white blood cells differs significantly from red blood cells. They have nuclei and do not contain hemoglobin. The different types of white blood cells are identified by their microscopic appearance after histologic staining, and each has a different specialized function. The two main groups, are the **granulocytes**, which include the **neutrophils, eosinophils, and basophils**, and the **agranulocytes**, which include the **monocytes and lymphocytes**. Granulocytes contain granules in their cytoplasm; the agranulocytes are so named because of the lack of granules in their cytoplasm. Lymphocytes are the primary cells of the immune system and include B cells, T cells, and natural killer cells. B cells destroy bacteria and inactivate their toxins. They also produce antibodies. T cells attack viruses, fungi, some bacteria, transplanted cells, and cancer cells. T cells attack viruses by releasing toxins that kill the viruses. Natural killer cells attack a variety of infectious microbes and certain tumor cells.

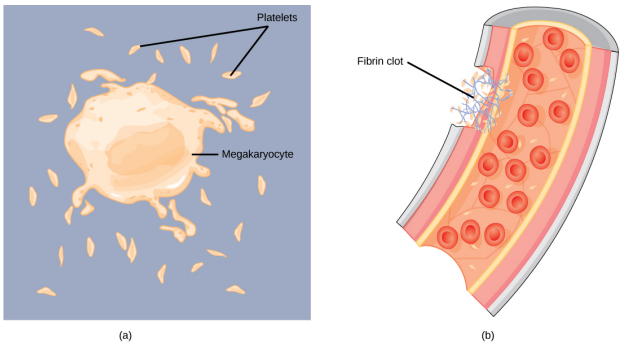


White Blood Cells. Granulocytes—including neutrophils, eosinophils and basophils—are characterized by a lobed nucleus and granular inclusions in the cytoplasm. Granulocytes are typically first-responders during injury or infection. Agranulocytes include lymphocytes and monocytes. Lymphocytes, including B and T cells, are responsible for adaptive immune response (credit: BruceBlaus, CC BY 3.0)

One reason that HIV poses significant management challenges is because the virus directly targets T cells by gaining entry through a receptor. Once inside the cell, HIV then multiplies using the T cell's own genetic machinery. After the HIV virus replicates, it is transmitted directly from the infected T cell to macrophages. The presence of HIV can remain unrecognized for an extensive period of time before full disease symptoms develop.

(4) Platelets and Coagulation Factors

Blood must clot to heal wounds and prevent excess blood loss. Small cell fragments called **platelets** (thrombocytes) are attracted to the wound site where they adhere by extending many projections and releasing their contents. These contents activate other platelets and also interact with other coagulation factors, which convert **fibrinogen**, a water-soluble protein present in blood serum into fibrin (a non-water soluble protein), causing the blood to clot. Many of the clotting factors require **vitamin K** to work, and vitamin K deficiency can lead to problems with blood clotting. Many platelets converge and stick together at the wound site forming a platelet plug (also called a fibrin clot). The plug or clot lasts for a number of days and stops the loss of blood. Platelets are formed from the disintegration of larger cells called megakaryocytes. For each megakaryocyte, 2000–3000 platelets are formed with 150,000 to 400,000 platelets present in each cubic millimeter of blood. Each platelet is disc shaped and 2–4 µm in diameter. They contain many small vesicles but do not contain a nucleus.



Platelets and Coagulation. (a) Platelets are formed from large cells called megakaryocytes. The megakaryocyte breaks up into thousands of fragments that become platelets. (b) Platelets are required for clotting of the blood. The platelets collect at a wound site in conjunction with other clotting factors, such as fibrinogen, to form a fibrin clot that prevents blood loss and allows the wound to heal (credit: CNX OpenStax, CC BY 4.0)

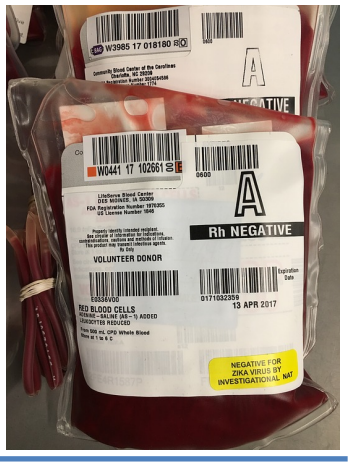
Activity 4. Blood Smear Observation & Anemia

The size, shape, and number of erythrocytes, and the number of hemoglobin molecules can have a major impact on a person's health. When the number of red blood cells (RBCs) or hemoglobin is deficient, the general condition is called **anemia**. There are more than 400 types of anemia and more than 3.5 million Americans suffer from this condition. Anemia can be broken down into three major groups: those caused by blood loss, those caused by faulty or decreased RBC production, and those caused by excessive destruction of RBCs. Anemias caused by faulty or decreased RBC production include sickle cell anemia, iron deficiency anemia, vitamin deficiency anemia, and diseases of the bone marrow and stem cells. Nowadays many laboratories will use automated hematology analyzers to process blood samples. However, performing and viewing a blood smear for microscopy analysis is usually warranted when some abnormalities are detected. This allows diagnosis of blood disorders or other medical condition.

4.1 - Obtain prepared normal blood and Human Iron Deficiency Anemia blood smears slides for observation.
4.2 - Identify the red blood cells, leukocytes and platelets on the normal blood slide.
4.3 - Compare the HIDA slide and normal blood slides in a similar area for each slide, where cells do not overlap and at the same magnification. What difference(s) do you observe? How do you explain the difference(s)?

What Are Blood Types and Why Are They Important?

Blood transfusions in humans were risky procedures until the discovery of the major human blood groups by Karl Landsteiner, an Austrian biologist and physician, in 1900. Until that point, physicians did not understand that death sometimes followed blood transfusions, when the type of donor blood infused into the patient was incompatible with the patient's own blood. Blood groups are determined by the presence or absence of **specific marker molecules** on the plasma membranes of erythrocytes. With their discovery, it became possible for the first time to match patient-donor blood types and prevent transfusion reactions and deaths. Now we know that red blood cells are coated in **antigens**, the specific marker molecules which can elicit an immune reaction, made of glycolipids and glycoproteins. The composition of these molecules is determined by genetics, which have evolved over time. In humans, the different surface antigens are grouped into 24 different blood groups with more than 100 different antigens on each red blood cell. The two most well-known blood groups are the **ABO**, and **Rh systems**.

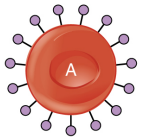
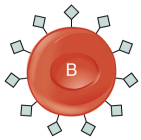
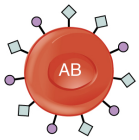


Blood Bags for Transfusion. (credit: kshirl02, Public Domain)

The surface antigens in the ABO blood group are glycolipids, called antigen A and antigen B. People with blood type A have antigen A, those with blood type B have antigen B, those with blood type AB have both antigens, and people with blood type O have neither antigen.

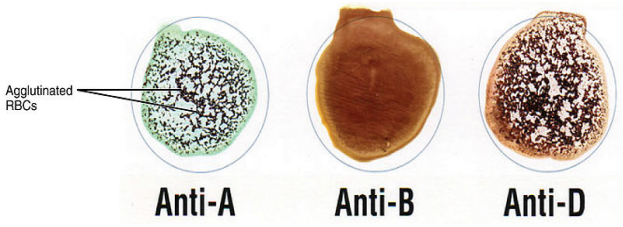
Antibodies (molecules that recognize antigens) called agglutinogens are found in the blood plasma and react with the A or B antigens, if the two are mixed. When type A and type B blood are combined, **agglutination (clumping)** of the blood occurs because of antibodies in the plasma that bind with the opposing antigen; this causes clots that coagulate in the kidney causing kidney failure. Type O blood has neither A or B antigens, and therefore, type O blood can be given to all blood types. Type O negative blood is the universal donor. Type AB positive blood is the universal acceptor because it has both A and B antigen. The Rh blood group was first discovered in Rhesus monkeys. Most people have the Rh antigen (Rh+) and do not have anti-Rh antibodies in their blood. The few people who do not have the Rh antigen and are Rh– can develop anti-Rh antibodies if exposed to Rh+ blood. This can happen after a blood transfusion or after an Rh– woman has an Rh+ baby. Problems are rare in a first pregnancy, since the baby's Rh^+ cells rarely cross the placenta (the organ of gas and nutrient exchange between the baby and the mother). However, during or immediately after birth, the Rh^- mother can be exposed to the baby's Rh^+ cells. Research has shown that this occurs in about 13−14 percent of such pregnancies. After exposure, the mother's immune system begins to generate anti-Rh antibodies. If the mother should then conceive another Rh^+ baby, the Rh antibodies she has produced can cross the placenta into the fetal bloodstream and destroy the fetal RBCs. This condition, known **as hemolytic disease of the newborn (HDN)** or *erythroblastosis fetalis*, may cause anemia in mild cases, but the agglutination and hemolysis can be so severe that without treatment the fetus may die in the womb or shortly after birth. An injection of a medicine that stops the mother's antibody reaction early in pregnancy can prevent this outcome.

Blood Type

	A	B	AB	O
Red Blood Cell Type				
Antibodies in Plasma	 Anti-B	 Anti-A	None	 Anti-A and Anti-B
Antigens in Red blood Cell	 A antigen	 B antigen	 A and B antigens	None
Blood Types Compatible in an Emergency	A, O	B, O	A, B, AB, O (AB^+ is the universal recipient)	O (O is the universal donor)

ABO Blood Group. This chart summarizes the characteristics of the blood types in the ABO blood group. See the text for more on the concept of a universal donor or recipient. (credit: OpenStax College, CC BY 3.0)

To avoid transfusion reactions, it is best to transfuse only matching blood types; that is, a type B^+ recipient should ideally receive blood only from a type B^+ donor and so on. That said, in emergency situations, when acute hemorrhage threatens the patient's life, there may not be time for cross matching to identify blood type. In these cases, blood from a **universal donor**—an individual with type O^- blood—may be transfused. A patient with blood type AB^+ is known as the **universal recipient**. This patient can theoretically receive any type of blood, because the patient's own blood—having both A and B antigens on the erythrocyte surface—does not produce anti-A or anti-B antibodies. In addition, an Rh^+ patient can receive both Rh^+ and Rh^- blood. However, keep in mind that the donor's blood will contain circulating antibodies, again with possible negative implications.



Cross Matching Blood Types. This sample of a commercially produced "bedside" card enables quick typing of both a recipient's and donor's blood before transfusion. The card contains three reaction sites or wells. One is coated with an anti-A antibody, one with an anti-B antibody, and one with an anti-D antibody (tests for the presence of Rh factor D). Agglutination of RBCs in a given site indicates a positive identification of the blood antigens, in this case A and Rh antigens for blood type A^+. For the purpose of transfusion, the donor's and recipient's blood types must match (credit: OpenStax College, CC BY 3.0)

Activity 5. Blood Groups, Blood Typing

5.1 - In this activity, you will work to determine the blood groups of different blood samples. This is called blood typing. Carefully follow the instructions provided by your instructor and use the form below to guide your steps and record your results and answers.

Student Instructions

Name _____

70-0101

Date _____

ABO-Rh Blood Typing With Synthetic Blood

1. Using the dropper vial, place a drop of the first synthetic blood sample in each well of the blood typing slide. Replace the cap on the dropper vial. Always replace the cap on one vial before opening the next vial to prevent cross contamination.
2. Add a drop of synthetic anti-A (blue) to the well labeled A. Replace the cap.
3. Add a drop of synthetic anti-B serum (yellow) to the well labeled B. Replace the cap.
4. Add a drop of synthetic anti-Rh serum (clear) to the well labeled Rh. Replace the cap.
5. Using a different color mixing stick for each well (blue for anti-A, yellow for anti-B, white for anti-Rh), gently stir the synthetic blood and anti-serum drops for 30 seconds. Remember to discard each mixing stick after a single use to avoid contamination of your samples.
6. Carefully examine the thin films of liquid mixture left behind. If a film remains uniform in appearance, there is no agglutination. If the sample appears granular, agglutination has occurred. Determine the blood type of the sample using the data table below. Answer yes or no as to whether agglutination occurred in each sample. A positive agglutination reaction indicates the blood type.
7. Record the results for the first blood sample in the data table.
8. Thoroughly rinse the blood typing slide, then repeat steps 1 through 7 for synthetic blood samples 2, 3, and 4.

Data Table

	Sample 1	Sample 2	Sample 3	Sample 4
Anti-A				
Anti-B				
Rh				
Blood Type				

5.2 - Questions

a. Indicate the donor and recipient to which each blood type is compatible.

	Recipient	Donor
Sample 1	_____	_____
Sample 2	_____	_____
Sample 3	_____	_____
Sample 4	_____	_____

b. Is any sample the …

a universal donor? If so indicate which one _____
a universal recipient? If so indicate which one _____

Review Questions

1. What is cardiovascular disease? How can it be prevented?
2. Describe the components of the human cardiovascular system
3. List the different parts of the heart and their function
4. Are all blood vessels the same? Explain
5. What are basic tests to assess the cardiovascular health? What do they measure?
6. What is blood made of?
7. How is an erythrocyte different from a leukocyte
8. Explain blood types
9. Why is it important for one to know their blood type?
10. Why do hospitals keep supplies of O Negative blood?
11. What is meant by "blood compatibility" (in the context of a blood transfusion for example).
12. Explain blood typing.

With text modified from OpenStax Biology 2e, Anatomy and Physiology, Concepts of Biology and Wikipedia "Cardiovacular Disease"