The Circulatory System

**VOCABULARY**

- antigen
- artery
- atherosclerosis
- blood
- blood pressure
- blood type
- capillary
- cardiovascular disease (CVD)
- circulatory system
- heart attack
- hypertension
- plasma
- platelet
- pulmonary circulation
- red blood cell
- systemic circulation
- vein
- white blood cell

**INTRODUCTION**

The circulatory system can be compared to a system of interconnected, one-way roads that range from superhighways to back alleys. Like a network of roads, the job of the circulatory system is to allow the transport of materials from one place to another. As described in Figure below, the materials carried by the circulatory system include hormones, oxygen, cellular wastes, and nutrients from digested food. Transport of all these materials is necessary to maintain homeostasis of the body. The main components of the circulatory system are the heart, blood vessels, and blood. Each of these components is described in detail below.

The function of the circulatory system is to move materials around the body.

**THE HEART**

The heart is a muscular organ in the chest. It consists mainly of cardiac muscle tissue and pumps blood through blood vessels by repeated, rhythmic contractions. The heart has four chambers, as shown in Figure below: two upper atria (singular, atrium) and two lower ventricles. Valves between chambers keep blood flowing through the heart in just one direction.

The chambers of the heart and the valves between them are shown here.

**BLOOD FLOW THROUGH THE HEART**

Blood flows through the heart in two separate loops, which are indicated by the arrows in this image.

Blood from the lungs enters the left atrium of the heart. The left atrium pumps the blood to the left ventricle, which pumps it to the body. This loop is represented by the red arrows in Figure above.
HEARTBEAT
Unlike skeletal muscle, cardiac muscle contracts without stimulation by the nervous system. Instead, specialized cardiac muscle cells send out electrical impulses that stimulate the contractions. As a result, the atria and ventricles normally contract with just the right timing to keep blood pumping efficiently through the heart.

BLOOD VESSELS
Blood vessels form a network throughout the body to transport blood to all the body cells. There are three major types of blood vessels: arteries, veins, and capillaries.

Blood vessels include arteries, veins, and capillaries.

• **Arteries** are muscular blood vessels that carry blood away from the heart. They have thick walls that can withstand the pressure of blood being pumped by the heart. Arteries generally carry oxygen-rich blood. The largest artery is the aorta, which receives blood directly from the heart.

• **Veins** are blood vessels that carry blood toward the heart. This blood is no longer under much pressure, so many veins have valves that prevent backflow of blood. Veins generally carry deoxygenated blood. The largest vein is the inferior vena cava, which carries blood from the lower body to the heart.

• **Capillaries** are the smallest type of blood vessels. They connect very small arteries and veins. The exchange of gases and other substances between cells and the blood takes place across the extremely thin walls of capillaries.

BLOOD VESSELS AND HOMEOSTASIS
Blood vessels help regulate body processes by either constricting (becoming narrower) or dilating (becoming wider). These actions occur in response to signals from the autonomic nervous system or the endocrine system. Constriction occurs when the muscular walls of blood vessels contract. This reduces the amount of blood that can flow through the vessels (see Figure below). Dilation occurs when the walls relax. This increases blood flows through the vessels.

*When a blood vessel constricts, less blood can flow through it.*

Constriction and dilation allow the circulatory system to change the amount of blood flowing to different organs. For example, during a fight-or-flight response, dilation and constriction of blood vessels allow more blood to flow to skeletal muscles and less to flow to digestive organs. Dilation of blood vessels in the skin allows more blood to flow to the body surface so the body can lose heat. Constriction of these blood vessels has the opposite effect and helps conserve body heat.

BLOOD VESSELS AND BLOOD PRESSURE
The force exerted by circulating blood on the walls of blood vessels is called **blood pressure**. Blood pressure is highest in arteries and lowest in veins. When you have your blood pressure checked, it is the blood pressure in arteries that is measured. High blood pressure, or **hypertension**, is a serious health risk but can often be controlled with lifestyle changes or medication. You can learn more about hypertension by
PULMONARY CIRCULATION
Pulmonary circulation is the part of the circulatory system that carries blood between the heart and lungs (the term pulmonary means “of the lungs”). It is illustrated to the left. Deoxygenated blood leaves the right ventricle through pulmonary arteries, which transport it to the lungs. In the lungs, the blood gives up carbon dioxide and picks up oxygen. The oxygenated blood then returns to the left atrium of the heart through pulmonary veins. The pulmonary circulation carries blood between the heart and lungs.

SYSTEMIC CIRCULATION
Systemic circulation is the part of the circulatory system that carries blood between the heart and body. It is illustrated to the right. Oxygenated blood leaves the left ventricle through the aorta. The aorta and other arteries transport the blood throughout the body, where it gives up oxygen and picks up carbon dioxide. The deoxygenated blood then returns to the right atrium through veins. The systemic circulation carries blood between the heart and body.

CARDIOVASCULAR DISEASE
Diseases of the heart and blood vessels, called cardiovascular diseases (CVD), are very common. The leading cause of CVD is atherosclerosis.

ATHEROSCLEROSIS
Atherosclerosis is the buildup of plaque inside arteries (see Figure below). Plaque consists of cell debris, cholesterol, and other substances. Factors that contribute to plaque buildup include a high-fat diet and smoking. As plaque builds up, it narrows the arteries and reduces blood flow. The fatty material inside the artery on the right is plaque. Notice how much narrower the artery has become. Less blood can flow through it than the normal artery.

CORONARY HEART DISEASE
Atherosclerosis of arteries that supply the heart muscle is called coronary heart disease. This disease may or may not have symptoms such as chest pain. As the disease progresses, there is an increased risk of heart attack. A heart attack occurs when the blood supply to part of the heart muscle is blocked and cardiac muscle fibers die. Coronary heart disease is the leading cause of death of adults in the U.S.

PREVENTING CARDIOVASCULAR DISEASE
Many factors may increase the risk of developing coronary heart disease and other CVDs. The risk of CVDs increases with age and is greater in males than females at most ages. Having a close relative with CVD also
increases the risk. These factors cannot be controlled, but other risk factors can, including smoking, lack of exercise, and high-fat diet. By making healthy lifestyle choices, you can reduce your risk of developing CVD.

**Blood**

Blood is a fluid connective tissue. It circulates throughout the body through blood vessels by the pumping action of the heart. Blood in arteries carries oxygen and nutrients to all the body’s cells. Blood in veins carries carbon dioxide and other wastes away from the cells to be excreted. Blood also defends the body against infection, repairs body tissues, transports hormones, and controls the body’s pH. Cells in blood include red blood cells, white blood cells, and platelets. The trillions of red blood cells in blood plasma carry oxygen. Red blood cells contain hemoglobin, a protein with iron that binds with oxygen.

Blood type is important for medical reasons. A person who needs a blood transfusion must receive blood that is the same type as his or her own. Otherwise, the transfused blood may cause a potentially life-threatening reaction in the patient’s bloodstream.

**Lesson Summary**

- The heart contracts rhythmically to pump blood to the lungs and the rest of the body. Specialized cardiac muscle cells trigger the contractions.
- Arteries carry blood away from the heart, veins carry blood toward the heart, and capillaries connect arteries and veins.
- The pulmonary circulation carries blood between the heart and lungs. The systemic circulation carries blood between the heart and body.
- A disease that affects the heart or blood vessels is called a cardiovascular disease (CVD). The leading cause of CVD is atherosclerosis, or the buildup of plaque inside arteries. Healthy lifestyle choices can reduce the risk of developing CVD.
- Blood is a fluid connective tissue that contains a liquid component called plasma. It also contains dissolved substances and blood cells. Red blood cells carry oxygen, white blood cells defend the body, and platelets help blood clot.

**Lesson Review Questions**

Recall

1. Describe how blood flows through the heart.
2. What controls heartbeat?
3. How do arteries differ from veins?
4. What is blood pressure? What is hypertension?
5. List factors that increase the risk of cardiovascular disease.
6. Identify three types of blood cells and their functions.

Apply Concepts

7. To take your pulse, you press your fingers against an artery near the surface of the body. What are you feeling and measuring when you take your pulse? Why can’t you take your pulse by pressing your fingers against a vein?
8. People with type O blood are called “universal donors” because they can donate blood to anyone else, regardless of their ABO blood type. Explain why.

Think Critically

9. Compare and contrast the pulmonary and systemic circulations.
10. Explain the role of blood vessels in homeostasis.