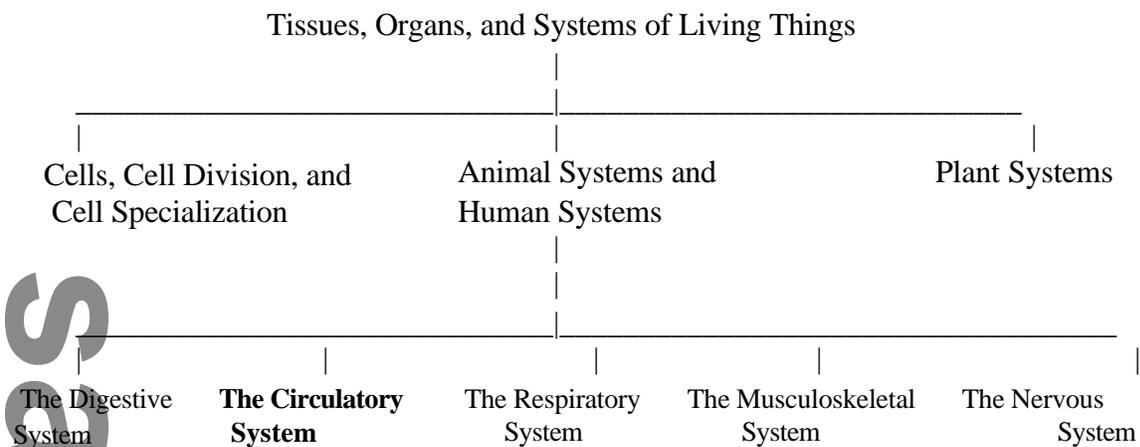


# Animal Systems: The Circulatory System



## The Circulatory System

Complex animals are made up of cells, tissues, organs, and organ systems.

**Tissue:** a collection of cells that perform a particular function.

An **organ** consists of groups of tissues and works with other organs to form organ systems.

**Organ Systems** perform one or more functions in the human body.

Each organ system has a specific function and corresponding specific structures.

Organ systems work together to accomplish digestion, transport, gas exchange, waste removal, movement, support, protection, communication, and reproduction i.e. organ systems work together to keep the organism functioning.

### Recall:

The purpose of digestion is to break down food into pieces that are small enough to be used by cells. But how does the food from the digestive system get delivered to the cells?

The digested food enters the blood through the small intestine and gets delivered to the rest of the body through the circulatory system.

The circulatory system delivers the nutrients processed in the digestive system throughout the organism, essentially making sure the entire organism is fed.

**Circulatory system:** the organ system that is made up of the heart, the blood, and the blood vessels, the system that transports oxygen and nutrients throughout the body and carries away waste.

The human circulatory system is made up of the **blood**, the **heart**, and the **blood vessels**.

*The function of the circulatory system is to transport substances to all of the cells of the body.*

The blood moves nutrients absorbed from the small intestine and oxygen from the lungs (respiratory system) and delivers them to the cells.

Blood exchanges the nutrients and oxygen for carbon dioxide and wastes from the cells.

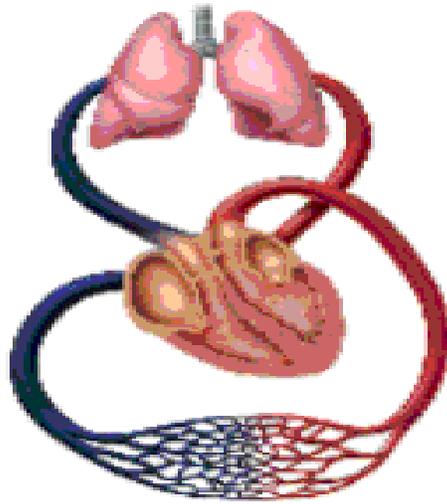
Blood now contains the transferred carbon dioxide and wastes, the carbon dioxide is carried to the lungs to be expelled and the wastes are carried to the kidneys to be excreted.

The blood passes through the kidneys for cleaning and then the filtered blood re-enters the heart. The cycle continues.

The circulatory system carries the waste from throughout the organism to the urinary system, which takes care of excreting the waste from the organism.

Other function of the circulatory system is to regulate the temperature of the body and to transport white blood cells, (disease fighting).

Label the following diagram:



In the above diagram, the difference between the blood shown in blue and the blood shown in red is due to the oxygen content in the blood.

The heart pumps the blood through the lungs, where the blood receives oxygen—shown in red, oxygenated blood is bright red in colour and generally referred to as “**red**” blood.

Then the blood is pumped throughout the body delivering oxygen and returns to the heart and lungs deoxygenated—shown in blue; deoxygenated blood is dark red in colour but generally referred to as “**blue**” blood.

The heart pumps blood through large blood vessels called arteries, these branch into smaller and smaller blood vessels; the smallest being referred to as capillaries.

In the capillaries, nutrients and oxygen are transferred to, and carbon dioxide and waste are transferred from the cells.

**Capillaries** exchange nutrients and gases between them and the body’s tissues.

**Arteries** carry blood away from the heart to the rest of the body.

**Veins** carry blood from the body back to the heart.

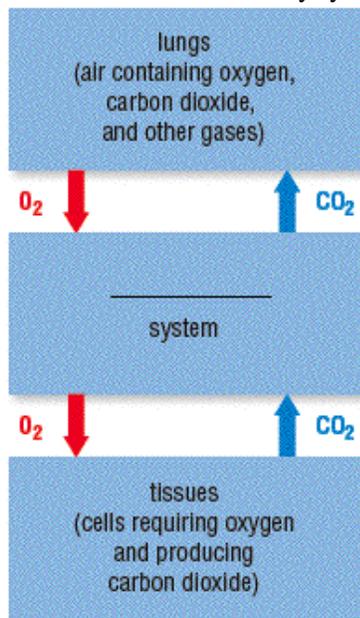
Fill in the following table: **Function of Each Component of the Circulatory System**

Heart	Blood	Arteries	Veins	Capillaries

How the circulatory system works?

1. Blood receives oxygen from the lungs and is pumped back through the heart and throughout the body in arteries.
2. Capillaries receive the oxygenated blood and take it to the organs and other tissues.
3. Oxygen is taken out of the blood and used by the body.
4. The capillaries return the deoxygenated blood to veins, which carry it back to the heart and lungs to receive oxygen again.
5. The cycle is continuous.

The Circulatory System: The diagram below is a circle, with oxygenated air, (red blood), moving downward on the chart, from the lungs to the circulatory system to the tissues, and deoxygenated blood, (blue blood), running upward on the chart, from the tissues to the circulatory system to the lungs.



## Blood

Blood is a tissue: because red blood cells, white blood cells, and platelets are all types of blood cells that perform a particular function.

*Blood is made of connective tissue.*

Blood is composed of:

1. Red blood cells, making up ~ half of the blood's volume, ~ 45%, contain a protein called hemoglobin— this binds to oxygen molecules and thus allows oxygen to be transported to the body; and it gives blood cells their characteristic red colour. The main function of the red blood cells is to transport oxygen.

2. White blood cells, make up < 1% of the volume, they are the only blood cells that have a nucleus, their main function is to fight infection.
3. Platelets, make up < 1% of the volume, their function is to help to clot blood. Platelets control the blood's ability to clot when there is a tear or an injury.
  - If there are too many platelets, the clots get too large and will cause blockages, which lead to serious health issues and sometimes death.
  - If there are not enough platelets, sufficient clotting does not occur, leading to excessive bleeding and possibly death.
4. Plasma, make up more than half of the blood's volume, ~ 55% of the volume, it is the protein liquid that carries the blood cells.

Fill in the following table:

Blood component	Red blood cells	White blood cells	Platelets	Plasma
Function				

## The Heart

The function of the heart is to pump the blood throughout the body to distribute oxygen to cells and help remove carbon dioxide.

The heart is a double pump:

The two sides of the heart are separate: the right side (right atrium, right ventricle) receives blue blood, i.e. deoxygenated blood, and pumps it to the lungs for oxygenation.

The left chambers receive the oxygenated blood from the lungs and pump red blood i.e. the oxygenated blood to the rest of the body.

Heart is made of three different types of tissue: cardiac muscle tissue, nerve tissue, and connective tissue.

Connective tissue carries oxygen throughout the body.

The muscles and the nerves of the heart are covered by a layer of epithelial tissues.

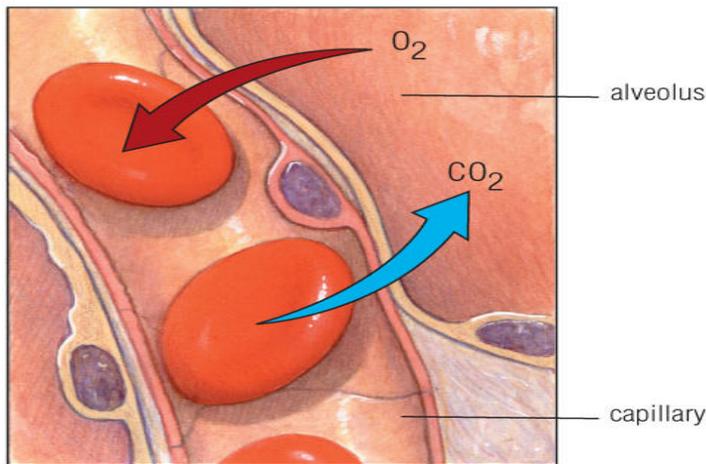
The layer of epithelial tissue reduces friction and protects the heart from damage when the lungs expand and contract.

The inner surface of the heart, through which the blood flows, is also covered by a layer of epithelial tissue to allow for the easy flow of the blood.

The heart beats with a regular beat; the frequency of the heart beat varies with physical activity, stress, temperature, etc.

The “**pulse rate**” indicates how often the heart beats per minute. The average range for the pulse rate of a teenager is 60 – 80 beats per minute.

## Gas exchange between a capillary and an alveolus



**Figure 2.25** Gas exchange between a capillary and the membrane of an alveolus

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### Blood Vessels

The three types of blood vessels are the *arteries*, the *veins* and the *capillaries*, these together make up a network of tubes throughout the body to transport blood.

**Arteries** carry blood from the heart to the rest of the body.

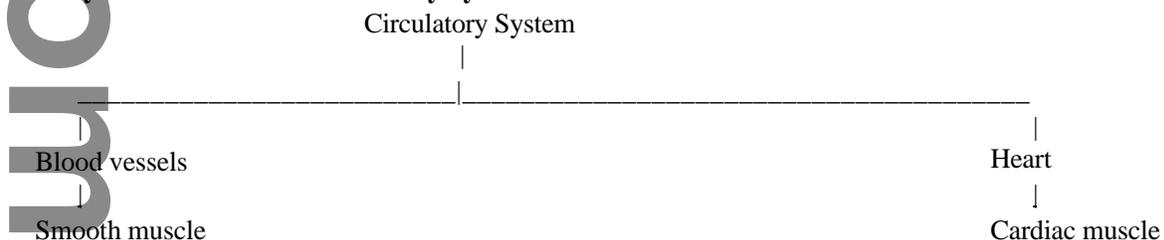
The walls of the arteries are thicker than those of the other blood vessels, in order to withstand the high pressure at which the blood is pumped away from the heart.

**Veins** carry blood from the body to the heart. The veins have thin walls because the blood flowing through it them is under much lower pressure.

**Capillaries** link the arteries and veins, every part of the body receives blood by the capillaries.

They are very tiny blood vessels with small diameter which allows more efficient exchange of oxygen and nutrients for carbon dioxide and wastes via diffusion between them and the body's tissues.

### Summary of Muscles in the Circulatory System:



## Diseases and Disorders of the Circulatory System

### **1. Coronary Artery Disease**

Coronary arteries are the blood vessels that provide blood to the heart muscle tissue.

Sometimes, these arteries that deliver oxygen to the heart muscle become partially blocked with **plaque**— a deposit made up of fat, cholesterol, calcium and other substances that circulate in the blood.

If the coronary arteries become partially blocked or clogged, then the person will experience tiredness, dizziness and pain or a burning sensation in the chest or arms.

Coronary Artery Disease may be diagnosed by a X-ray technique known as an angiogram.

An angiogram differs from a regular X-ray scan, in that a fluorescent dye is injected so blockages in arteries show up in X-ray images. An ordinary X-ray scan does not include the dye.

### **2. Aneurysm**

An aneurysm is the rupture or split of an artery. This usually occurs when the thick walled arteries can not withstand the blood pressure so they bulge and split.

People who are aging, smokers and people who have family histories of aneurysm are more likely to get one.

Similarly to atherosclerosis, (—is a disease in which plaque builds up inside your arteries), both of these conditions are often fatal as blood cannot reach its intended destination.

Unlike atherosclerosis where the arteries are blocked, when someone gets an aneurysm, there arteries can split open.

### **3. Heart Attack**

If the blockage by plaque or by a blood clot of the coronary arteries, the arteries that deliver oxygen to the heart muscle, become sever, a heart attack can result.

The heart muscle cells are no longer able to receive oxygen or nutrients in order to keep functioning— this will result in the heart tissue to start to die.

The actual symptoms of a heart attack can vary, but generally they are anxiety, dizziness, chest pains or pressure, nausea, abdominal or stomach pains, unusual fatigue, or upper body pain.

A heart attack may be diagnosed by a blood test and an electrocardiogram, ECG, this measures the electrical signal created by the heart as it beats.

The two numbers represented in a person's blood pressure represent the pressure of blood travelling from the heart and the pressure of blood travelling back to the heart.

**4. Blood clot disorders** occur when blood clots too easily so it blocks blood vessels, or when blood does not clot easily and excess bleeding occurs.

### Organ systems interact to keep the organism functioning:

The systems of the body are interdependent.

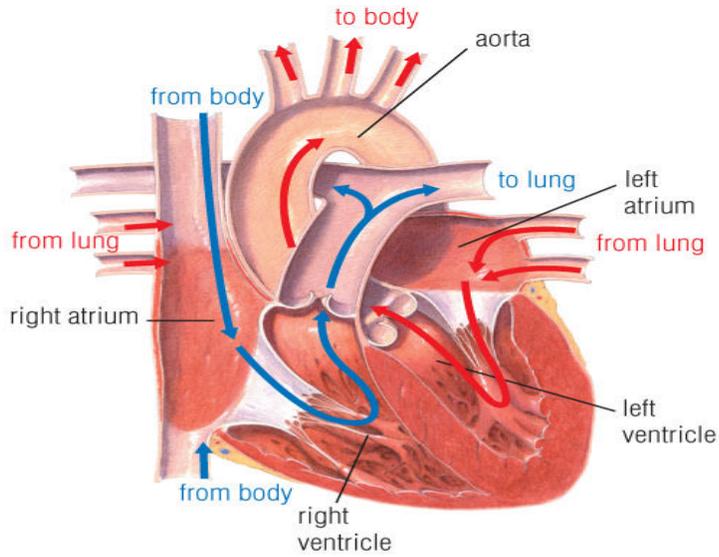
The jobs that one system carries out depends on and influences jobs carried out by other systems.

For example, the digestive system relies on the circulatory system to deliver the nutrients to the entire body. Because the systems influence each other, problems in one system may lead to problems in another.

## Assignment

1. Fill in the following spaces:
  - a. The body's main form of transportation for things it needs, like oxygen and nutrients, is the \_\_\_\_\_ system.
  - b. A collection of similar cells that perform a particular, but limited, function is called a \_\_\_\_\_.
  - c. The infection-fighting cells found in blood are \_\_\_\_\_.
  - d. \_\_\_\_\_ carry blood away from the heart.
  - e. The blood is pumped at the greatest pressure in the \_\_\_\_\_.
  - f. \_\_\_\_\_ allow nutrients and oxygen to diffuse from the blood into the surrounding tissues.
  - g. \_\_\_\_\_ tissue is involved in carrying oxygen throughout the body.
2. What is the difference in 'red' blood and 'blue' blood?
3. Why is the number of platelets in blood important?
4. What is the role of the heart?
5. Explain why the circulatory system is important with regard to the digestive system of a living organism.
6. Name at least four substances that are carried by the circulatory system.
7. How does an angiogram differ from a regular X-ray scan.
8. Name and briefly describe one disease or a disorder of the circulatory system.
9.
  - a. Which system is responsible for transporting nutrients to all parts of the body?
  - b. What is the main organ in this system?
10. Name two systems that interact with the circulatory system.
11. Explain how the structure of each blood vessel suits its function:
  - a. arteries
  - b. veins
  - c. capillaries
12. In sports, the illegal practice of "blood doping" involves removing some blood cells from an athlete about two weeks before competition and storing them. Just before the competition, the blood cells are injected back into the athlete. Explain why this practice might give the athlete an advantage.
13. Anemia is a fairly common condition in children, teens, and adult women. It usually results from having too few red blood cells. People with anemia often do not seem to have much energy. Explain this using your knowledge of the circulatory system.
14. At altitudes of 5500 m above sea level, the body has more difficulty functioning because there is less oxygen available to breathe. The highest city in the world is Wenzhuan, in the Himalayas, at an elevation of 5099 m above sea level. How does your knowledge of the circulatory system and respiratory systems help you make a connection between these two facts?
15.
  - a. Explain why the heart is considered to be an organ.
  - b. Explain how angioplasty works.
  - c. Compare and contrast heart attack and stroke.
  - d. Explain how arteriosclerosis occurs and its impact on the functioning of the artery.

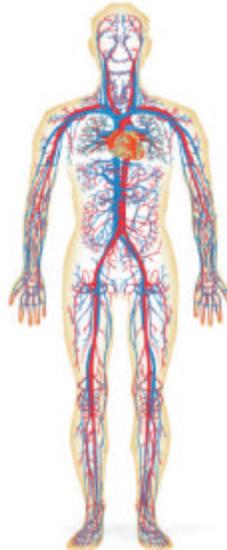
## The Human Heart



**Figure 2.6** The right side of the heart (right atria and right ventricle) pumps blood to the lungs so that the blood can pick up oxygen. The left side of the heart (left atria and left ventricle) pumps the oxygenated blood through the aorta to the rest of the body.

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## The Circulatory System



**Figure 2.24** The circulatory system

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