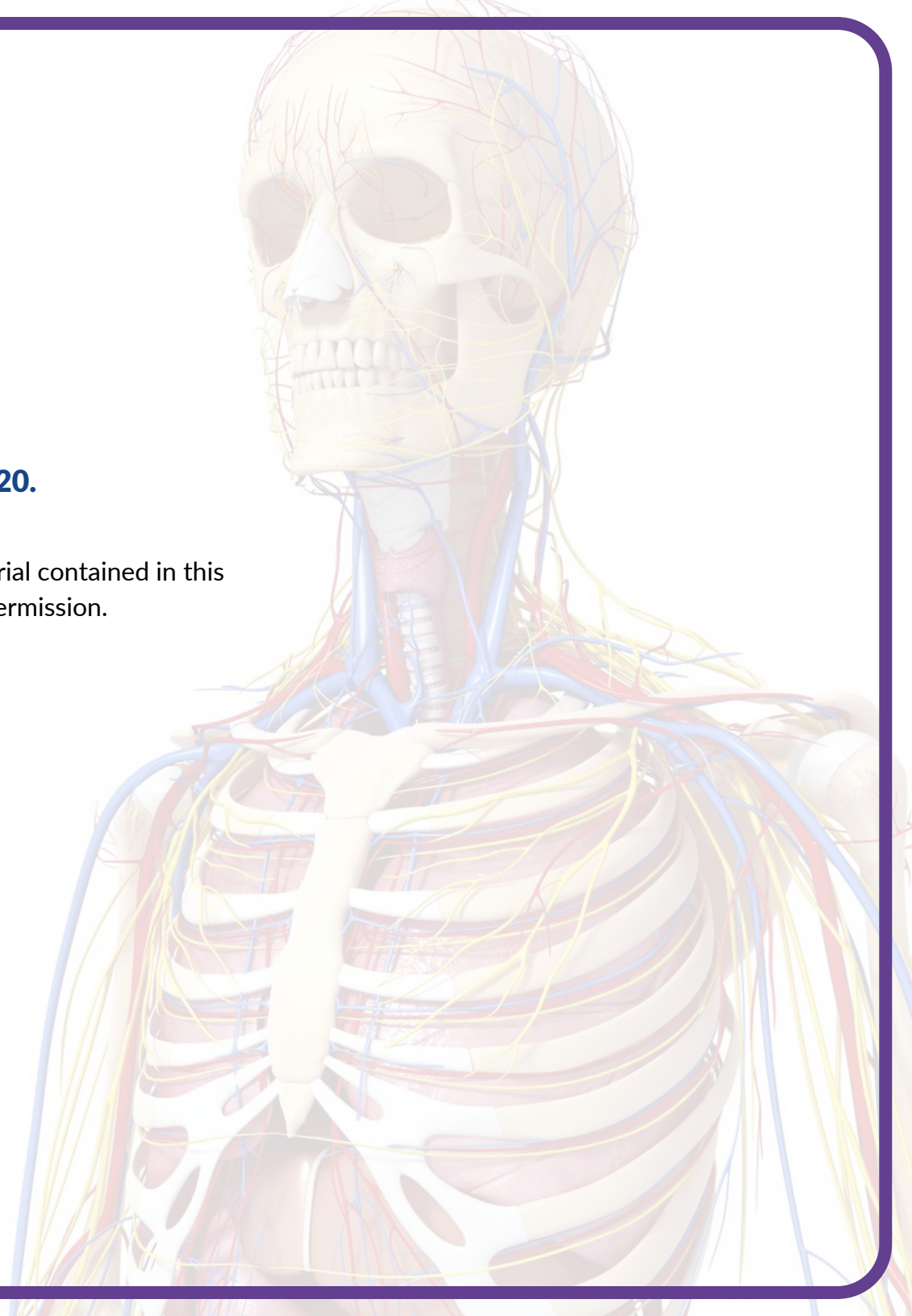




# Cardiovascular System Workbook

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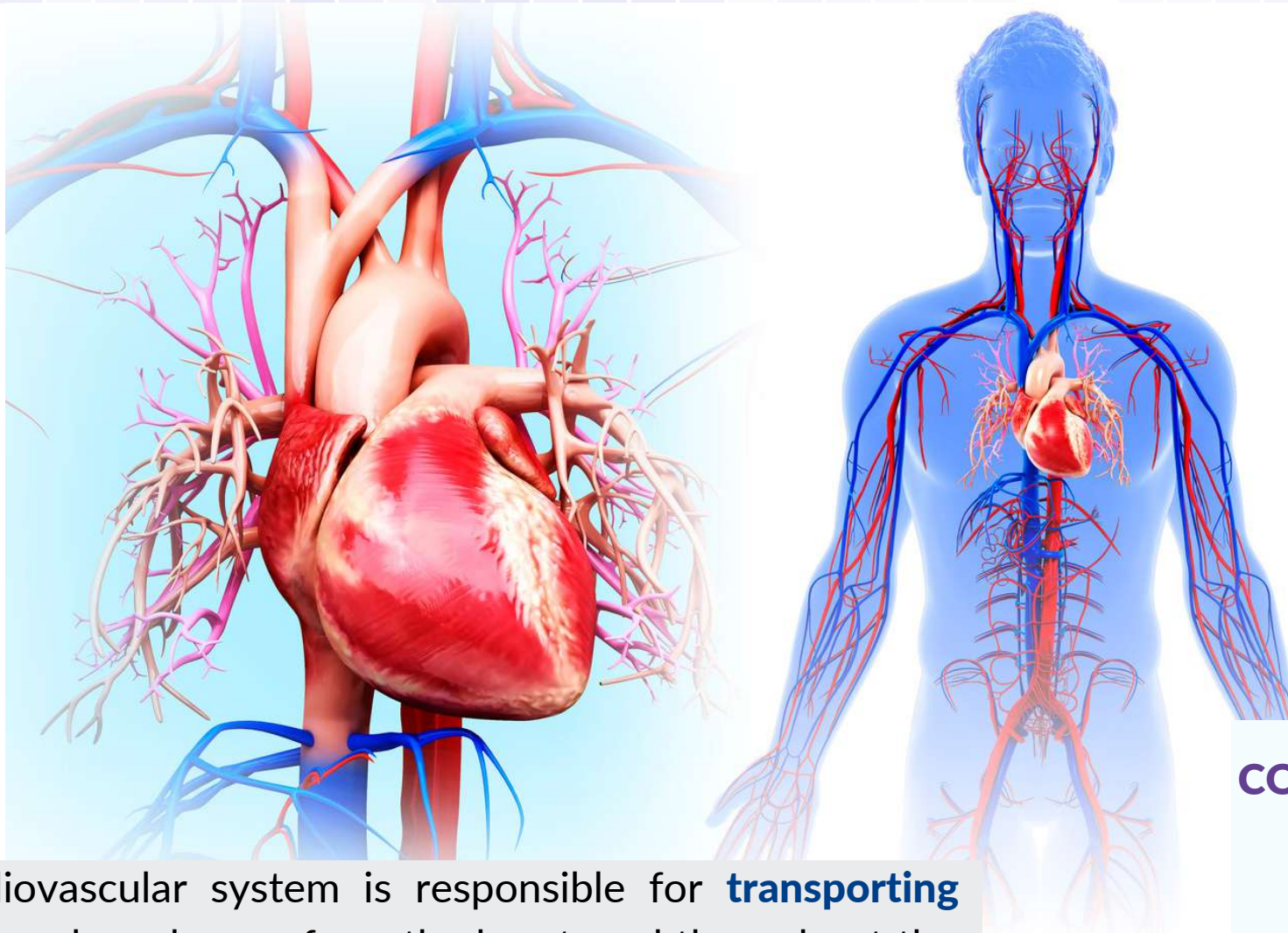
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# Learning Objectives

- Describe the function of the cardiovascular system and its major components.
- Describe the relationships between the different components of the cardiovascular system.
- Explain how the cardiovascular system is interdependent with other organ systems.
- Explain how the cardiovascular system maintains homeostasis in the body



# Cardiovascular System Overview

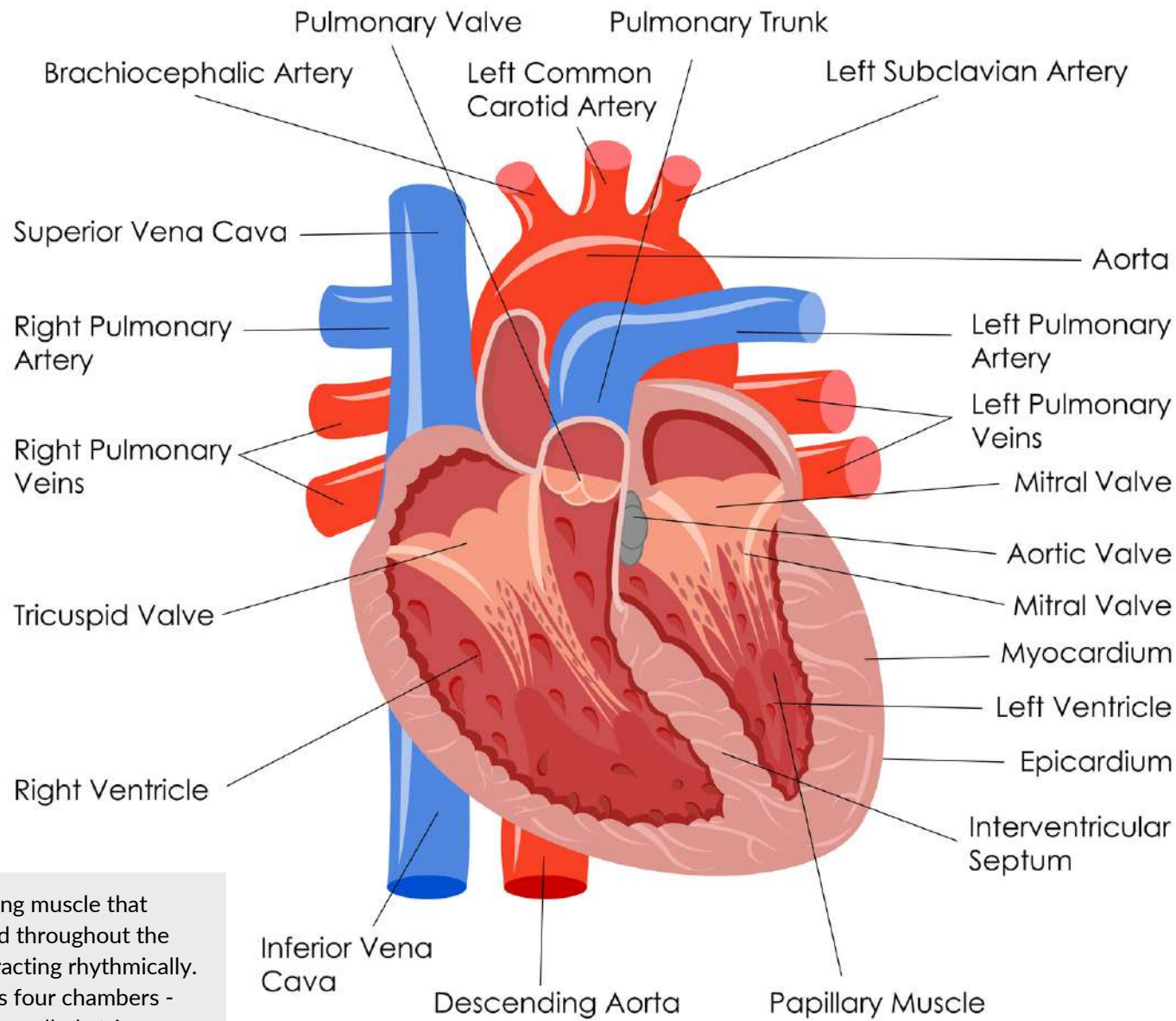


The cardiovascular system is responsible for **transporting blood** towards and away from the heart, and throughout the body. The blood carries oxygen, nutrients, and hormones to cells while simultaneously removing waste products, such as carbon dioxide.

## COMPONENTS

Heart  
Veins  
Arteries  
Capillaries

# Heart Anatomy



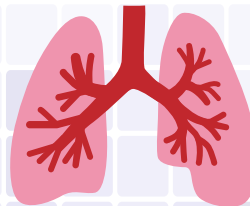
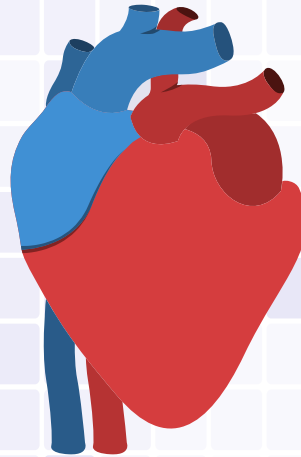
The **HEART** is a strong muscle that works to pump blood throughout the entire body by contracting rhythmically. The human heart has four chambers - the two at the top are called atria (atrium singular), and the bottom two are the ventricles.

# Blood Flow Through the Heart

The caudal, inferior and superior vena cava vessels carry **deoxygenated** blood to the right **atrium**.

Blood is then pumped from the right atrium to the **right ventricle** via the **tricuspid valve**

Blood is pumped from the right ventricle out to the **pulmonary arteries**, which carry the blood to the lungs to receive oxygen.



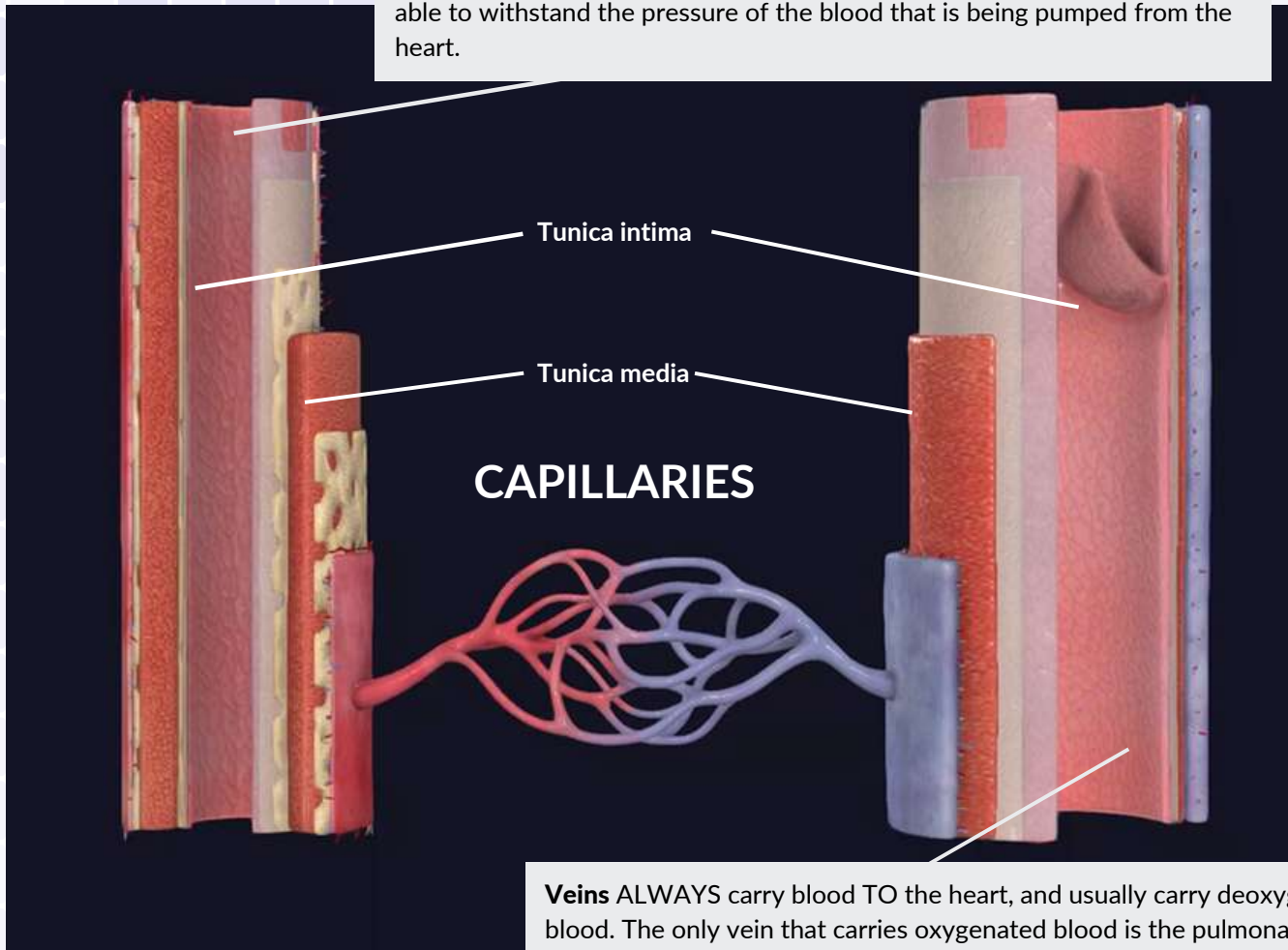
The left ventricle pumps **oxygenated** blood out to the body via the **aorta**

Blood is then pumped from the left atrium to the **left ventricle** via the **bicuspid (mitral) valve**

**Pulmonary veins** carry oxygenated blood back to the heart and into the **left atrium**

# Blood Vessel Anatomy

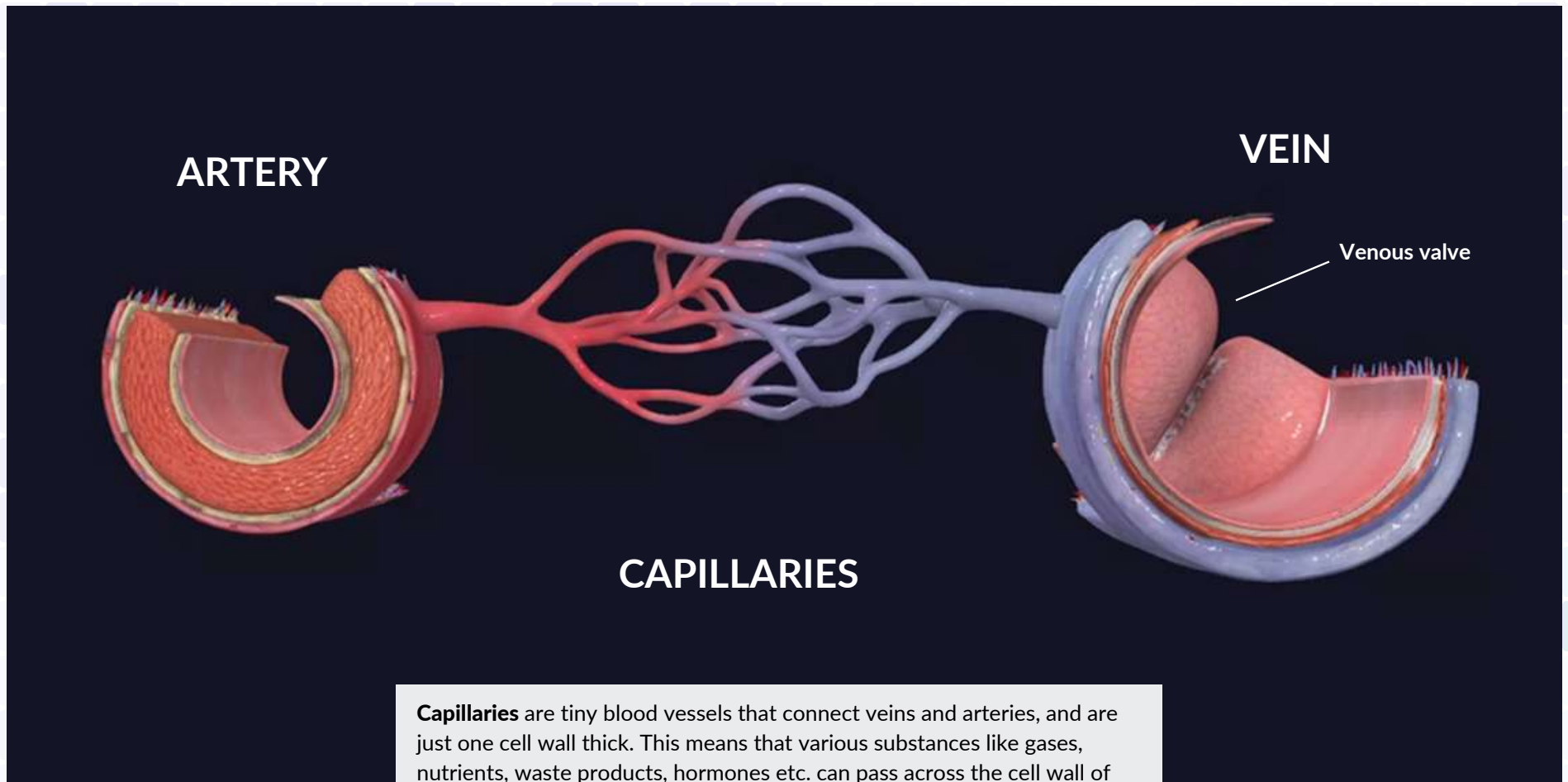
**Arteries** ALWAYS carry blood AWAY from the heart, and usually carry oxygenated blood. The only vein that carries deoxygenated blood is the pulmonary artery that carries deoxygenated blood away from the heart to the lungs. Like veins, the anatomy of arteries consist of three main layers: an outer layer of connective tissue called the tunica externa or tunica adventitia; a middle layer of smooth muscle called the tunica media; and an inner layer of endothelial cells called the tunica intima. The layers of the arteries are thicker than the layers of veins, making them more rigid and able to withstand greater pressure. This is important because arteries need to be able to withstand the pressure of the blood that is being pumped from the heart.



**Veins** ALWAYS carry blood TO the heart, and usually carry deoxygenated blood. The only vein that carries oxygenated blood is the pulmonary vein which carries blood from the lungs towards the heart. The anatomy of a vein consists of three main layers: an outer layer of connective tissue called the tunica externa or tunica adventitia; a middle layer of smooth muscle called the tunica media; and an inner layer of endothelial cells called the tunica intima. Medium to large veins have venous valves, which ensure that blood keeps flowing in the correct direction (i.e. prevents backflow).



# Blood Vessel Anatomy

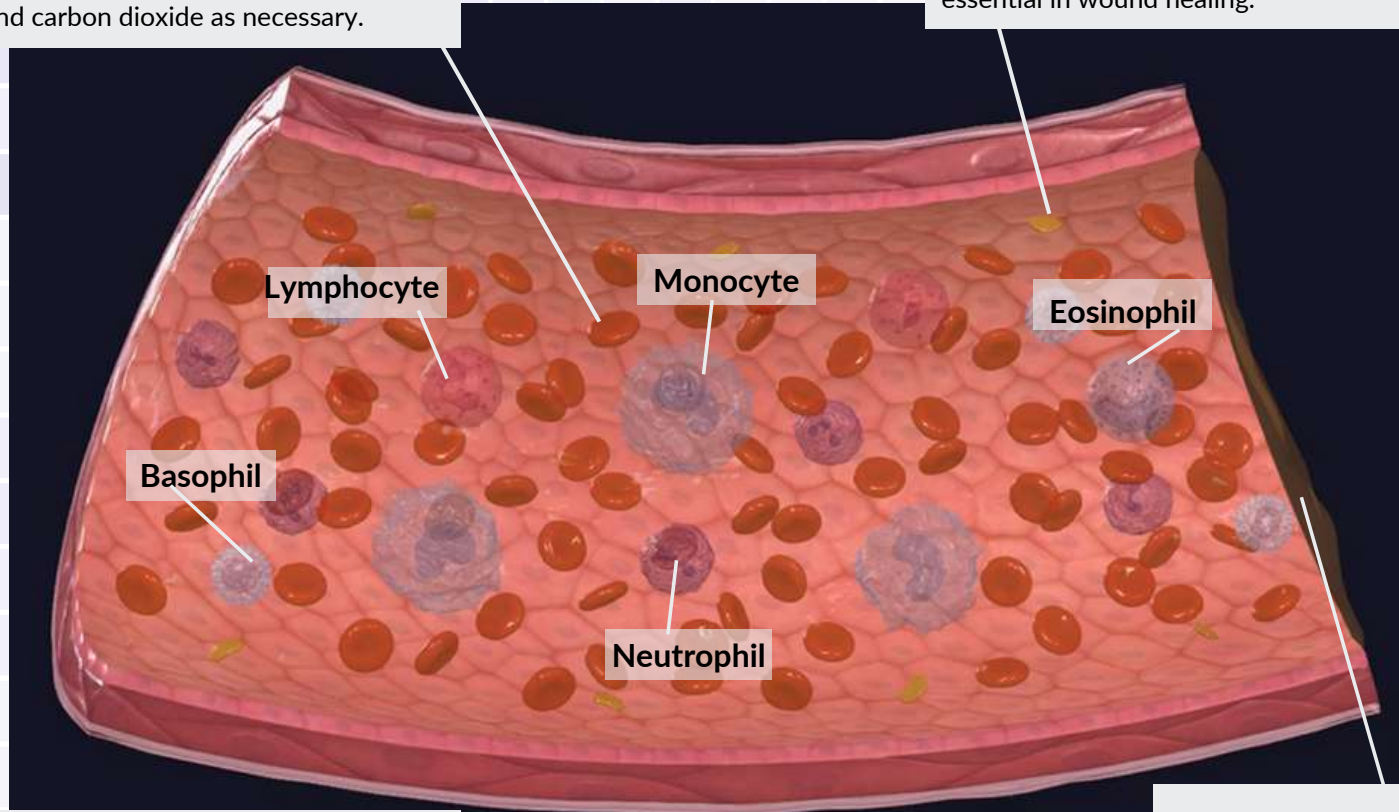


**Capillaries** are tiny blood vessels that connect veins and arteries, and are just one cell wall thick. This means that various substances like gases, nutrients, waste products, hormones etc. can pass across the cell wall of capillaries. It is through the capillaries that oxygen, nutrients, and other substances are exchanged between the blood and tissues. The majority of blood vessels found in the body are capillaries. The anatomy of a capillary consists of a thin layer of endothelial cells (tunica intima) and is surrounded by a protein matrix called the basal lamina.

# Blood Composition

**Red blood cells**, also known as **erythrocytes** and shaped like a disc with shallow indentations on both sides, are the most abundant type of cell in the blood. They have no nucleus and can change shape, which allows them to fit through the various types of blood vessels in the body. The primary function of red blood cells is to carry a protein known as hemoglobin, which carries oxygen and carbon dioxide as necessary.

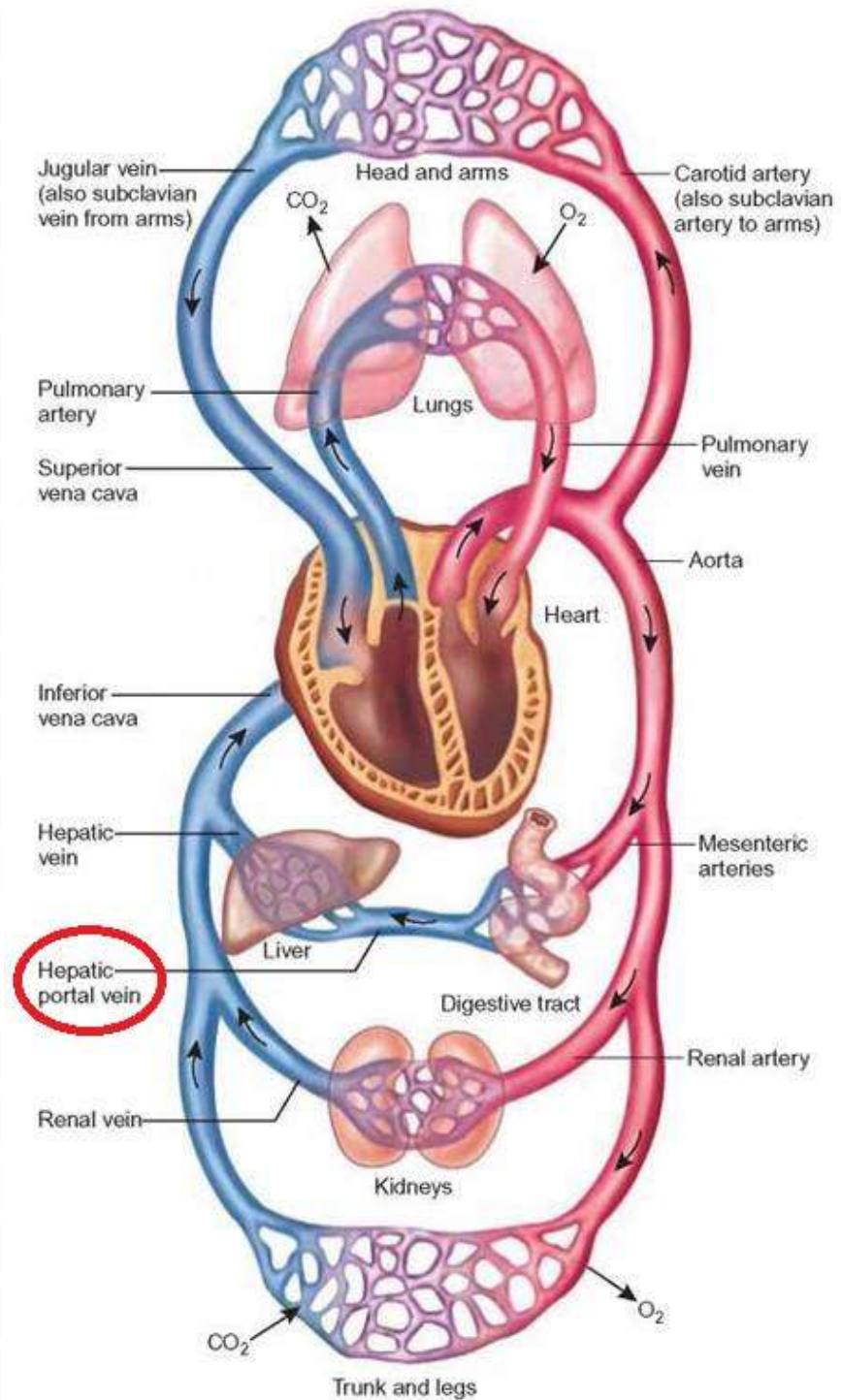
**Platelets**, also known as thrombocytes, are cell fragments which assist in blood clotting and prevent bleeding. They are essential in wound healing.



**White blood cells**, also known as **leukocytes**, protect the body from infection. There are five types: **Neutrophils**, which destroy and digest bacteria and fungi. They are considered the 'first line of defence'. **Monocytes**, which help break down bacteria and clean up dead cells. **Lymphocytes**, which create antibodies to fight against bacteria, viruses, and other harmful invaders. There are two main types of lymphocytes - T lymphocytes which regulate the functioning of other immune cells and assist in the destruction of invaders, and B lymphocytes which make antibodies. **Basophils**, which secrete chemicals like histamine to assist in controlling the body's immune response. **Eosinophils**, which attack and destroy parasites and cancer cells, and assist in allergic responses.

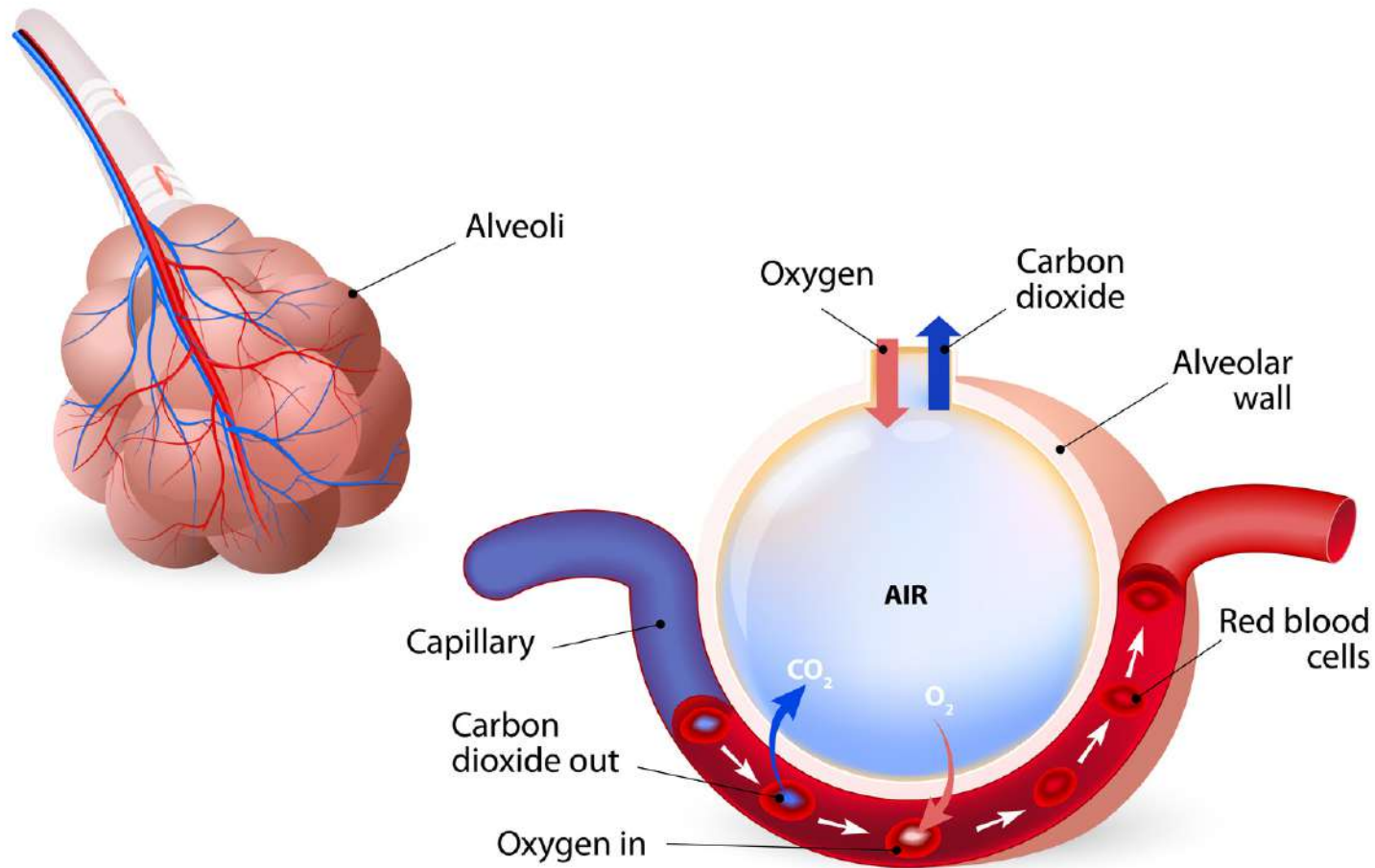
**Plasma**, the liquid portion of the blood, constitutes approximately 55% of the total blood volume; it is composed of mostly water with a mixture of lipids, proteins, and salts. The primary function of plasma is to transport blood cells and platelets throughout the body with nutrients, waste products, antibodies, hormones, and proteins.

# Cardiovascular System & Other Organ Systems



# Gas Exchange in the Lungs

*Interdependence of cardiovascular and respiratory systems*



## **CAPILLARIES:**

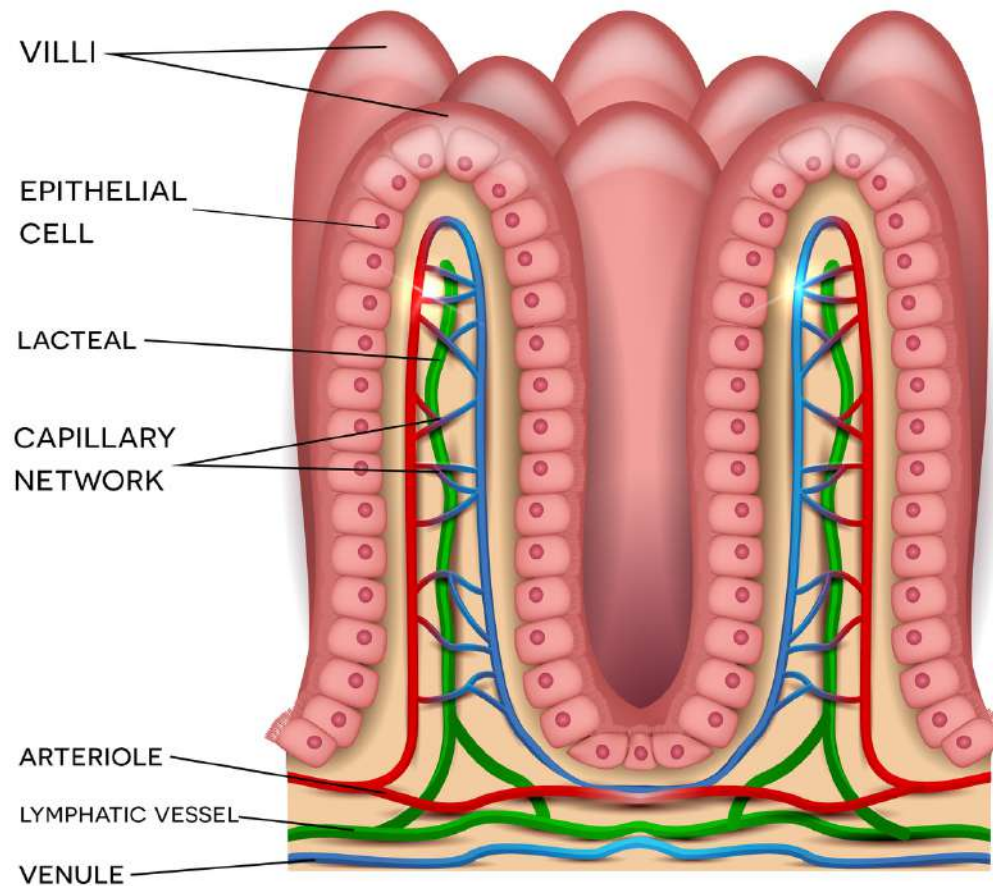
Tiny blood vessels that connect veins and arteries throughout the body, and are just one cell wall thick. This means that various substances like gases, nutrients, waste products, hormones etc. can pass across the cell wall of capillaries; it is through the capillaries that oxygen, nutrients, and other substances are exchanged between the blood and tissues. They cover alveoli to allow oxygen and carbon dioxide to move freely between the respiratory and cardiovascular systems. The majority of blood vessels found in the body are capillaries. The anatomy of a capillary consists of a thin layer of endothelial cells (tunica intima) and is surrounded by a protein matrix called the basal lamina.



# Nutrient Absorption in the Small Intestine

## *Interdependence of cardiovascular and digestive systems*

Villi are specialized for absorption in the small intestine as they have a thin wall, one cell thick, which enables a shorter diffusion path. They have a large surface area which facilitates more efficient absorption of fatty acids and glycerol into the blood stream.



# Hepatic Portal System

## *Interdependence of cardiovascular and digestive systems*

The **hepatic portal system** is a series of veins that carry blood from the capillaries of the stomach, intestine, spleen, and pancreas to capillaries in the liver. It is part of the body's filtration system. Its main function is to deliver de-oxygenated blood to the liver to be detoxified further before it returns to the heart.

The hepatic portal system consists of:

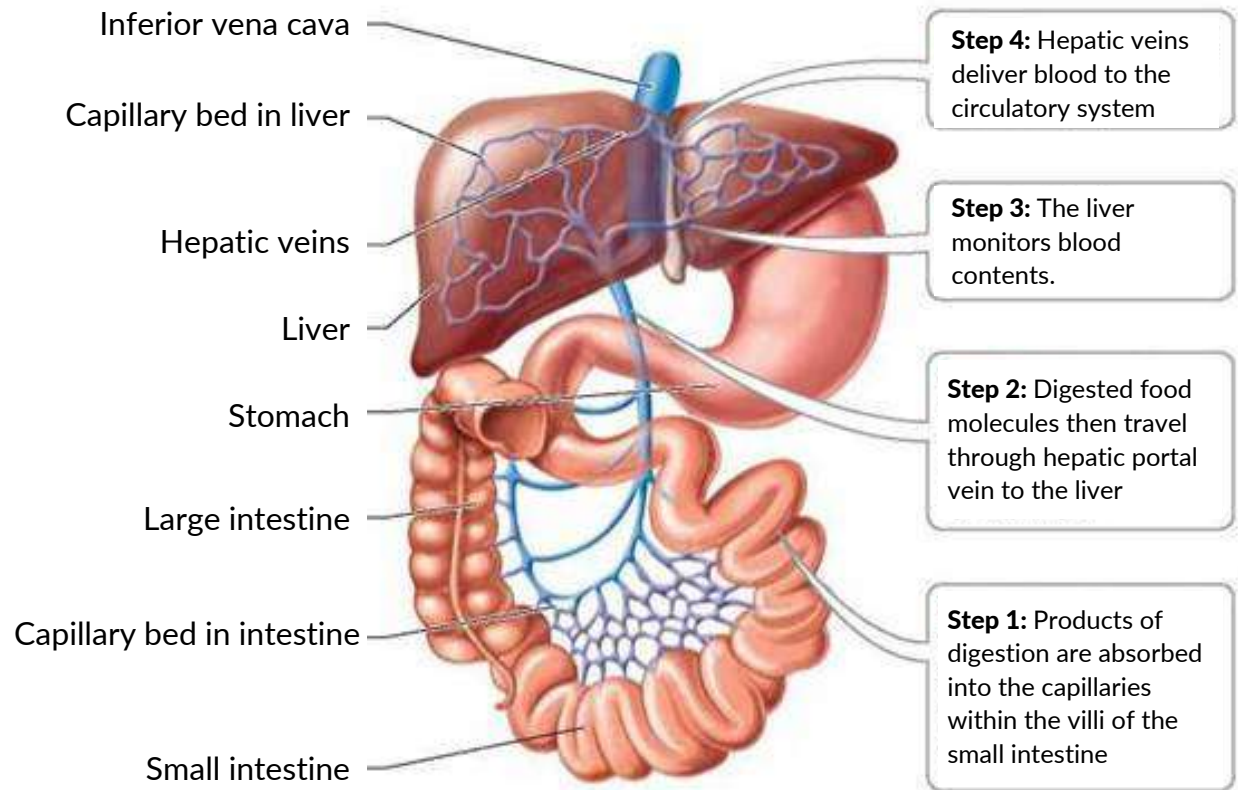
**Hepatic portal vein** - This is the main vein connected to the liver. It forms at the connection of the inferior and superior mesenteric veins.

**Inferior mesenteric vein** - This vein takes blood from the colon and rectum and connects with the portal vein.

**Superior mesenteric vein** - This drains blood from the small intestine and connects with the hepatic portal vein.

**Gastrosplenic vein** - This tributary is formed by the union of the splenic vein from the spleen and the gastric vein from the stomach. It joins with the mesenteric vein inside the pancreas.

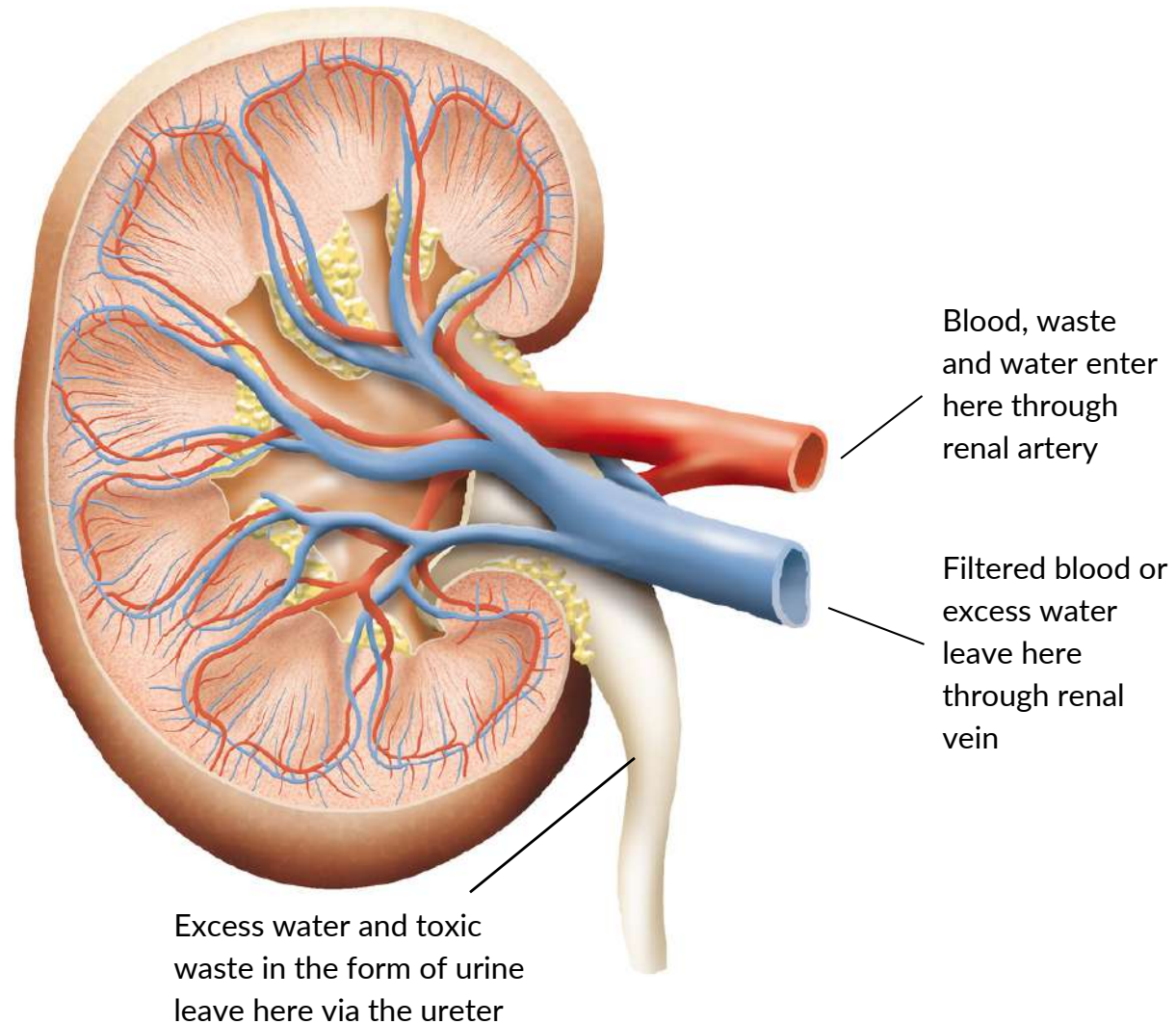
The hepatic portal system is designed to rid the body of toxins, but it cannot detect those that are designed to help it. Some drugs must be taken under the tongue, through the skin, or via suppository to avoid entering the hepatic portal system and being prematurely metabolized in the liver before reaching general circulation.



# Kidney Filtration and Absorption

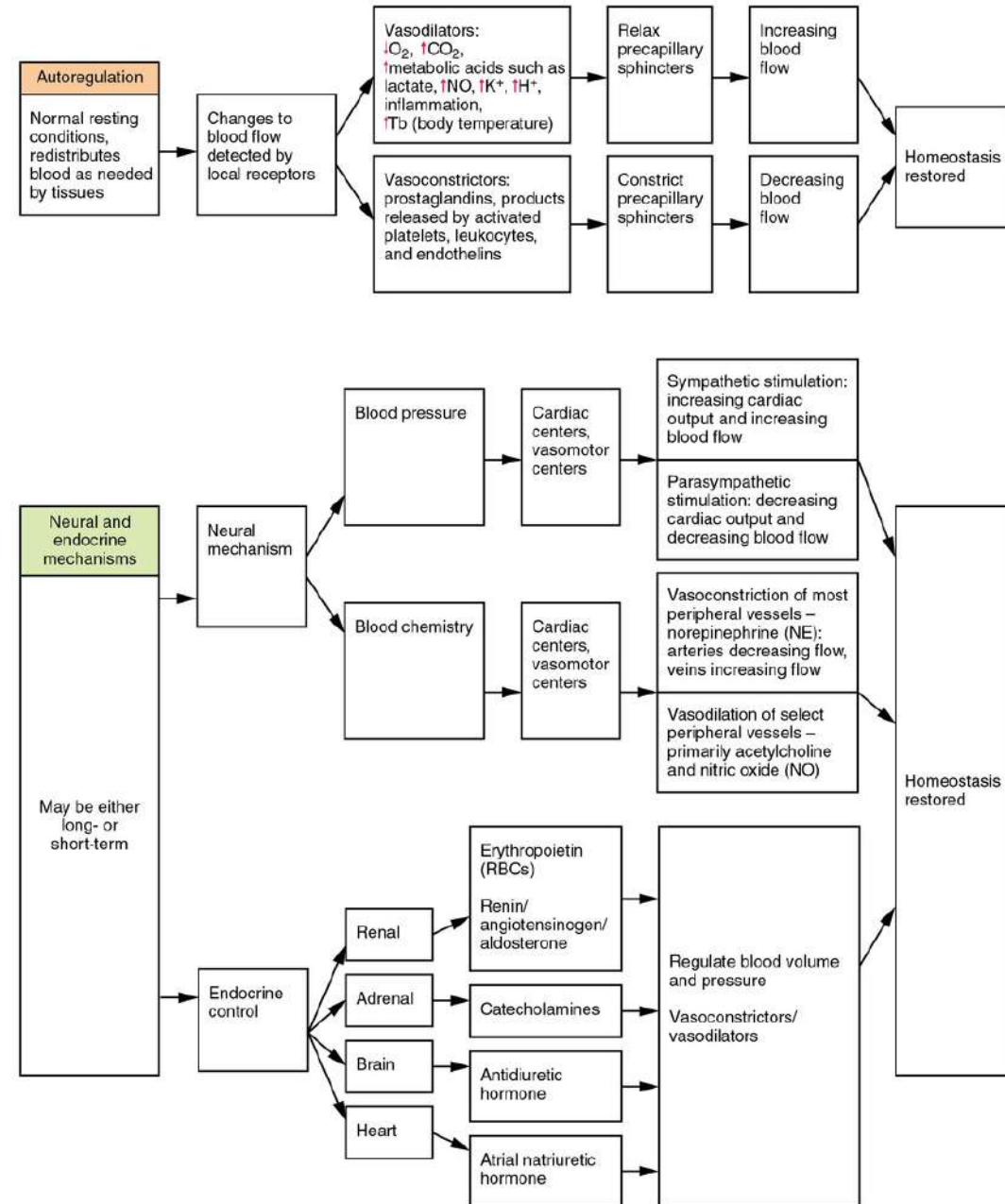
*Interdependence of cardiovascular and urinary systems*

The urinary and cardiovascular systems work together: the urinary system cleans the blood in the circulatory system. Blood traveling back to the heart passes through the kidneys in the urinary system. The kidneys clean the blood and control the amount of salt, water, and other substances in the blood.



# Cardiovascular System & Homeostasis

In order to maintain homeostasis in the cardiovascular system and provide adequate blood to the tissues, blood flow must be redirected continually to the tissues as they become more active. In a very real sense, the cardiovascular system engages in resource allocation, because there is not enough blood flow to distribute blood equally to all tissues simultaneously. For example, when an individual is exercising, more blood will be directed to skeletal muscles, the heart, and the lungs. Following a meal, more blood is directed to the digestive system. Only the brain receives a more or less constant supply of blood whether you are active, resting, thinking, or engaged in any other activity.



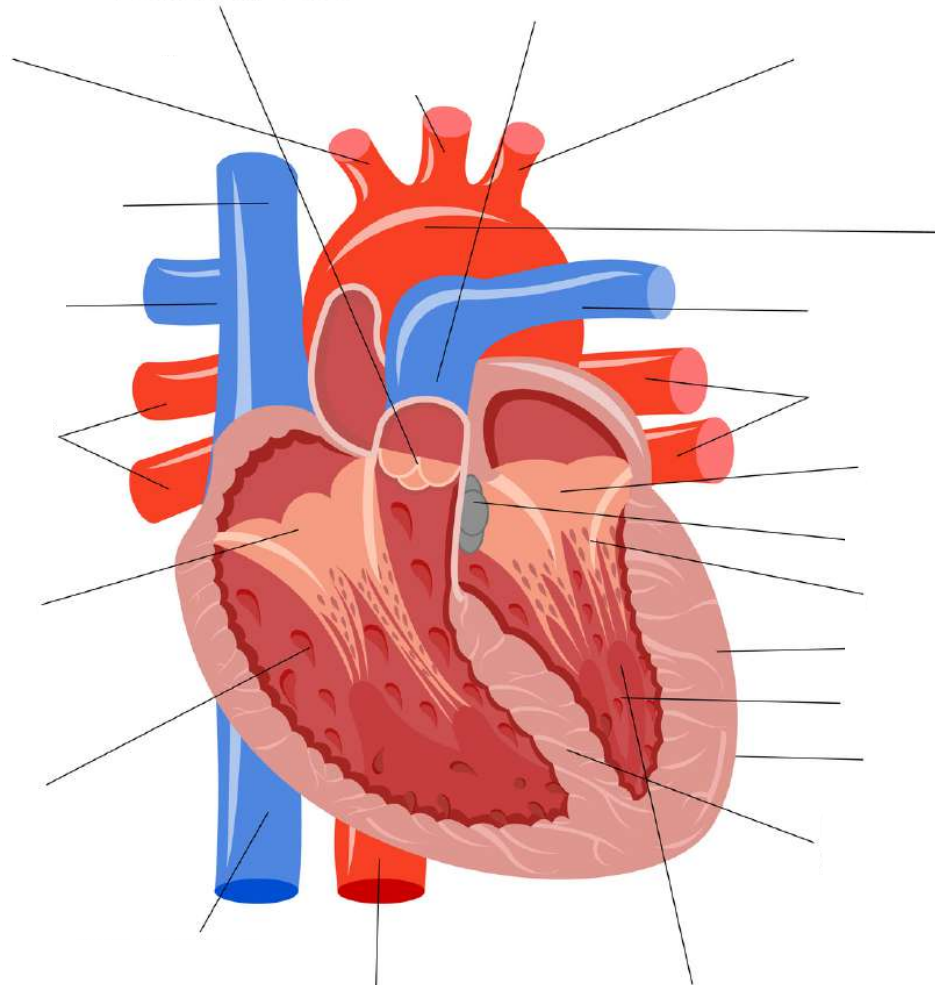


# Review Break

- What is one way the cardiovascular system maintains homeostasis within the body?
- What is one way the cardiovascular system interacts with other body systems?
- What are the main structures blood moves through within the cardiovascular system (include a detailed description of blood flow through the heart)?

# QUIZ!

Label the heart diagram below.



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