

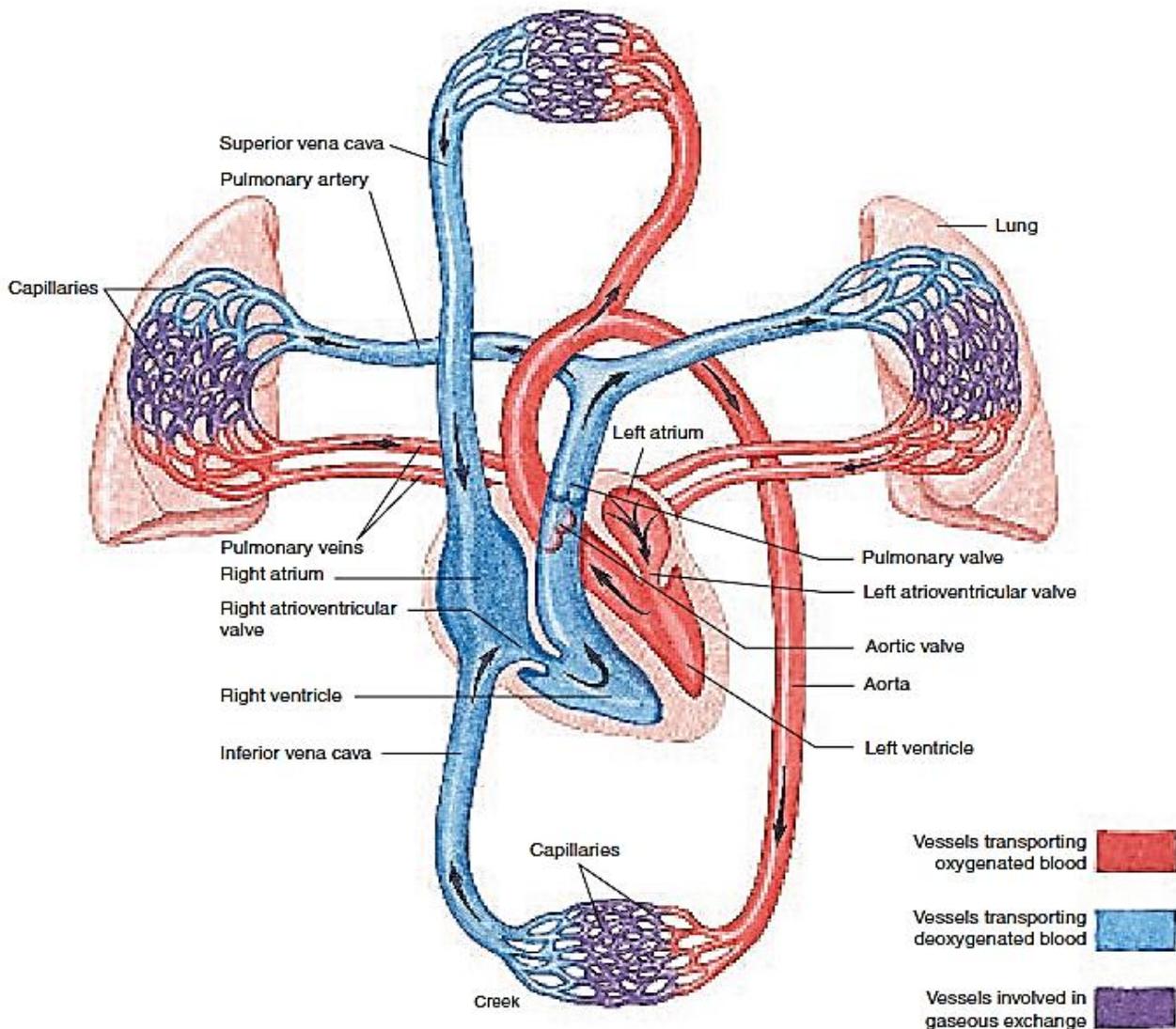
## The circulatory system

The circulatory system is divided into:

- (1) **cardiovascular system**, which consists of the heart, blood vessels, and blood.
- (2) **lymphatic system**, which consists of lymphatic vessels and lymphoid tissues within the spleen, thymus, tonsils, and lymph nodes.

### Cardiovascular system (CVS)

The cardiovascular system which is closed system consists of : (1) the **heart**, which pumps blood so that it flows to body tissue capillaries, (2) the series of **blood vessels** through which the blood flows, there are certain blood vessels are a part of the pulmonary circuit, and others are a part of the systemic circuit and (3) **blood**.



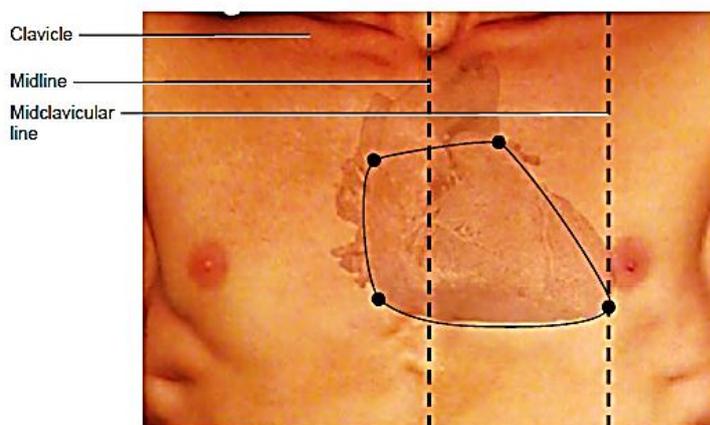
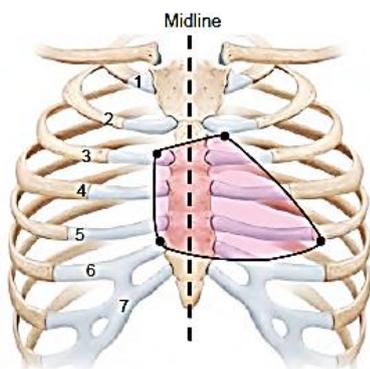
## Heart

The heart is located in the thoracic cavity between the lungs within the mediastinum (anatomical region that extends from the sternum to the vertebral column) rests on the diaphragm. It is a hollow, cone-shaped, relatively small roughly the same size as a **closed fist**. Its mass averages 250 g in adult females and 300 g in adult males. The base of the heart is superior to its apex which rests inferiorly on the diaphragm.

The heart is on a slant. About two-thirds of the mass of the heart lies to the left of the body's midline.

As the heart pumps the blood through the pulmonary and systemic vessels, it performs these functions:

1. Keeps O<sub>2</sub>-poor blood separate from O<sub>2</sub>-rich blood.
2. Keeps the blood flowing in one direction—blood flows away from and then back to the heart in each circuit.
3. creates blood pressure, which moves the blood through the circuits.
4. Regulates the blood supply based on the current needs of the body.



(d) Surface projection of the heart

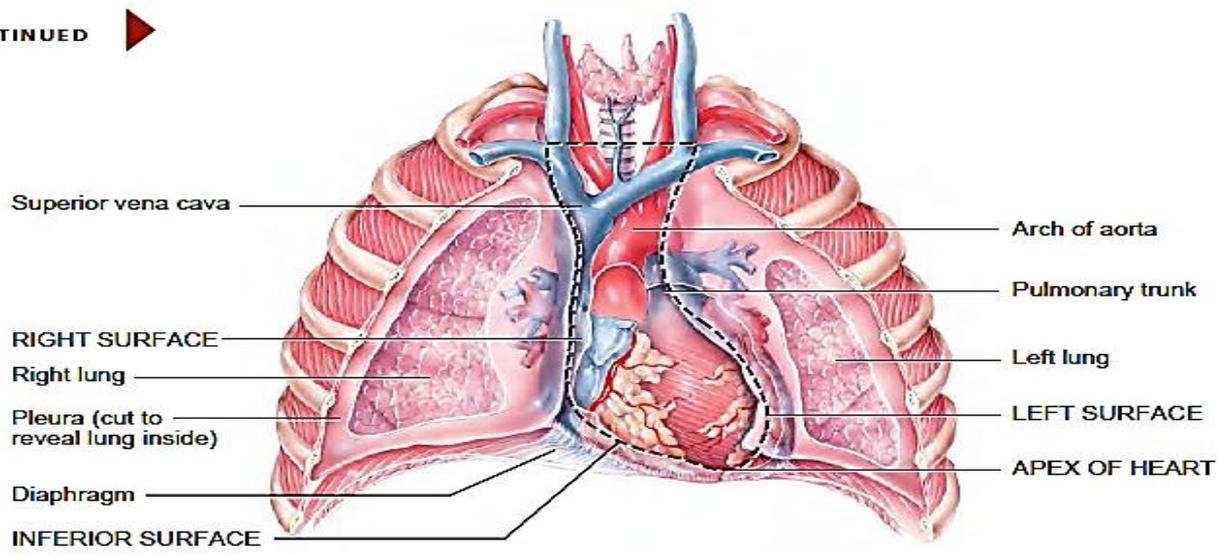
## Pericardium

The membrane that surrounds and protects the heart is the *pericardium* fused with base of great vessels. The Function of the Pericardium: (1) Protects and anchors the heart (2) Prevents overfilling of the heart with blood (3) allows for the heart to work in a relatively friction-free environment.

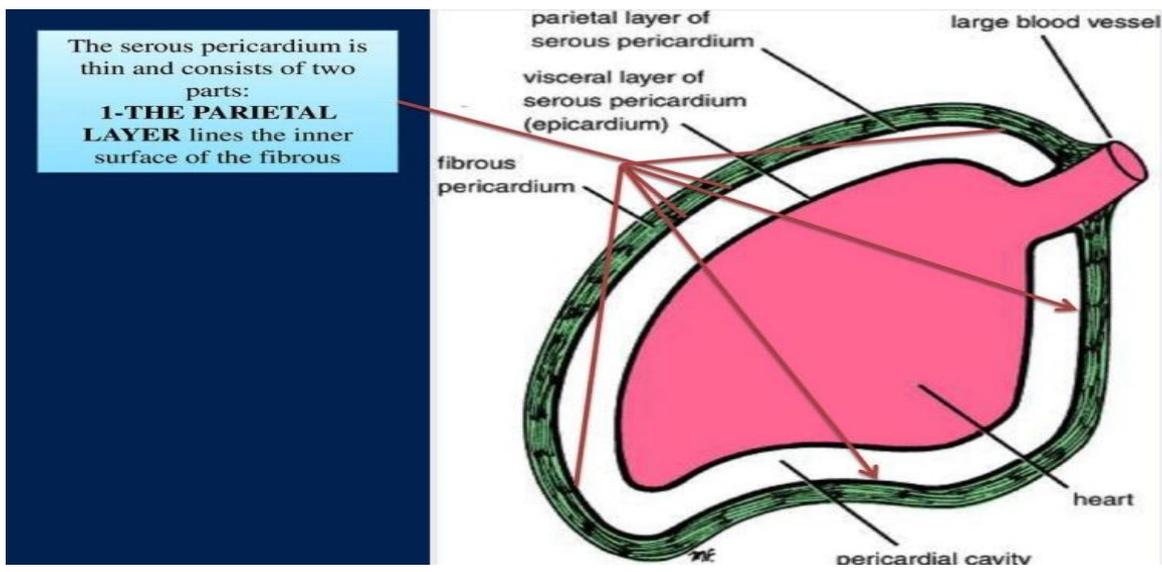
The pericardium consists of two principal portions: (1) the superficial **fibrous pericardium** is composed of tough, inelastic, dense irregular connective tissue.

(2) The deeper **serous pericardium** is a thinner, more delicate membrane that forms a double layer around the heart. The outer *parietal layer* of the serous pericardium is fused to the fibrous pericardium. The inner *visceral layer* of the serous pericardium, also called the *epicardium* adheres tightly to the surface of the heart. Between them is a space called the pericardial cavity that contains the few milliliters of thin film of lubricating fluid called *pericardial fluid* reduces friction between the membranes as the heart moves.

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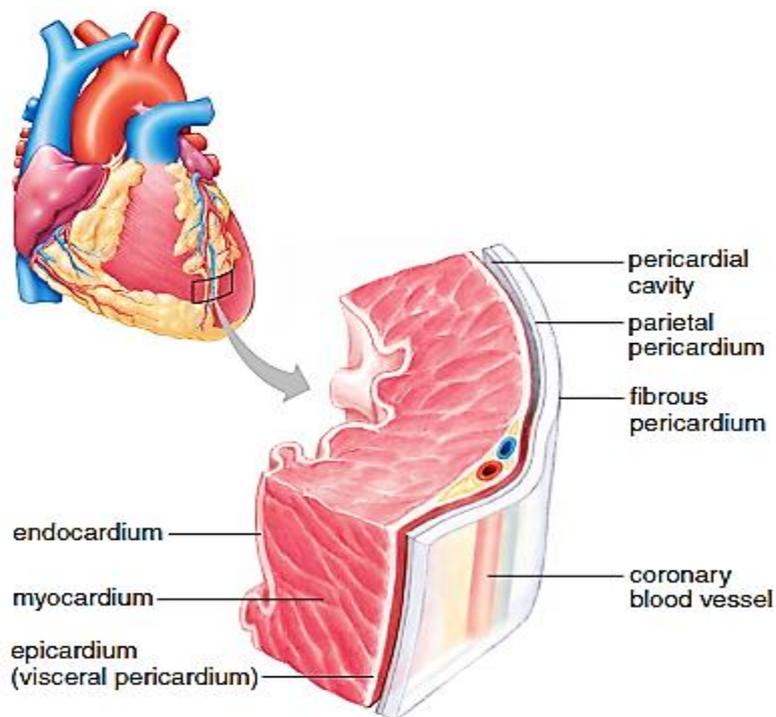


(b) Anterior view of the heart in the thoracic cavity



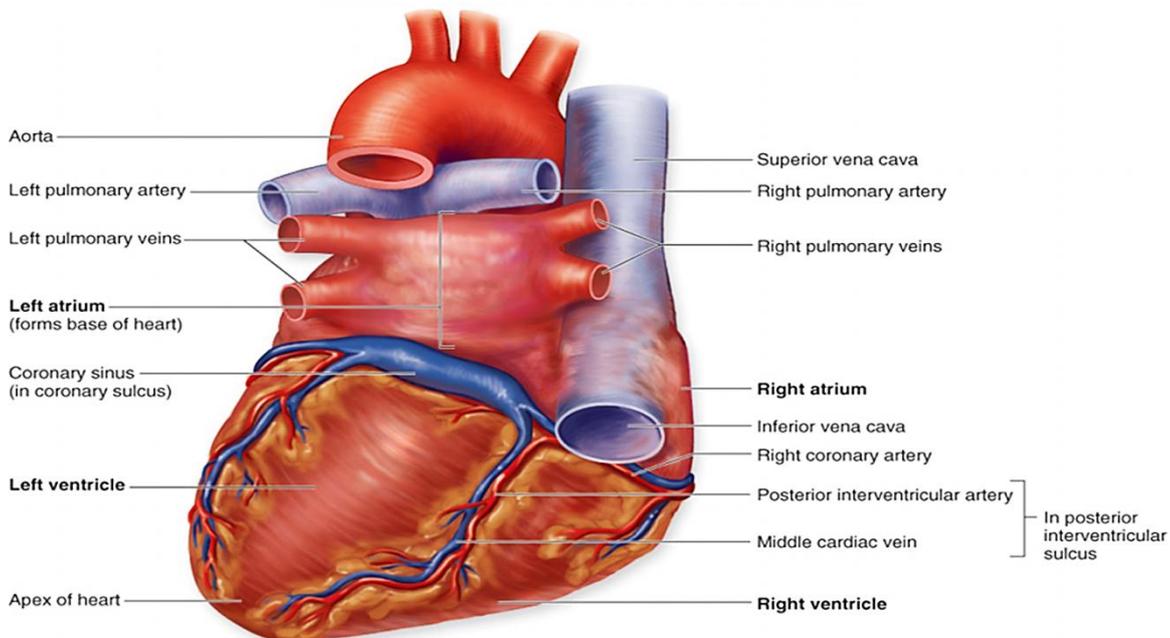
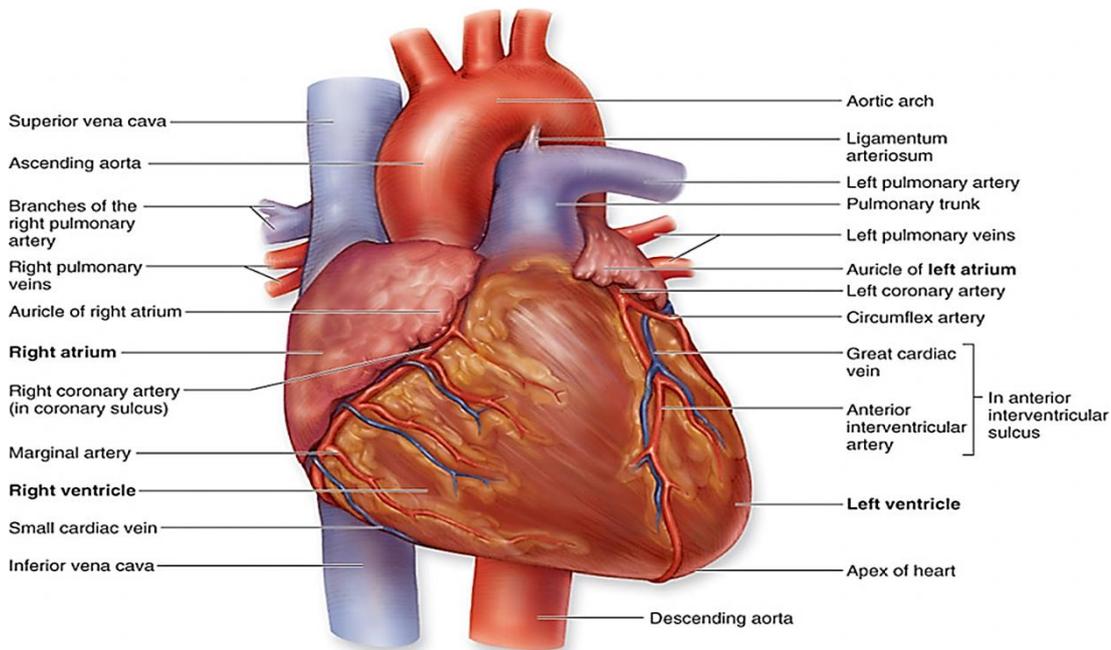
## Layers of the Heart Wall

The wall of the heart consists of three layers: the *epicardium* (external layer), the *myocardium* (middle layer) composed of cardiac muscle, It's the thickest of the three layers and the *endocardium* (inner layer).



## Chambers of the Heart

The heart has four hollow chambers: two superior *atria* (single atrium) and two inferior *ventricles*. Each atrium has a wrinkled anterior pouch called an *auricle*. Internally, the atria are separated by the *interatrial septum*, and the ventricles are separated by the *interventricular septum*. Therefore, the heart has a left and a right side. The thickness of a chamber's myocardium is suited to its function. The atria have thin walls, and they send blood into the adjacent ventricles. The ventricles are thicker, and they pump blood into blood vessels that travel to parts of the body. The left ventricle has a thicker wall than the right ventricle; the right ventricle pumps blood to the lungs, which are nearby. The left ventricle pumps blood to all the other parts of the body.



## **Right Atrium**

The **right atrium** forms the right border of the heart. It receives blood from three veins: *superior vena cava*, *inferior vena cava*, and *coronary sinus*. Veins always carry blood toward the heart. Venous blood passes from the right atrium into the right ventricle through an **atrioventricular (AV) valve**. This valve, like the other heart valves, directs the flow of blood and prevents any backflow. The AV valve also called the **tricuspid valve** because it has three cusps, or flaps.

## **Right Ventricle**

In the **right ventricle**, the cusps of the tricuspid valve are connected to fibrous cords, called the **chordae tendineae**. The chordae tendineae in turn are connected

to the **papillary muscles**, which are conical extensions of the myocardium. Blood from the right ventricle passes through a **semilunar valve**(resemble half-moons) into the **pulmonary trunk**. This particular semilunar valve, called the **pulmonary semilunar valve**, prevents blood from flowing back into the right ventricle. The **pulmonary trunk** divides into the **left** and **right pulmonary arteries**.

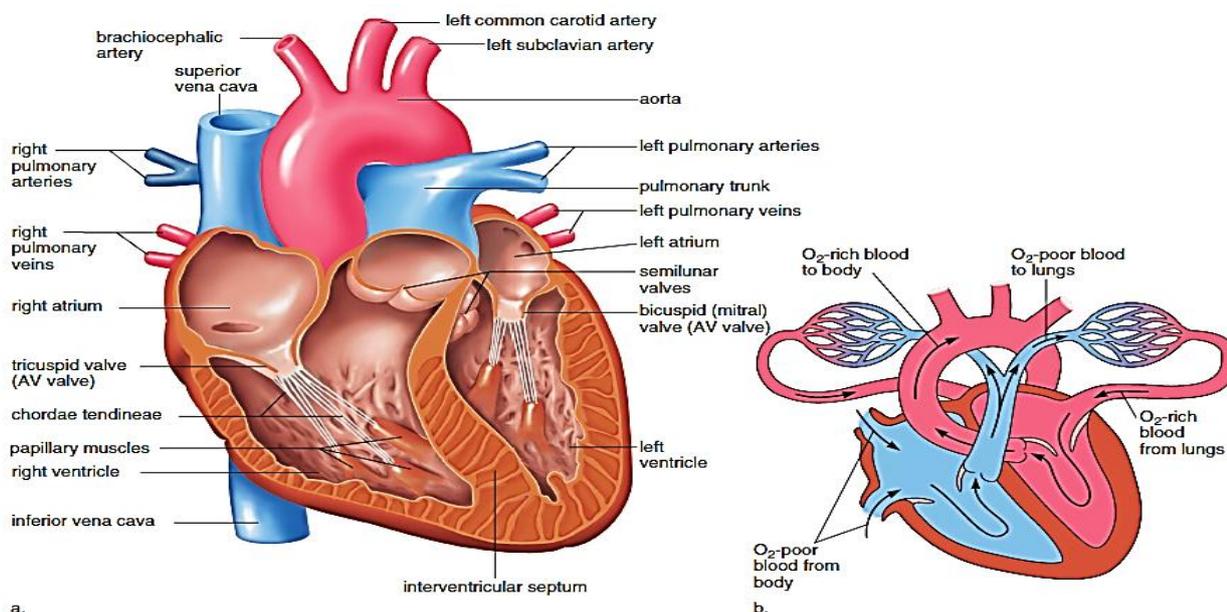
### Left Atrium

At its posterior wall, the **left atrium** receives O<sub>2</sub>-rich blood from **four pulmonary veins**. Two pulmonary veins come from each lung. Blood passes from the left atrium into the left ventricle through an AV valve. The AV valve on the left side is specifically called the **bicuspid (mitral) valve** because it has two cusps.

### Left Ventricle

The **left ventricle** forms the apex of the heart. The cavity of the left ventricle is oval-shaped, while that of the right ventricle is crescent-shaped in transverse section. The papillary muscles in the left ventricle are quite large, and the chordae tendineae attached to the AV valve are thicker and stronger than those in the right ventricle. As mentioned, the AV valve on the left side is also called the bicuspid (or mitral) valve. Blood passes from the left ventricle through a semilunar valve into the **aorta**. This semilunar valve is appropriately called the **aortic semilunar valve**. Just beyond the aortic semilunar valve, some blood passes into the two **coronary arteries**, termed the **left** and **right coronary arteries**, blood vessels that lie on and nourish the heart itself. The aorta continues as **ascending aorta** then the **arch of the aorta** and then the **descending aorta**. The path of O<sub>2</sub>-rich blood through the heart, from the pulmonary veins to the aorta.

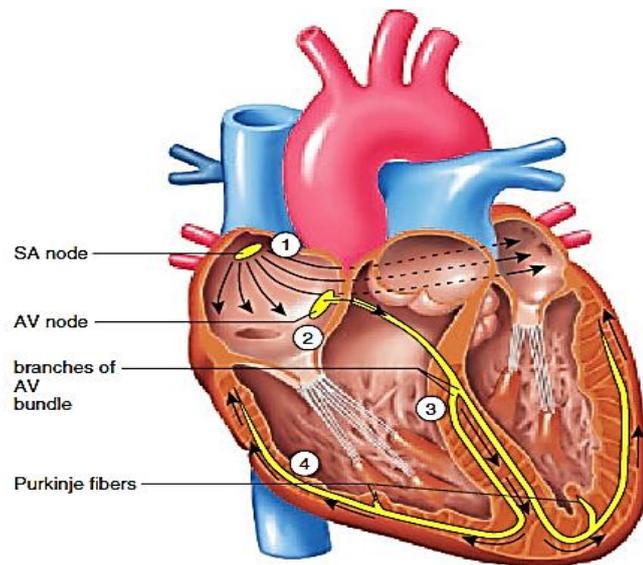
The heart have coronary veins are specifically called **cardiac veins**. The cardiac veins enter a **coronary sinus**, which is essentially a thin-walled vein. The **coronary sinus** enters the **right atrium**.



## Conduction System of the Heart

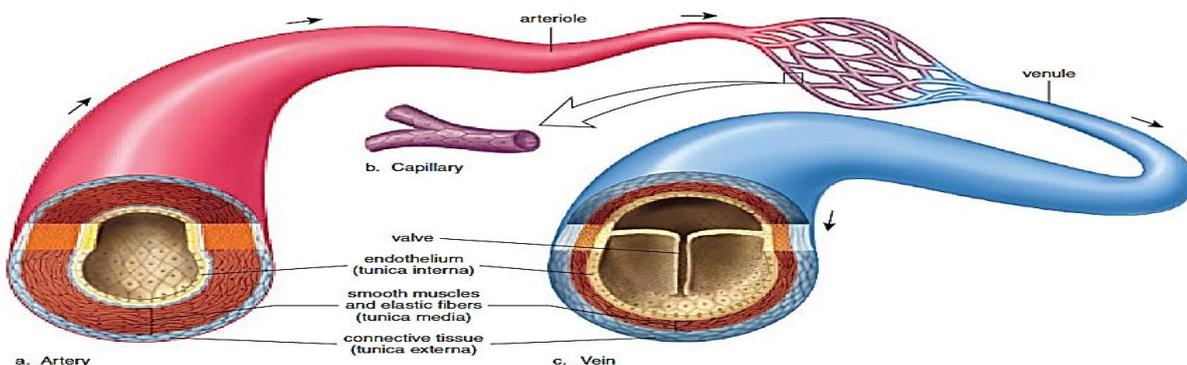
The **conduction system of the heart** is a route of specialized cardiac muscle fibers that initiate and stimulate contraction of the atria and ventricles. The conduction system is said to be **intrinsic**, meaning that the heart beats automatically without the need for external nervous stimulation. The conduction system coordinates the contraction of the atria and ventricles so that the heart is an effective pump. Without this conduction system, the atria and ventricles would contract at different rates. Conduction system of the heart. (1) The **sinoatrial node (SA) cardiac pacemaker** sends out a stimulus, which causes the atria to contract. (2) When this stimulus reaches the **atrioventricular node (AV)**, it signals the ventricles to contract. (3) Impulses pass down the two branches of the **atrioventricular bundle** (4) and then to the **Purkinje fibers**, and thereafter, the ventricles contract.

- ① Stimulus originates in the SA node and travels across the walls of the atria, causing them to contract.
- ② Stimulus arrives at the AV node and travels along the AV bundle.
- ③ Stimulus descends to the apex of the heart through the bundle branches.
- ④ After stimulus reaches the Purkinje fibers, the ventricles contract.

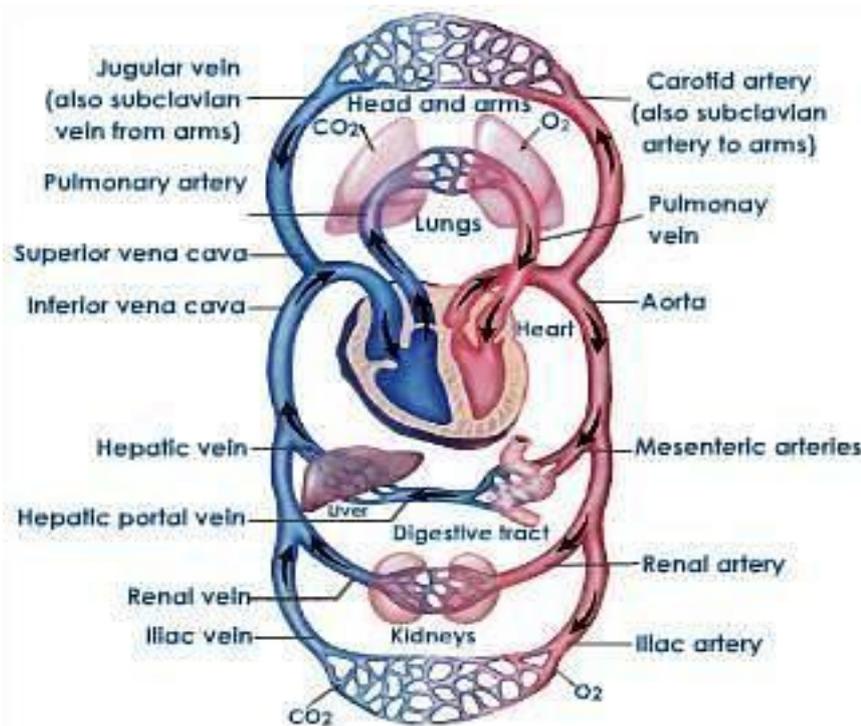


## Anatomy of Blood Vessels

Blood vessels are of three types: **arteries, capillaries, and veins**. These vessels function to transport blood and its contents; Carry out exchange of gases in the pulmonary capillaries and exchange of gases plus nutrients for waste at the systemic capillaries; Regulate blood pressure; Direct blood flow to those systemic tissues that most require it at the moment.



**Arteries** transport blood away from the heart. Blood vessels belong to either the *pulmonary circuit* or the *systemic circuit*. The path of blood through the **pulmonary circuit** can be traced as follows: deoxygenated blood from all regions of the body first collects by veins in the right atrium and then passes into the right ventricle, which pumps it into the pulmonary trunk. The pulmonary trunk divides into the **pulmonary arteries**, which in turn divide into the arterioles of the lungs. The arterioles then take blood to the pulmonary capillaries, where carbon dioxide and oxygen are exchanged. The blood then enters the pulmonary venules and flows through the **pulmonary veins** back to the left atrium. The **systemic circuit** includes all of the other arteries and veins of the body. The largest artery in the systemic circuit is the **aorta**, and the largest veins are the **superior vena cava** and **inferior vena cava**. The superior vena cava collects blood from the head, chest, and arms, and the inferior vena cava collects blood from the lower body regions. Both venae cavae enter the right atrium. The aorta and venae cavae are the major pathways for blood in the systemic system.



### The Major Systemic Arteries

After the aorta leaves the heart, it divides into the **ascending aorta**, the **aortic arch**, and the **descending aorta**. The left and right coronary arteries, which supply blood to the heart, branch off the ascending aorta. Three major arteries branch off the aortic arch: the **brachiocephalic artery**, the **left common carotid artery**, and the **left subclavian artery**. The brachiocephalic artery divides into the **right common carotid** and the **right subclavian arteries**. These blood vessels serve the head (right and left common carotids) and arms (right and left subclavians). The descending aorta is divided into the **thoracic aorta**, which branches off to the organs within the

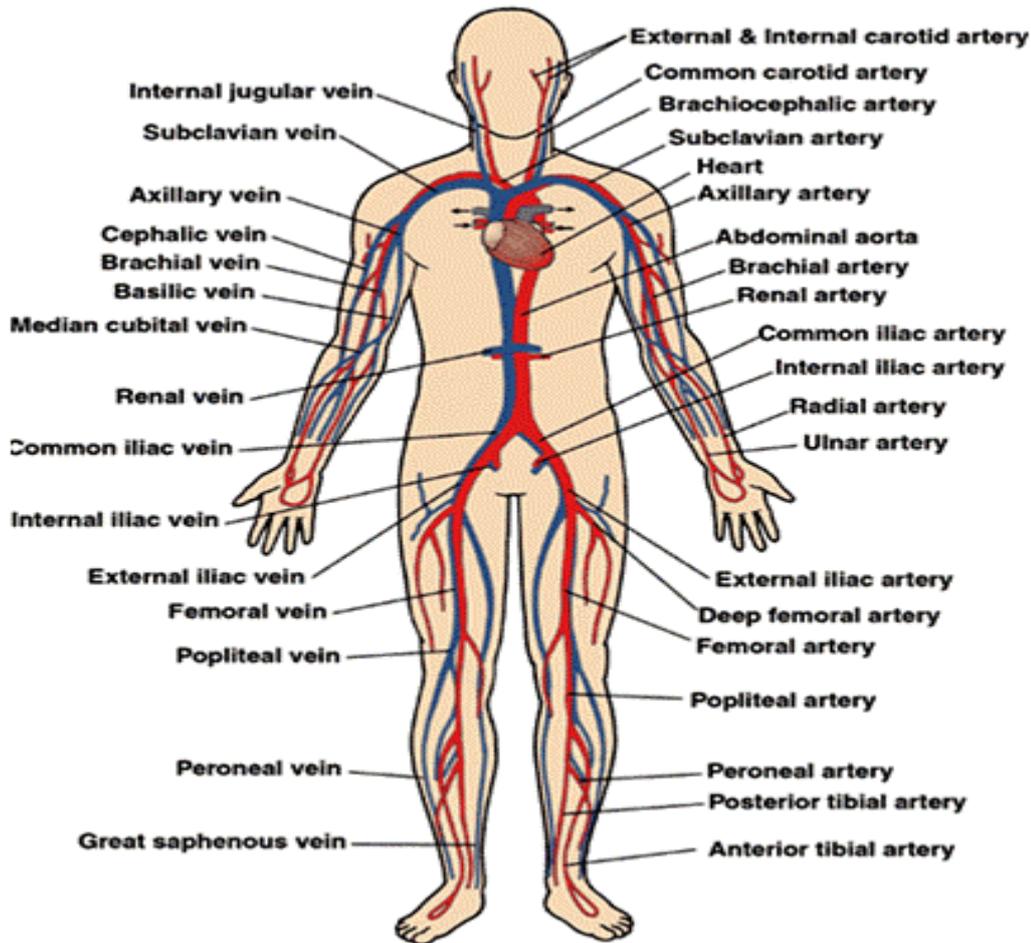
thoracic cavity, and the **abdominal aorta**, which branches off to the organs in the abdominal cavity. The descending aorta ends when it divides into the **common iliac arteries** that branch into the **internal iliac artery** and the **external iliac artery**. The internal iliac artery serves the pelvic organs, and the external iliac artery serves the legs.

Portion of Aorta	Major Branch	Regions Supplied
Ascending aorta	Left and right coronary arteries	Heart
Aortic arch	Brachiocephalic artery	Right side of head Right arm
	Right common carotid Right subclavian	
	Left common carotid artery Left subclavian artery	Left side of head Left arm
	Descending aorta	
Thoracic aorta	Intercostal artery	Thoracic wall
Abdominal aorta	Celiac artery	Stomach, spleen, and liver
	Superior mesenteric artery	Small and large intestines (ascending and transverse colons)
	Renal artery	Kidney
	Gonadal artery	Ovary or testis
	Inferior mesenteric artery	Lower digestive system (transverse and descending colons, and rectum)
	Common iliac artery	Pelvic organs and legs

### The Major Systemic Veins

the major veins of the body. The **external** and **internal jugular veins** drain blood from the brain, head, and neck. An external jugular vein enters a **subclavian vein** that, along with an internal jugular vein, enters a **brachiocephalic vein**. Right and left brachiocephalic veins merge, giving rise to the superior vena cava. In the abdominal cavity the **hepatic portal vein** receives blood from the abdominal viscera and enters the liver. Emerging from the liver, the **hepatic veins** enter the inferior vena cava. In the pelvic region, veins from the various organs enter the **internal iliac veins**, while the veins from the legs enter the **external iliac veins**. The internal and external iliac veins become the **common iliac veins** that merge, forming the **inferior vena cava**.

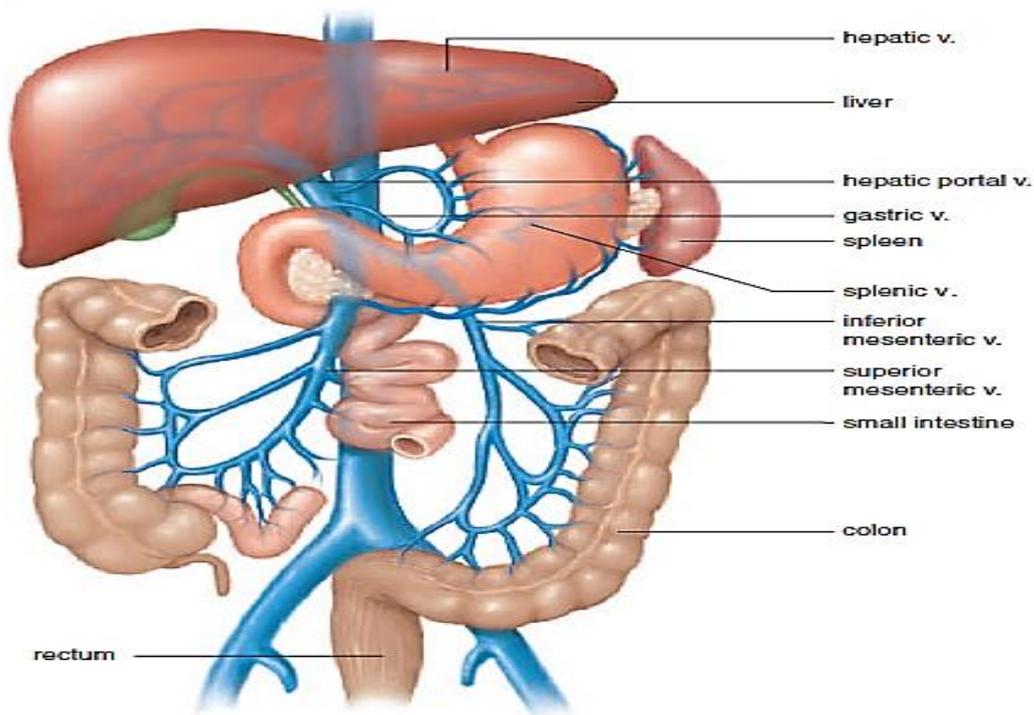
## Circulatory System



### Special Systemic Circulations

#### Hepatic Portal System

The **hepatic portal system** receives all of the blood draining from the abdominal digestive tract, as well as from the **pancreas**, **gallbladder**, and **spleen**. It is called a portal system because it connects capillaries of the intestines and other digestive organs to modified capillaries (**hepatic sinusoids**) of the **liver**; thus, the blood passes through two capillary beds in series before it returns to the heart.



### Fetal circulation

The lungs are not functional in the fetus. The blood passes directly from the right atrium to the left atrium via the **foramen ovale** or from the right ventricle to the aorta via the pulmonary trunk through **ductus venosus to aorta**. The two **umbilical arteries** take fetal blood to the placenta where exchange of molecules between **fetal** and **maternal** blood takes place. Oxygen and nutrient molecules diffuse into the fetal blood, and carbon dioxide and urea diffuse from the fetal blood. The umbilical vein returns blood from the placenta to the fetus.

