

Circulatory System

The cardiovascular system is transport system of body, it comprises blood, heart and blood vessels.

The system supplies nutrients to and remove waste products from various tissue of body.

The blood vascular system is composed of the following structures:

- The **heart**, an organ whose function is to pump the blood.
- The **arteries**, a series of efferent vessels that become smaller as they branch, and whose function is to carry the blood, with nutrients and oxygen, to the tissues.
- The **capillaries**, the smallest blood vessels, constituting a complex network of thin tubules that anastomose profusely and through whose walls the interchange between blood and tissues takes place.
- The **veins**, which result from the convergence of the capillaries into a system of channels. These channels become larger as they approach the heart, toward which they convey the blood to be pumped again.

Types of circulatory systems:

Animals that have a circulatory system have one of two kinds

1-Open: fluid is circulated through an open body chamber

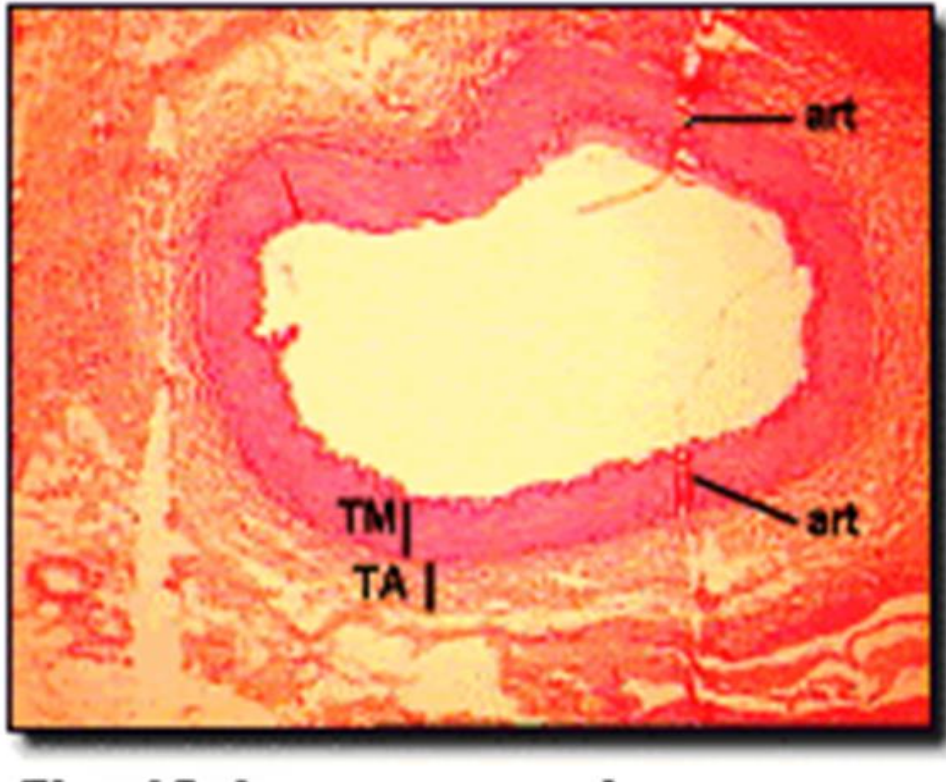
2-Closed: fluid is circulated through blood vessels.

Structure of the blood vessels: The arteries and veins have three layers, but the middle layer is thicker in the arteries than it is in the veins:

1.Tunica intima

2.Tunica media

3.Tunica adventitia



The structure of the 1- **tunica intima**

- A. A layer of pavement endothelium, the cells of which are polygonal, oval, or fusiform, and have very distinct round or oval nuclei.
- B. A subendothelial layer, consisting of delicate connective tissue with branched cells lying in the interspaces of the tissue; in arteries of less than 2 mm in diameter the subendothelial layer consists of a single stratum of stellate cells, and the connective tissue.
- C. An elastic or fenestrated layer, which consists of a membrane containing a network of elastic fibers, having principally a longitudinal direction, and in which, under the microscope, small elongated apertures or perforations may be seen, giving it a fenestrated appearance. It was therefore called by Henle the *fenestrated membrane*. This membrane forms the chief

thickness of the inner coat, and can be separated into several layers, some of which present the appearance of a network of longitudinal elastic fibers, and others a more membranous character, marked by pale lines having a longitudinal direction. In minute arteries the fenestrated membrane is a very thin layer; but in the larger arteries, and especially in the [aorta](#), it has a considerable thickness.

2-Tunica media: (thickest layer in arteries) composed mainly of bundles of elastic fibers, connective tissue, polysaccharide substances, the second and third layer are separated by another thick elastic band called external elastic lamina. The tunica media may (especially in arteries) be rich in vascular smooth muscle, which controls the caliber of the vessel.

3-Tunica adventitia : (thickest layer in veins) relatively developed. Entirely made of connective tissue. It also contains nerves that supply the vessel as well as nutrients capillaries (vasa vasorum) in the larger blood vessels.

a- External elastic membrane: short bundles of elastic fibers.

b- Loose connective tissue.

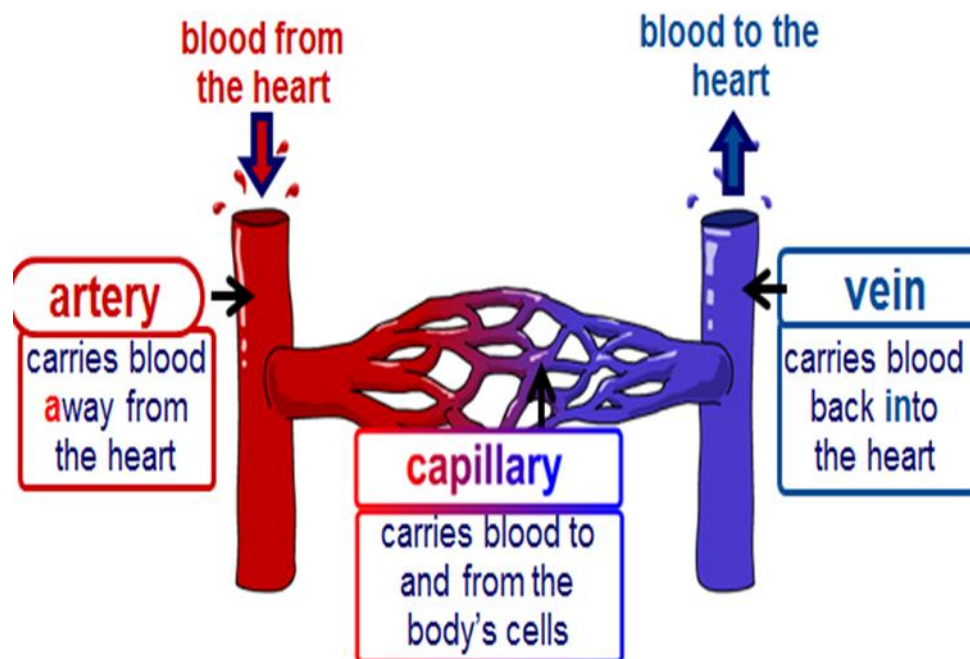
c- Lamina contain smooth muscle cells.

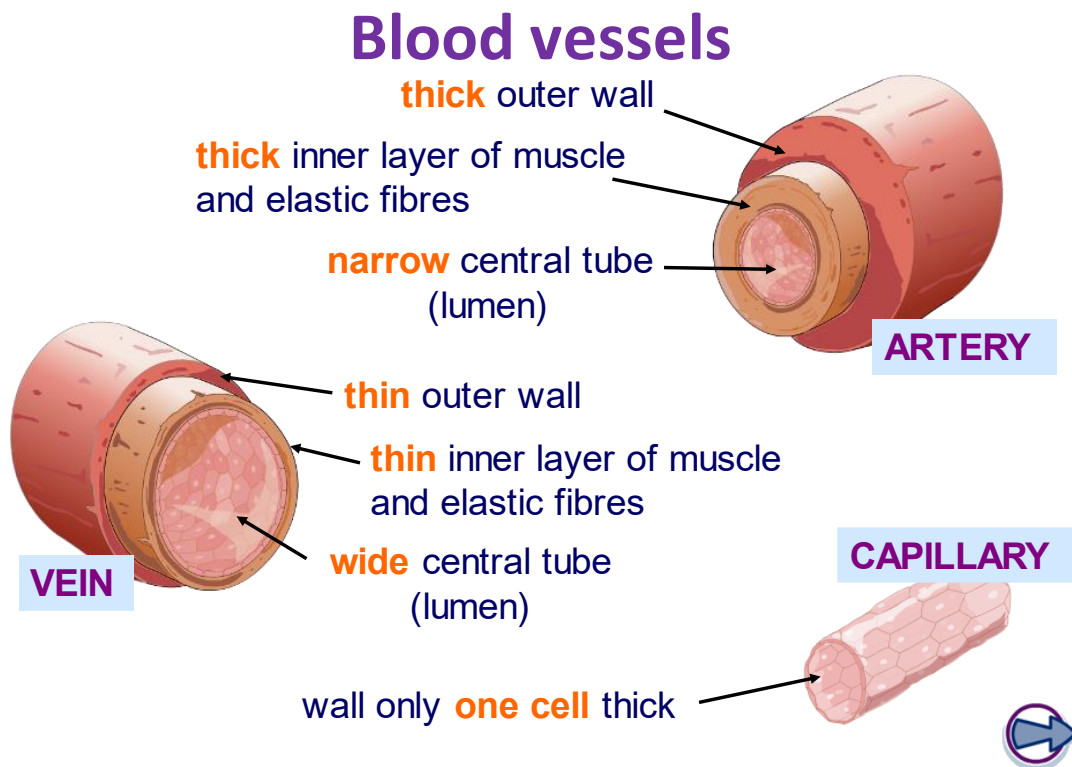
BLOOD VESSELS

- **Blood Vessels -A closed network of tubes**
- **These includes:**
 - **1- Arteries:** are blood vessels that carry oxygen rich blood a way from the heart.
 - **2- Capillaries:** Capillaries connect arteries to veins
 - **3- Veins:** carry blood back toward the heart.

Arteries (Distributing channel)

- Thick-walled tubes
 - Elastic Fibers
 - Circular Smooth Muscle
- **Capillaries (microscopic vessels)**
- One cell thick
 - Serves the Respiratory System
- **Veins (draining channel)**





Arteries: are classified into two main groups:

Blood vessels that carry blood away from the heart are called arteries . They are the thickest blood vessels and they carry blood high in oxygen known as oxygenated blood (oxygen rich blood).

Conducting (elastic arteries):

1. Aorta and its large branches
2. Thick intima
3. Media concentrically perforated elastic lamina with smooth muscle and ground substance in between
4. Poorly formed external layer.
5. The function of the elastic arteries can be considered as an auxiliary pump, when no forward pressure is exerted by the heart.

Distributing (muscular arteries):

1. Most arteries in the body

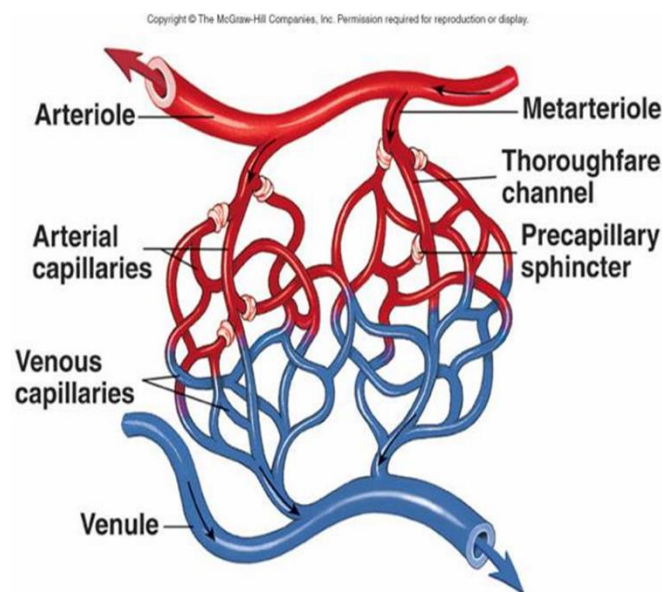
2. Thin intimal layer
3. Well-developed internal elastic lamina
4. Muscle layer up to 40 layers

5. Varying intermingled elastic fibers
6. adventitia consists of nerves, vessels, collagen, elastic fibers, fibroblasts and adipose cells.

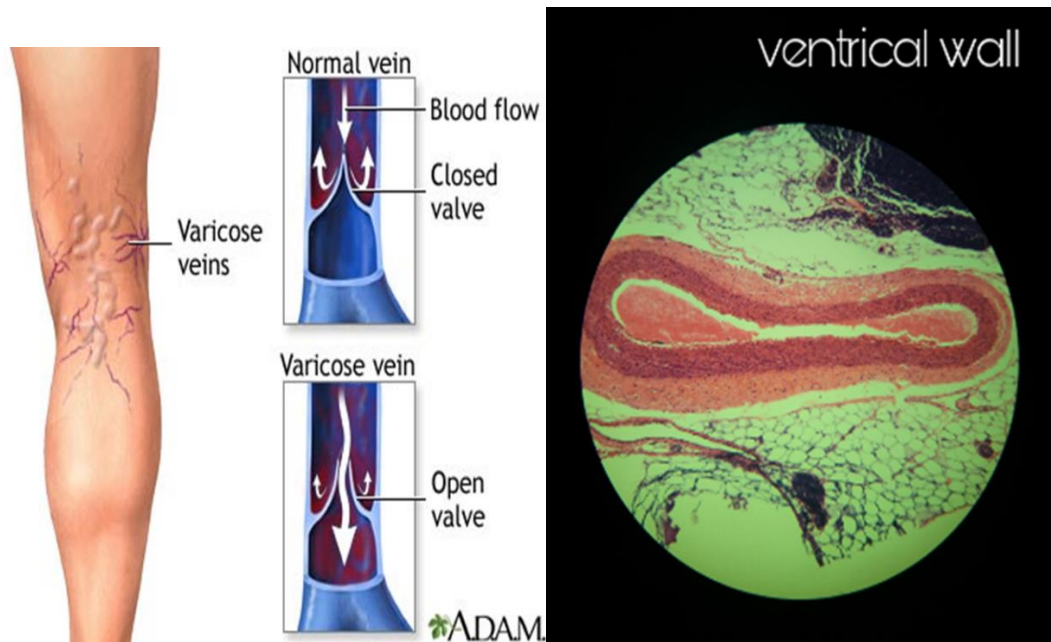
CAPILLARIES (5-8 micron):

The smallest blood vessels are capillaries and they connect the arteries .and veins

This is where the exchange of nutrients and gases occurs.



VEINS: Blood vessels that carry blood back to the heart are called veins .They have one-way valves which prevent blood from flowing backwards .They carry blood that is high in carbon dioxide known as deoxygenated blood (oxygen poor blood).



Characteristics of veins:

- More numerous than arteries.
- Diameter of vessels is larger than that of adjacent arteries.
- Walls of veins are thinner and less elastic or distensible than arteries.
(as a result in histological preparations the lumen often appears collapsed or irregular)
- The relative number of vasa vasorum are greater in the veins(necessary as the vessels have much less oxygenated blood)
- Valves are found in veins.

Veins are classified as large, medium or small veins.

Heart wall have three layers of tissue:

- Epicardium:** This serous membrane of smooth outer surface of heart.
- Myocardium:** Middle layer composed of cardiac muscle cell and responsibility for heart contracting.
- Endocardium:** Smooth inner surface of heart chambers.

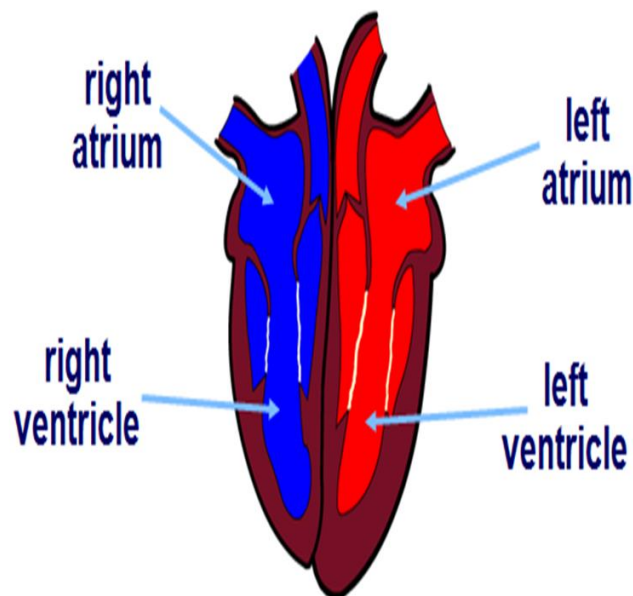
The heart has four valves - one for each chamber of the heart. The valves keep blood moving through the heart in the right direction.

The **mitral valve** and **tricuspid valve** are located between the atria (upper heart chambers) and the ventricles (lower heart chambers).

The **aortic valve** and **pulmonic valve** are located between the ventricles and the major blood vessels leaving the heart.

The four chambers of the heart have special names:

An **upper** chamber is called an **atrium** (plural: atria).



FUNCTIONS OF THE HEART:

1. **Generating blood pressure**
2. **Routing blood**
Heart separates pulmonary and systemic circulations
3. **Ensuring one-way blood flow**
Heart valves ensure one-way flow
4. **Regulating blood supply** Changes in contraction rate and force
match blood delivery to changing metabolic needs.



The circulatory system

