

كلية المستقبل الجامعة قسم الفيزياء الطبية
المرحلة الثالثة

ANATOMY

(L6)

The Cardiovascular System

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Introduction

The circulatory system is a complex system of distribution of nutrients, gases, electrolytes, removal of waste products of metabolism and other substances. The circulatory system includes the heart, the blood, the blood vessels and the lymphatic system. The blood vessels transport blood throughout the body. Blood consists of formed elements and a fluid portion called plasma. The blood vessels form a network that allows blood to flow from the heart to all living cells and back to the heart.

The Functions

Transport materials needed by cells : Oxygen , Glucose.

Remove waste materials from cells , Carbon dioxide

Major Components :

Pump (heart) Continuously circulates blood

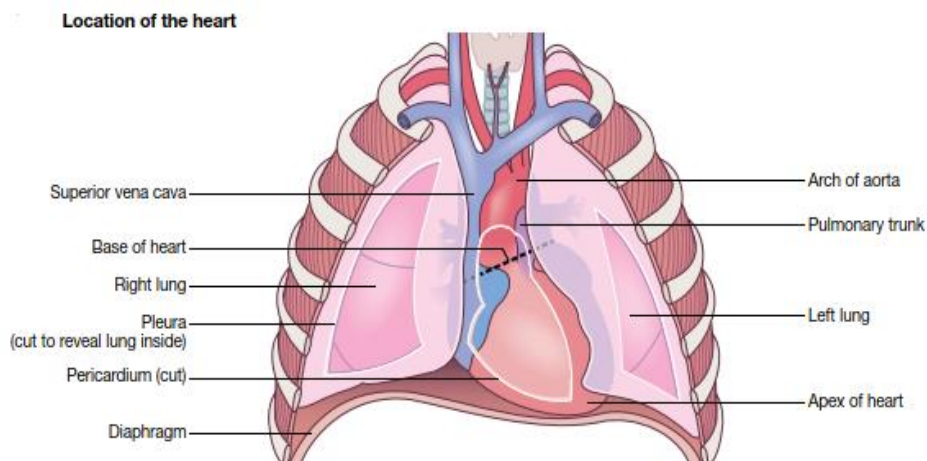
Network of tubes : Arteries : blood away from heart

Veins : blood back to the heart

Capillaries : gas exchange

Blood : Transports substances

The heart The heart weighs about 250–390 g in men and 200–275 g women and is a little larger than the owner's closed fist, being approximately 12 cm long and 9 cm wide. It is located in the thoracic cavity (chest) in the mediastinum (between the lungs), behind and to the left of the sternum (breast bone). The heart rests on the diaphragm in the thoracic cavity.

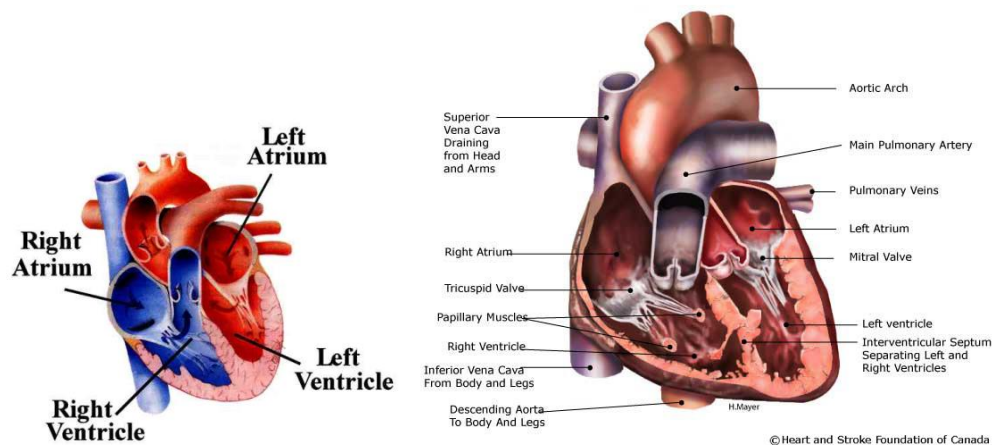


Heart Wall : Three layers of tissue

Epicardium: This serous membrane of smooth outer surface of heart

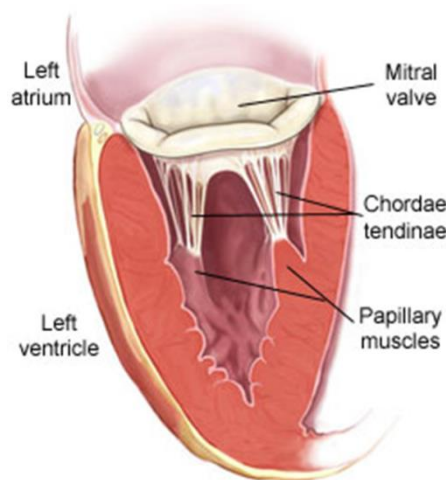
Myocardium: Middle layer composed of cardiac muscle cell and responsibility for heart contracting. **Endocardium**: Smooth inner surface of heart.

The heart has **four chambers**: two upper, thin-walled atria, and two lower, thick walled ventricles The septum is a wall dividing the right and left sides



Papillary muscles - Small muscles within the heart that anchor the heart valves.

Chordae Tendinae cord-like tendons that connect the papillary muscles to the tricuspid valve and the mitral valve in the heart.



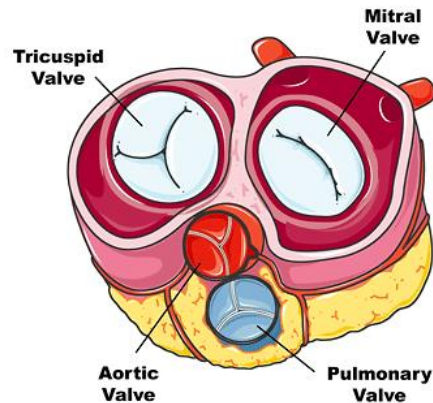
Valves : Maintain the unidirectional flow of blood in the heart by opening and closing depending on the difference in pressure on each side, There are four valves in the heart

The two atrioventricular (AV) valves , The two semilunar (SL) valves.

Atrioventricular (AV) valves occur between the atria and ventricles. 2 types

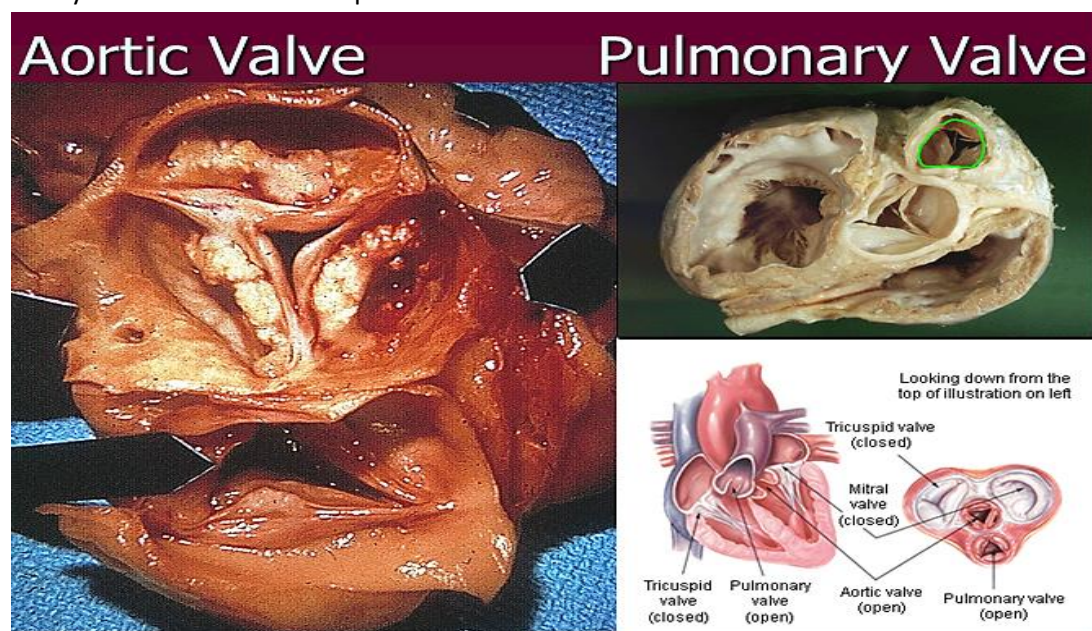
Tricuspid valve - The tricuspid valve is the three flapped valve on the right side of the heart, between the right atrium and the right ventricle which stops the backflow of blood between the two. It has three cusps.

Bicuspid or Mitral valve – It allows the blood to flow from the left atrium into the left ventricle. It is on the left side of the heart and has two cusps.

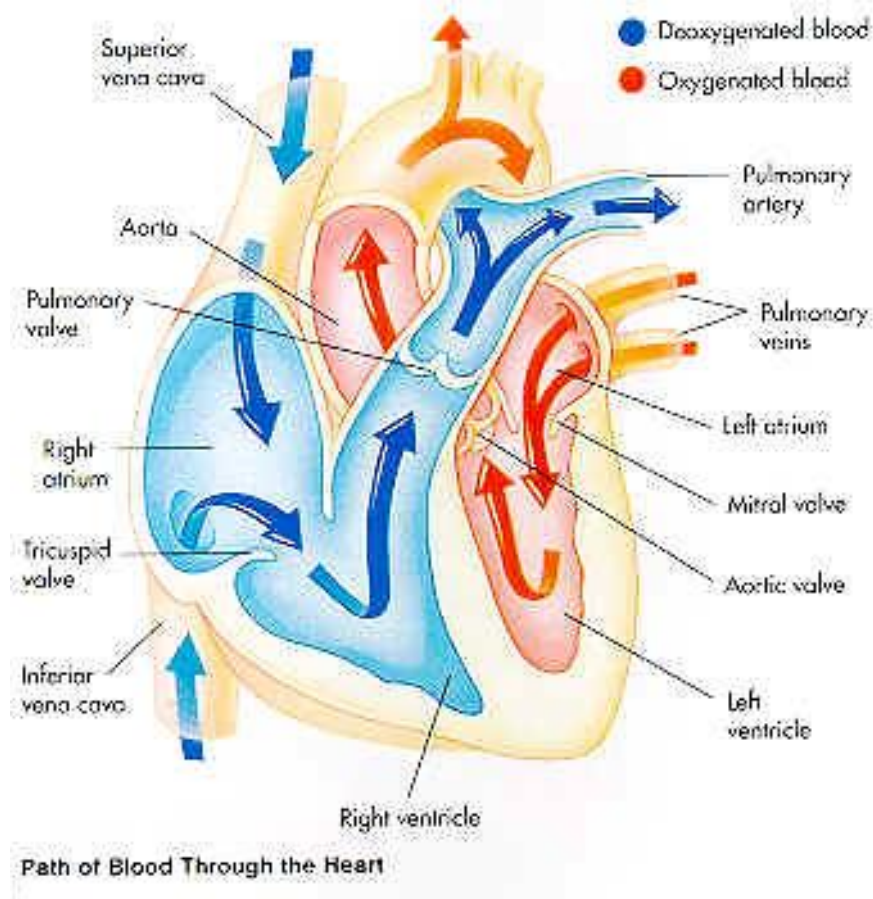


The semilunar (SL) valves Located at the base of both the pulmonary artery and the aorta, the two arteries taking blood out of the ventricles. These valves permit blood to be forced into the arteries, but prevent backflow of blood from the arteries into the ventricles. These valves do not have chordae tendinae, and are more similar to valves in veins than atrioventricular valves : 2 types **Aortic Valve** : lies between the left ventricle and the aorta and has three cusps.

Pulmonary Valve : The pulmonary valve lies between the right ventricle and the pulmonary artery and also has three cusps.



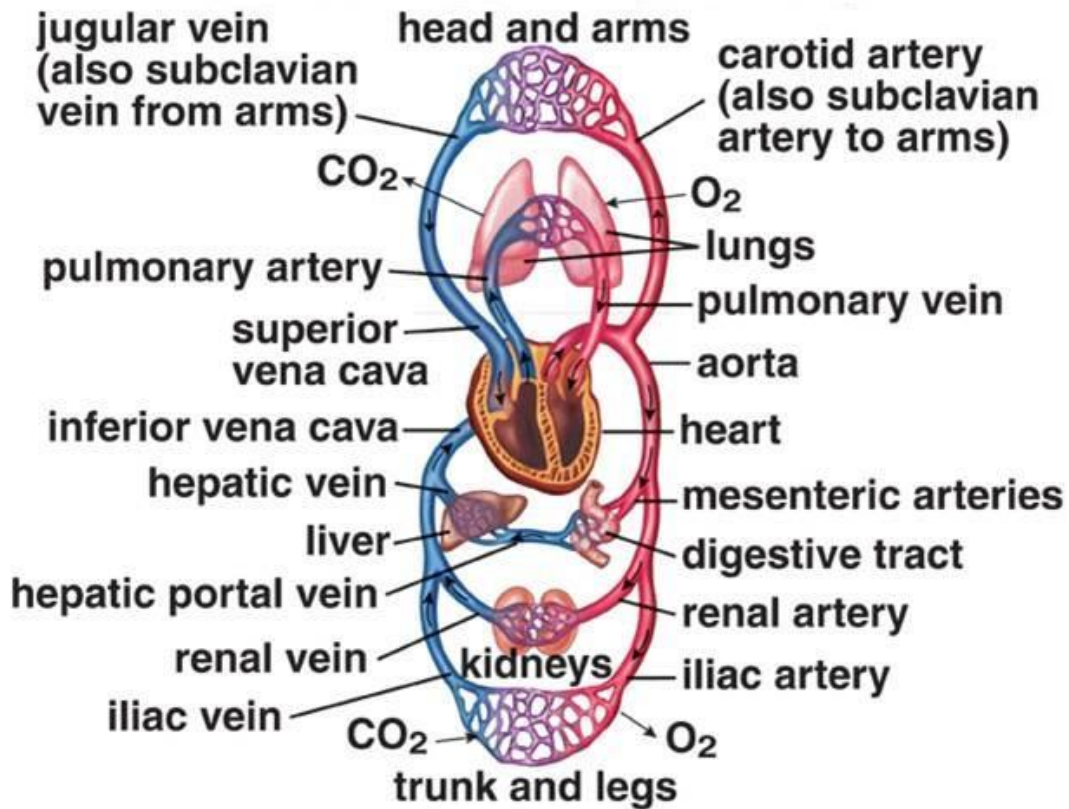
The right atrium receives the deoxygenated blood. Contraction of the right ventricle pushes blood through the pulmonary semilunar valve into the pulmonary arteries in which it travels to the lungs, After passing through the capillaries of the lungs, the blood which is now oxygenated returns to the heart in the pulmonary veins. The left atrium receives blood from the pulmonary vein.



Blood passes through the mitral valve into the left ventricle. Contraction of the left ventricle pushes blood through the aortic semilunar valve into the aorta. Blood travels to all regions of the body where it feeds cells with oxygen picked up from the lungs and nutrients from the digestive tract. Deoxygenated blood returns from the rest of the body through the superior and inferior vena cava.

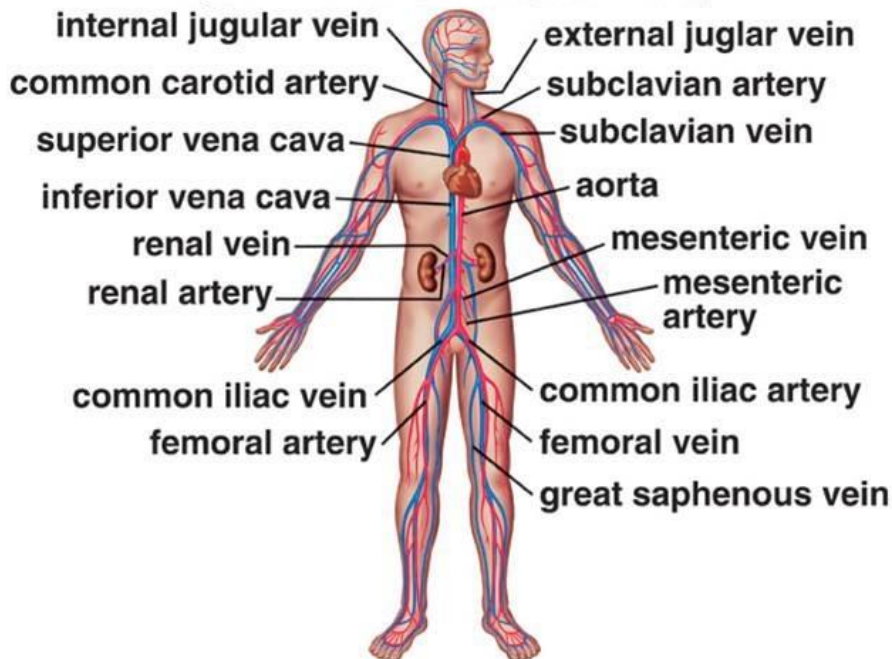
So, The cardiovascular system includes two circuits :

Pulmonary circuit which circulates blood through the lungs, it begins with the pulmonary trunk from the right ventricle which branches into two pulmonary arteries that take oxygen-poor blood to the lungs, where oxygen diffuses into the blood, and carbon dioxide diffuses out of the blood to be expelled by the lungs. Four pulmonary veins return oxygen-rich blood to the left atrium, and **Systemic circuit** which circulates blood to the rest of the body. The systemic circuit starts with the aorta carrying O₂-rich blood from the left ventricle.



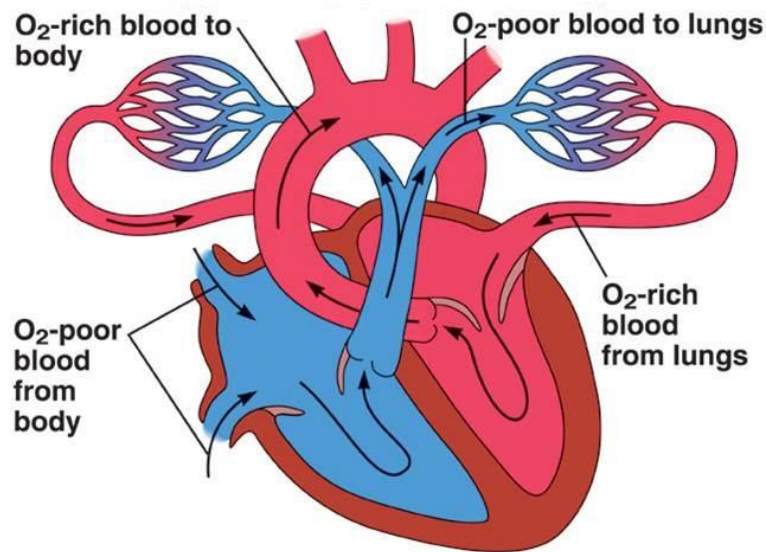
Cardiovascular system diagram

The aorta branches with an artery going to each specific organ. Generally, an artery divides into arterioles and capillaries which then lead to venules. The vein that takes blood to the vena cava often has the same name as the artery that delivered blood to the organ.



Major arteries and veins of the systemic circuit

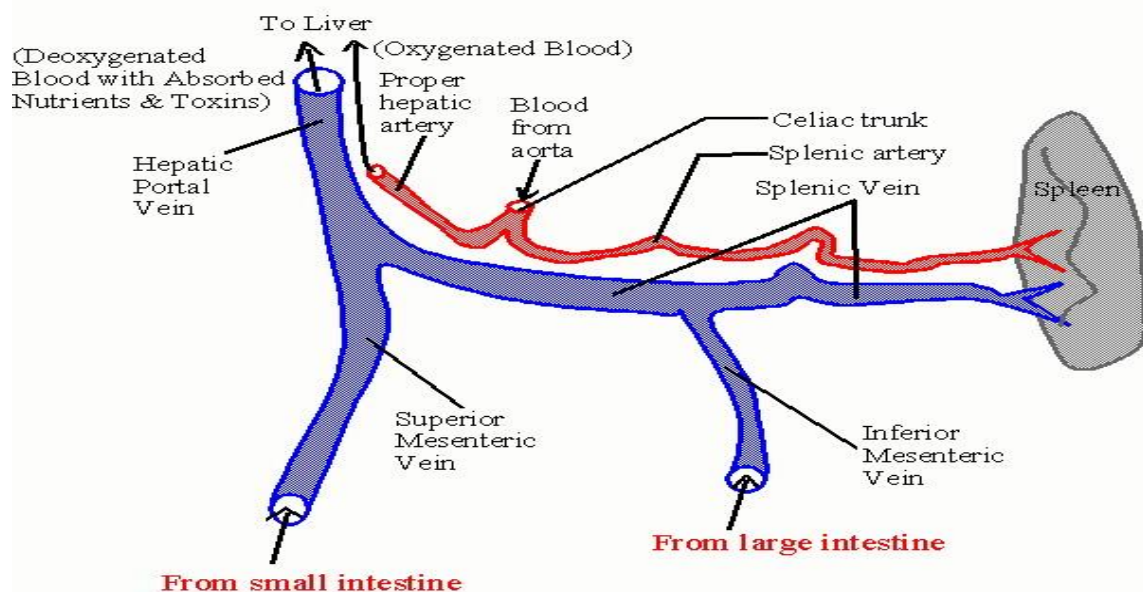
In the adult systemic circuit, arteries carry blood that is relatively high in oxygen and relatively low in carbon dioxide, and veins carry blood that is relatively low in oxygen and relatively high in carbon dioxide. This is the reverse of the pulmonary circuit.



Blood follows this sequence through the heart: superior and inferior vena cava → right atrium → tricuspid valve → right ventricle → pulmonary semilunar valve → pulmonary veins leaving the lungs → left atrium → bicuspid valve → left ventricle → aortic semilunar valve → aorta → to the body → back to the sup. and inf. vena cava

Hepatic Portal System : System of veins comprised of the hepatic portal vein. Special circulation that collects blood from the organs of digestion and takes it to the liver, the organ that monitors the composition of the blood.

Major Vessels of the Hepatic Portal System



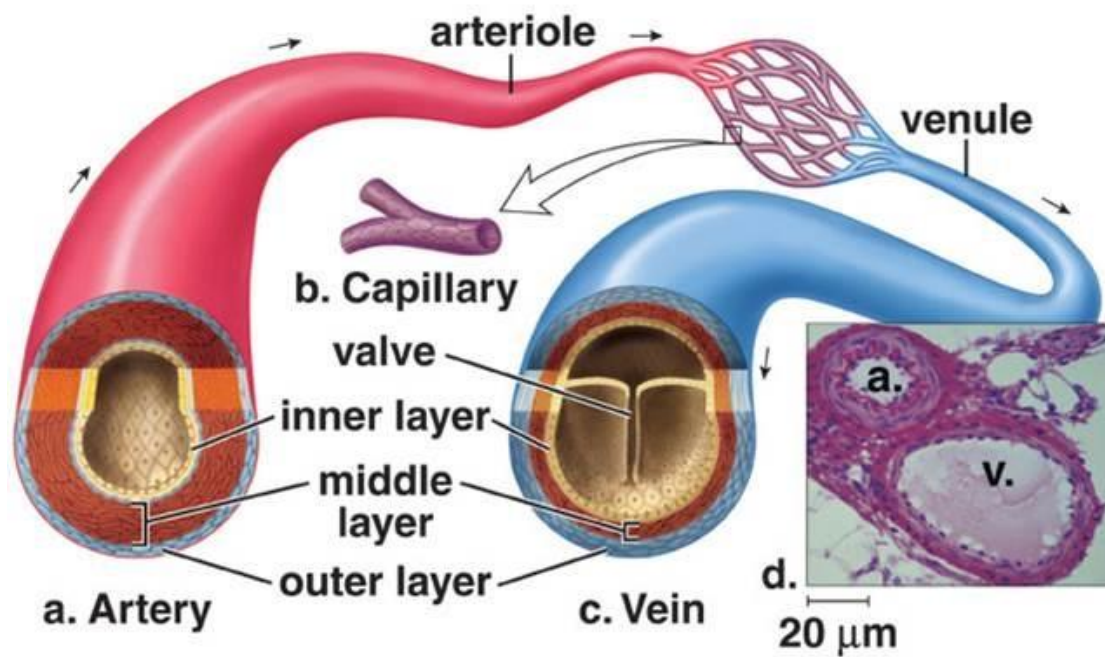
The Blood Vessels

The cardiovascular system has three types of blood vessels :

Arteries (and arterioles) – carry blood away from the heart.

Capillaries – where nutrient and gas exchange occur.

Veins (and venules) – carry blood toward the heart.

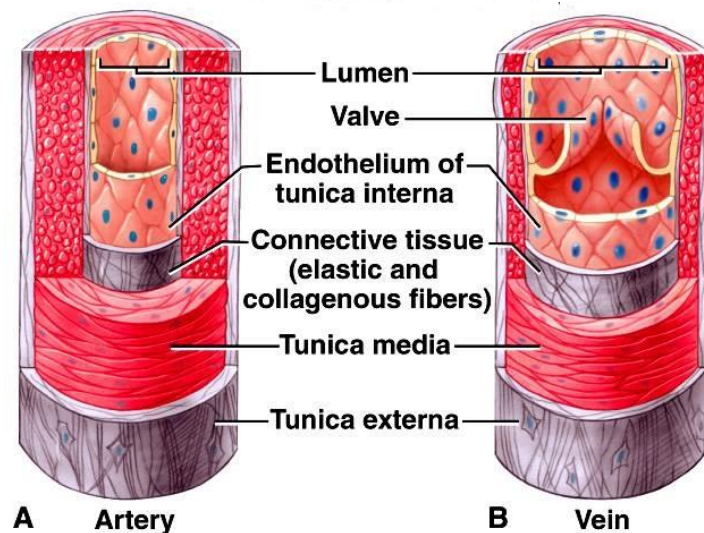


Layers of Arteries and Veins

Tunica interna – simple squamous epithelium, smooth and prevents blood clotting

Tunica media- smooth muscle. Constricts to regulate blood flow and blood pressure.
Missing in smallest arteries

Tunica externa- connective tissue, attaches to surrounding tissues.



Capillaries have walls only one cell thick to allow exchange of gases and nutrients with tissue fluid. Capillary beds are present in all regions of the body but not all capillary beds are open at the same time. Blood moves slowly in capillaries because there are more capillaries than arterioles. This allows time for substances to be exchanged between the blood and tissues

Veins : Venules drain blood from capillaries, then join to form veins that take blood to the heart. Veins have much less smooth muscle and connective tissue than arteries. Veins often have valves that prevent the backward flow of blood when closed. Veins carry about 70% of the body's blood and act as a reservoir during hemorrhage. **Major Veins and Arteries :**

Superior Vena Cava : Drains Deoxygenated Upper extremities.

Inferior Vena Cava : Drains Deoxygenated Lower extremities.

Pulmonary Veins : Oxygenated Blood to Left atrium.

Aorta : Delivers oxygenated blood to the body

Pulmonary Artery : Delivers deoxygenated blood to the lungs

The Heartbeat : Each heartbeat is called a cardiac cycle. When the heart beats, the two atria contract together, then the two ventricles contract; then the whole heart relaxes.

The actions within the heart are all coordinated. Atria fill at same time and ventricles fill at the same time. Atria contract at the same time and ventricles contract at the same time

Systole is the contraction of heart chambers; diastole is their relaxation

The heart sounds, lub-dub, are due to the closing of the atrioventricular valves (lub), followed by the closing of the semilunar valves (dub).

A person's pulse is the arterial palpation of a heartbeat. The blood from each contraction of the heart produces a bulge in the artery. We call that bulge a pulse. One pulse equals one

heartbeat. Can be found in the neck (carotid artery), at the wrist (radial artery), behind the knee (popliteal artery), on the inside of the elbow (brachial artery), and near the ankle joint (posterior tibial artery).

A normal pulse rate for a healthy adult, while resting, can range from 60 to 100 beats per minute (BPM).

