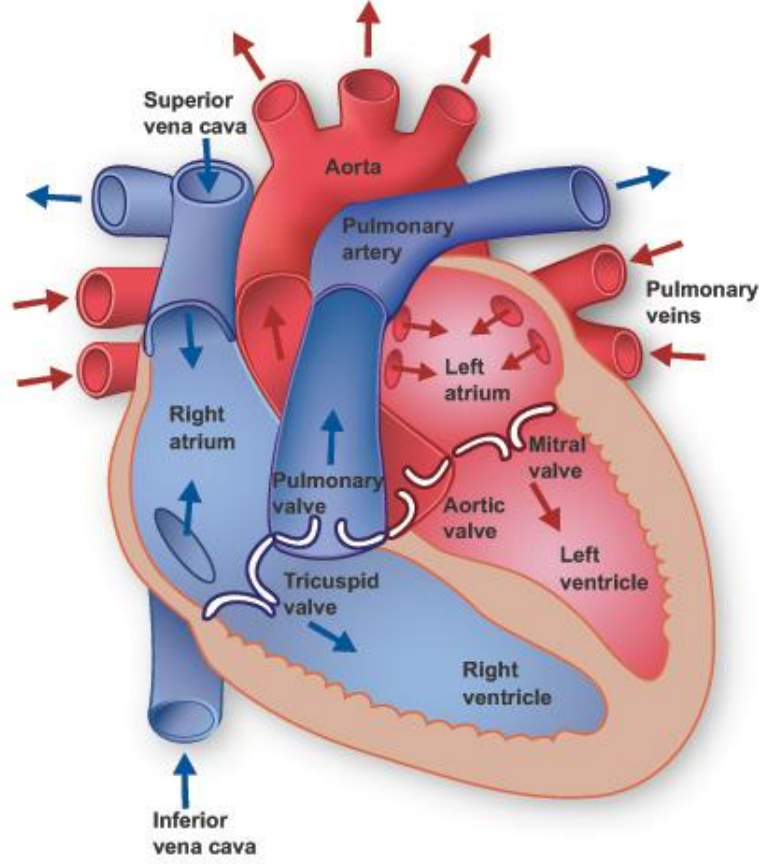


CARDIVASCULAR SYSTEM

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**A TOTAL 38 OF FIGURES & 1 VIDEO
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READABILITY SCORE

48 %

1. CARDIOVASCULAR SYSTEM

The vascular system is divided for descriptive purposes into 2 parts: The first part is the vascular (blood) system. It includes the heart and blood vessels for the circulation of the blood. The second part is the lymphatic vascular system. It has lymphatic glands and lymphatic vessels. Through the vessels a colorless fluid, the lymph, circulates. The two systems communicate with each other and are intimately associated developmentally.

The heart is the central organ of the blood vascular system. It is a hollow organ formed mainly by cardiac muscle. By its contraction the blood is pumped to all parts of the body. The blood is pumped through a complicated series of tubes; arteries. [The arteries undergo enormous ramification in their course throughout the body, and end in minute vessels, called arterioles, which in their turn open into a close-meshed network of microscopic vessels, termed capillaries.](#) The blood is returned to the heart via veins. The passage of the blood through the heart and blood-vessels constitutes the **circulation of the blood**.

HEART

The heart looks trapezoidal in the anterior-posterior dimensions. But in 3-D, it looks like a tipped-over pyramid. The **heart** is a crucial organ of the human body. We can only stand for five to six minutes without blood travelling in our vessels. You can see the heart as a self-adjusting suction and pressure pump. The function of this pump is to send blood to all parts of the body. The heart is slightly larger than a clenched fist. The parts of the heart work together to send blood to all parts of the body.

The right side of the heart (right heart) receives poorly oxygenated (venous) blood from the body through the superior vena cava (SVC) and inferior vena cava (IVC). These veins open into right atrium. The venous blood comes to the right ventricle via the right atrioventricular orifice. The right ventricle pumps the venous blood to the lungs through the pulmonary trunk and pulmonary arteries for oxygenation. The left side of the heart (left heart) receives well-oxygenated (arterial) blood from the lungs through the pulmonary veins. It pumps the oxygenated blood into the aorta for distribution to the body.

[The heart has four chambers: right and left atria \(atrium; singular\) and right and left ventricles.](#) The atria are receiving chambers that pump blood into the ventricles (the discharging chambers). The synchronous pumping actions of the heart's two atrioventricular (AV) pumps (right and left chambers) constitute the cardiac cycle. The cycle begins with a period of ventricular elongation and filling (diastole). The cycle ends with a period of ventricular shortening and emptying (systole).

The wall of each heart chamber consists of three layers, from superficial to deep:

- ♥ Endocardium, a thin internal layer
- ♥ Myocardium, a thick, helical middle layer composed of cardiac muscle.
- ♥ Epicardium, a thin external layer

Externally, the atria are demarcated from the ventricles by the coronary sulcus (atrioventricular groove). The right and left ventricles are separated from each other by the anterior and posterior interventricular sulci (grooves). The heart appears trapezoidal from an anterior or posterior view. In 3-D it is shaped like a tipped-over pyramid. [Its apex is directed anteriorly and to the left.](#) The base of the heart is opposite the apex. It faces mostly posteriorly. The heart has 4 sides. The heart also has 4 surfaces:

- ♥ Anterior (sternocostal) surface
- ♥ Diaphragmatic (inferior) surface
- ♥ Right pulmonary surface
- ♥ Left pulmonary surface

HEART LAB VIDEOS


Right atrium: forms the right border of the heart. It receives venous blood from the SVC, IVC, and coronary sinus. A distinct feature of the right atrium is fossa ovalis. It is the closed foramen ovale. It was open prior to the birth.

Right ventricle: forms the largest part of the anterior surface of the heart. It also forms a small part of the diaphragmatic surface, and almost the entire inferior border of the heart. The right ventricle receives blood from the right atrium through the right atrioventricular (tricuspid) orifice. The [interventricular septum](#) is composed of muscular and membranous parts. It is obliquely placed partition between the right and left ventricles. It forms part of the walls of each ventricle. The tricuspid valve is between the right atrium and right ventricle. It is made by three cusps.

Left Atrium: forms most of the base of the heart. The valveless two pairs of right and left pulmonary veins enter the left atrium. The tubular muscular [left auricle](#) creates an extra space. It projects anteriorly. The wall of the left atrium (also right atrium) is trabeculated with [pectinate muscles](#). There is also right auricle for the right atrium. **Left Ventricle:** forms the apex of the heart. It also forms nearly all its left (pulmonary) surface and border, and most of the diaphragmatic surface. The arterial pressure is much higher in the systemic circulation than in the pulmonary circulation. So the left ventricle performs more work than the right ventricle.

A double-leaflet bicuspid valve is between the left atrium and left ventricle. The [bicuspid valve](#) has two cusps. Its more common name is Mitral valve. It guards the left atrioventricular orifice. Both atria and ventricles have muscular elevations (**trabeculae carneae** in ventricles) to increase the strength of the pumping function.

Tendinous cords (L. chordae tendineae) attach to the free edges and ventricular surfaces of the cusps, much like the cords attaching to a parachute. The tendinous cords arise from the apices of [papillary muscles](#). They are conical muscular projections with bases attached to the ventricular wall. The papillary muscles begin to contract before contraction of the right ventricle, tightening the tendinous cords and drawing the [cusps](#) together. Thanks to the cords, attached to adjacent sides of two cusps, the cusps of the tricuspid valve are prevented from prolapsing (being driven into the right atrium) as ventricular pressure rises. Thus regurgitation of blood (backward flow of blood) from the right ventricle back into the right atrium is blocked during ventricular systole by the valve cusps. The same also occurs on the left side. This time we have a valve with two cusps. It is the mitral valve. The aortic and pulmonary valves are called semilunar valves. They close during diastole (filling phase) and are open during ejection phase (systole). By closing during diastole they prevent escaping of blood to these arteries when blood is filling into ventricles from both atria.

[The first heart sound \(S1\) "lub" is actually the sound of closing the mitral and tricuspid valves.](#)  It refers to the beginning of systole. The second heart sound (S2) "dub" is the closing sound of the aortic and pulmonary valves. These are semilunar valves between the arteries and the relevant ventricles. Diastole starts with S2.

The cardiac skeleton is a collection of dense, fibrous connective tissue in the form of four rings with interconnecting areas in a plane between the atria and the ventricles. The four rings of the cardiac skeleton surround the two atrioventricular orifices, the aortic orifice and opening of the pulmonary trunks. They are the anulus fibrosus.

Vasculature of the Heart

The blood vessels of the heart are the coronary arteries and cardiac veins. They carry blood to and from most of the myocardium.

Arterial Supply of the Heart

The coronary arteries are the first branches of the aorta. They supply the myocardium and epicardium. The right and left coronary arteries arise from the corresponding aortic sinuses. Anastomoses between the branches of the coronary arteries exist. This enables the development of the collateral circulation. The coronary arteries supply both the atria and the ventricles. The right coronary artery arises from the right side of the ascending aorta. The left coronary artery arises from the left side.

Venous Drainage of the Heart

The heart is drained mainly by veins majority of which empty into the [coronary sinus](#). The small veins empty directly into the right atrium. The coronary sinus is in the coronary groove (sulcus). This groove is between the atria and ventricles. The coronary sinus opens into the right atrium.

STIMULATING, CONDUCTING, AND REGULATING SYSTEMS OF HEART

The conducting system consists of nodal tissue that initiates the heartbeat and coordinates contractions of the four heart chambers, and highly specialized conducting fibers for conducting them rapidly to the different areas of the heart. The impulses are then propagated by the cardiac striated muscle cells so that the chamber walls contract simultaneously. Impulse generation and conduction can be summarized as follows:

The [sinu-atrial \(SA\) node](#) is the pacemaker of the heart. It is in the right atrium. The SA node initiates an impulse. This impulse is rapidly conducted to cardiac muscle fibers in the atria. It causes them to contract.

The impulse spreads by myogenic conduction. It rapidly transmits the impulse from the SA node to the atrioventricular (AV) node. The signal is distributed from the AV node through the atrioventricular (AV) bundle

and its branches (the right and left bundles). They pass on each side of the interventricular septum. These bundles supply subendocardial branches (Purkinje fibers) to the papillary muscles and the walls of the ventricles.

Innervation of the Heart

Innervation of the heart is through the autonomic nerves (both sympathetic and parasympathetics) from the cardiac plexus.

PERICARDIUM

The **pericardium** is a fibroserous membrane that covers the heart and the beginning of its great vessels. The pericardium is a closed sac composed of two layers.

The pericardium is a closed sac composed of two layers:

- 1) Fibrous pericardium (external): continuous with the central tendon of the diaphragm
- 2) Serous pericardium (internal) has two layers: Parietal layer & Visceral layer (epicardium)

The pericardial cavity is the potential space between opposing layers of the parietal and visceral layers of serous pericardium. It normally contains a thin film of fluid that enables the heart to move and beat in a frictionless environment.

THE GREAT VESSELS

The right and left brachiocephalic veins are formed by the union of the internal jugular and subclavian veins. The brachiocephalic veins unite to form the superior vena cava (SVC). The SVC returns blood from all structures superior to the diaphragm, except the lungs and heart. It ends by entering the right atrium of the heart. The inferior vena cava (IVC) collects the venous blood from the lower part of the body.

The **ascending aorta** begins at the aortic orifice. Its only branches are the coronary arteries. They arise from the aortic sinuses. The **arch of aorta** (aortic arch) is the curved continuation of the ascending aorta. The usual branches of the arch are the **brachiocephalic trunk, left common carotid artery, and left subclavian artery**. The **ligamentum arteriosum** is the remnant of the fetal ductus arteriosus. It passes from the root of the left pulmonary artery to the inferior surface of the arch of the aorta.

At the bifurcation, the common carotid artery and the beginning of the internal carotid artery are dilated. This dilation is the **carotid sinus** and contains receptors that monitor changes in blood pressure and are innervated by a branch of the glossopharyngeal nerve [IX]. Another accumulation of receptors in the area of the bifurcation is responsible for detecting changes in blood chemistry, primarily oxygen content. This is the **carotid body** and is innervated by branches from both the glossopharyngeal [IX] and vagus [X] nerves.

ARTERIES IN THE BODY

What happens to **descending aorta (thoracic aorta)**? It is the continuation of the arch of aorta. After passing through the diaphragm, it becomes the abdominal aorta. The abdominal aorta finally terminates as common iliac arteries. The abdominal aorta supplies the abdominal viscera and other contents in the abdominal cavity. The abdominal aorta bifurcates into the external and internal iliac arteries. The external iliac arteries, after passing below the inguinal ligament, become femoral arteries. The femoral arteries supply the lower limbs. On both sides, these arteries continue as popliteal arteries in the popliteal fossa (behind the knee). Popliteal artery has anterior and posterior tibial arteries as terminal branches. The subclavian artery continues as axillary artery, and later brachial artery on both arms. The brachial artery divides into ulnar and radial arteries.

The common carotid artery divides into external carotid artery and internal carotid artery. The external carotid artery basically supplies blood to the face and neck, and the internal one to the brain. The other artery of the brain is the vertebral artery which is a thick branch of the subclavian artery.

VEINS IN THE BODY

Although arteries are generally located in deep, well-protected body areas, many veins are more superficial and some are easily seen and palpated on the body surface. Most deep veins follow the course of the major arteries, and with a few exceptions, the naming of these veins is identical to that of their companion arteries. While major systemic arteries branch off the aorta, the veins converge on the **venae cavae**. Blood returns to the **right atrium** of the heart through the vena cavae. Veins draining the head and arms (upper limbs) empty into **superior vena cava**. Veins which drain the lower body empty into **inferior vena cava**. The veins listed below begin distally and move proximally to the heart.

Veins Draining into the Superior Vena Cava

- **Radial and ulnar veins** are deep veins draining the forearm. They unite to form the **brachial vein**. It drains the arm. It empties into the **axillary vein**.
- **Cephalic vein** provides superficial drainage of the lateral aspect of the arm and empties into the axillary vein.
- **Basilic vein** provides superficial drainage of the medial aspect of the arm into the **brachial vein**. The basilic vein joins the brachial vein to form the axillary vein. The basilic and cephalic veins are joined at the anterior aspect of the elbow by the **median cubital vein**. (This vein is often the site for blood removal for the purpose of blood testing.) The **dorsal venous arch of the hand** is drained into the basilica medially and cephalic veins laterally.
- **Subclavian vein receives blood from the arm through the axillary vein** and from the skin and muscles of the head through the **external jugular vein**.
- **Left & right brachiocephalic veins** drain the subclavian, vertebral, and internal jugular veins on their respective sides. The brachiocephalic veins join to form the **superior vena cava**, which enters the heart.

Veins Draining into the Inferior Vena Cava

- The **inferior vena cava**, which is much longer than the superior vena cava, returns blood to the heart from all body regions below the diaphragm.
 - **Anterior and posterior tibial veins and the peroneal (or fibular) vein** drain the calf and foot. The **posterior tibial vein** becomes the **popliteal vein** at the knee and then the **femoral vein** in the thigh. The femoral vein becomes the external iliac vein as it enters the pelvis.
 - **Great saphenous veins** are the longest veins in the body. They receive the superficial drainage of the leg. They are on the medial side of the leg and thigh and drain into the femoral vein. On the lateral side of the leg is the small saphenous vein. It empties into the popliteal vein.
- Each left and right common iliac vein is formed by the union of the external iliac vein and the internal iliac vein (which drains the pelvis) on its own side. The common iliac veins join to form the inferior vena cava, which then ascends superiorly in the abdominal cavity.

LYMPHATIC SYSTEM

Lymphatic vessels form an extensive and complex interconnected network of channels. They begin as blind-ended lymphatic capillaries in tissues of the body. They come together to form a number of larger vessels. These vessels connect with large veins in the root of the neck.

Lymphatic vessels mainly collect fluid lost from vascular capillary beds during nutrient exchange processes. They deliver it back to the venous system. Also included in this interstitial fluid that drains into the lymphatic capillaries are pathogens, cells of the lymphocytic system, cell products (such as hormones), and cell debris. The fluid in most lymphatic vessels is clear and colorless. It is known as **lymph**. There are lymphatic vessels in most areas of the body except the brain, bone marrow, and avascular tissues such as epithelia and cartilage. The movement of lymph through the lymphatic vessels is generated mainly by the indirect action of adjacent structures, particularly by contraction of skeletal muscles and pulses in arteries. Unidirectional flow is maintained by the presence of valves in the vessels.

Lymph nodes are small encapsulated structures. They interrupt the course of lymphatic vessels. They contain elements of the body's defense system, such as clusters of lymphocytes and macrophages.

All lymphatic vessels come together to form larger trunks or ducts. These trunks drain into the venous system at sites in the neck at the venous angle. The venous angle is formed where the internal jugular veins join the subclavian veins to form the brachiocephalic **veins**. The major lymphatic trunks (right lymphatic duct and thoracic duct) enter the venous angles formed by the convergence of these veins.

- Lymph from the right side of the head and neck, the right upper limb, right side of the thorax, and right side of the upper and more superficial region of the abdominal wall is carried by lymphatic vessels that connect with veins on the right side of the neck (right lymphatic trunk).
- Lymph from all other regions of the body is carried by lymphatic vessels that drain into veins on the left side of the neck (thoracic duct). The **thoracic duct** is a major lymphatic channel that begins in the abdomen, passes superiorly through the thorax, and ends in the venous channels in the neck.