

D.Saria .N. Mohsin

The Heart

The heart is a muscular organ that serves to collect deoxygenated blood from all parts of the body, carries it to the lungs to be oxygenated and release carbon dioxide. Then, it transports the oxygenated blood from the lungs and distributes it to all the body parts.

1-The heart pumps around 7,200 litres of blood in a day throughout the body.

2-The heart is situated at the centre of the chest and points slightly towards the left.

3-On average, the heart beats about 100,000 times a day, i.e., around 3 billion beats in a lifetime.

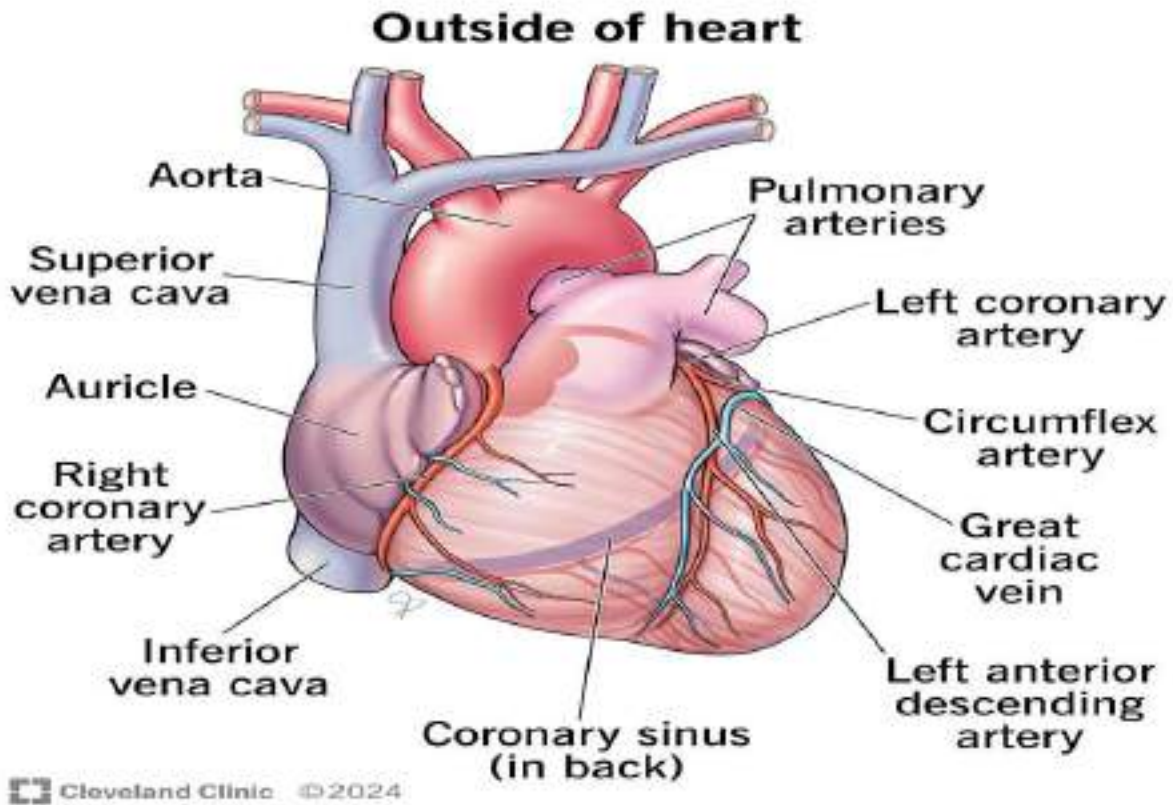
4-An adult heart beats about 60 to 80 times per minute, and newborn babies heart beats faster than an adult which is about 70 to 190 beats per minute.

Anatomy

The heart is a conical hollow muscular organ situated in the middle mediastinum and is enclosed within the pericardium. It is positioned posteriorly to the body of the sternum with one-third situated on the right and two-thirds on the left of the midline.

The heart measures 12 x 8.5 x 6 cm and weighs ~310 g (males) and ~255 g (females). It pumps blood to various parts of the body to meet

their nutritive requirements. The Greek name for the heart is cardia from which we have the adjective cardia.



Layers of the Heart Walls

The heart wall consists of three layers enclosed in the pericardium:

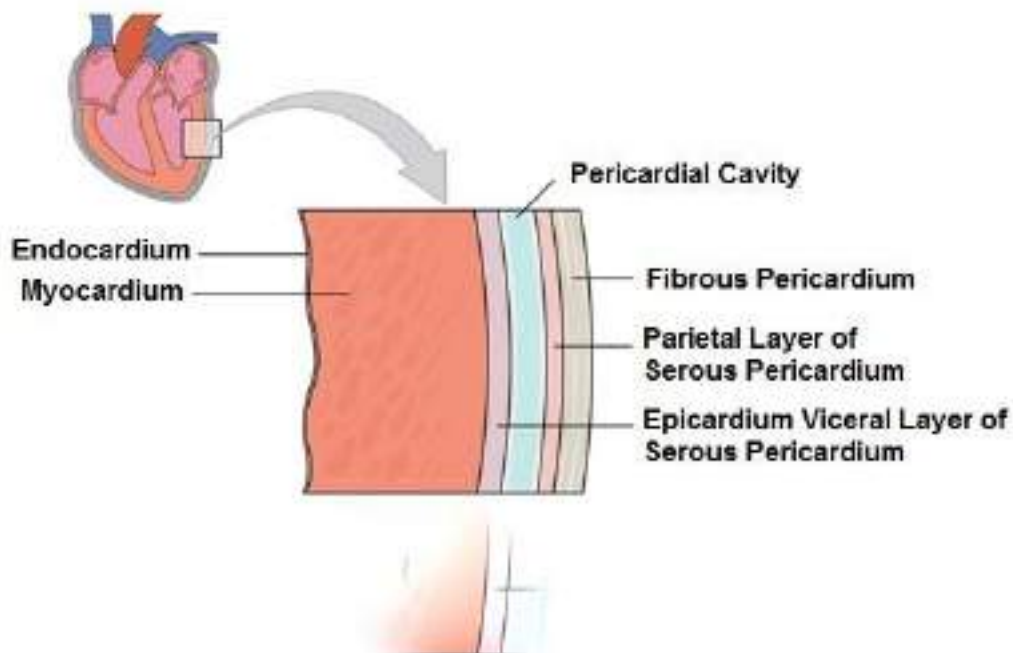
1-Epicardium - the outer layer of the wall of the heart and is formed by the visceral layer of the serous pericardium.

2-Myocardium - the muscular middle layer of the wall of the heart and has excitable tissue and the conducting system.

3-Endocardium . A middle concentric layer

4-A subendocardial layer.

The rest of the heart is composed mainly of the subepicardial and subendocardial layers.



Structure and Function

The heart is subdivided by septa into right and left halves, and a constriction subdivides each half of the organ into two cavities, the upper cavity being called the atrium, the lower the ventricle. The heart, therefore, consists of four chambers:

- right atrium
- left atrium
- right ventricle
- left ventricle

It is best to remember the four chambers and four valves in order of the series that blood travels through the heart:

1-Venous blood returning from the body drains into the right atrium via the (Superior vena cava SVC), (Inferior vena cava IVC) and coronary sinus

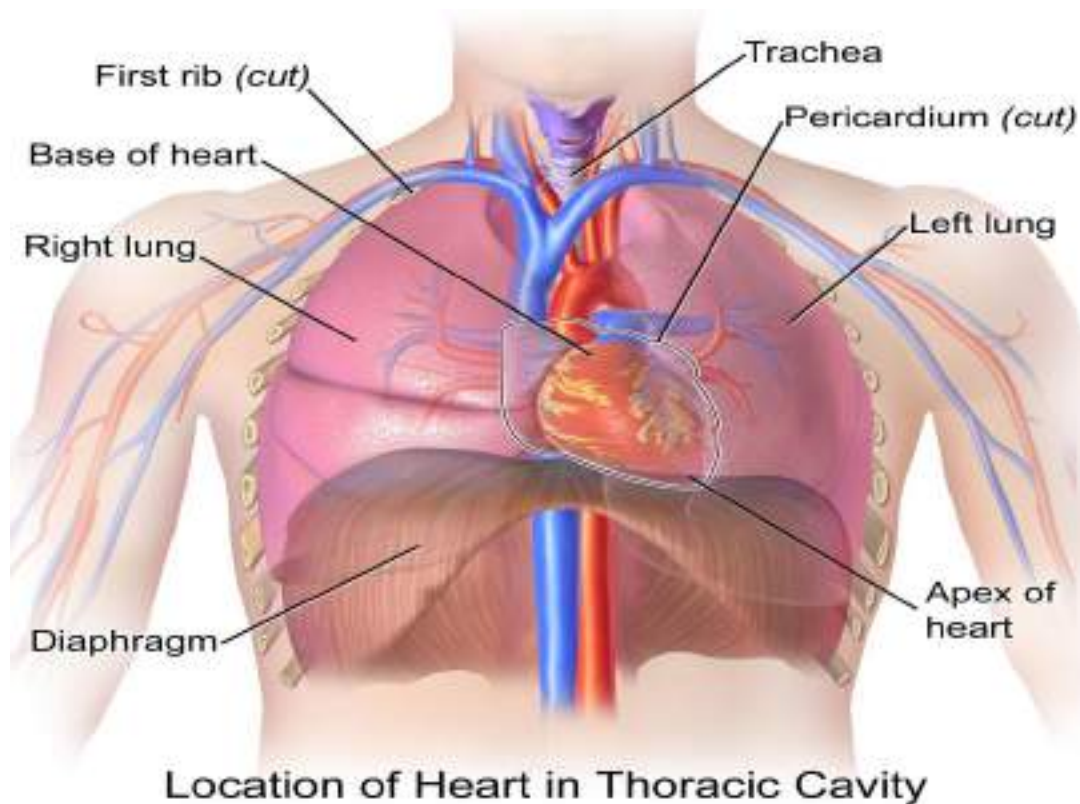
2-The right atrium pumps blood through the tricuspid valve into the right ventricle

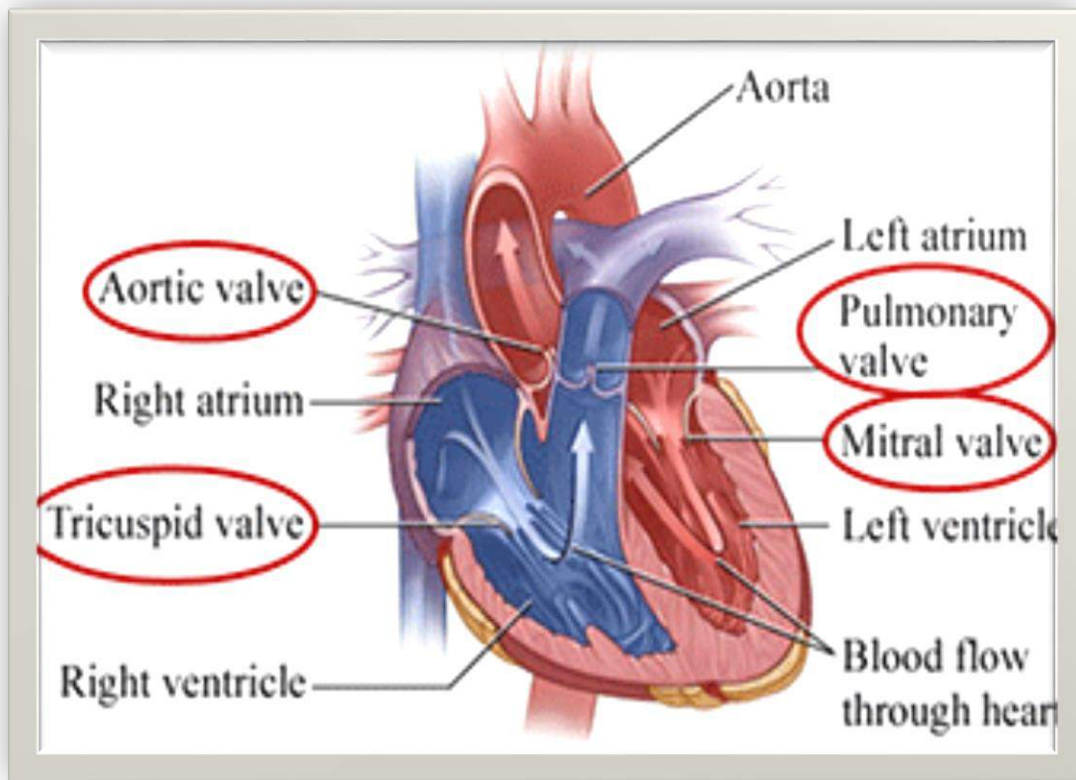
3-The right ventricle pumps blood through the pulmonary semilunar valve into the pulmonary trunk to be oxygenated in the lungs

4-Blood returning from the lungs drains into the left atrium via the four pulmonary veins

5-The left atrium pumps blood through the bicuspid (mitral) valve into the left ventricle

6-The left ventricle pumps blood through the aortic semilunar valve into the ascending aorta to supply the body.



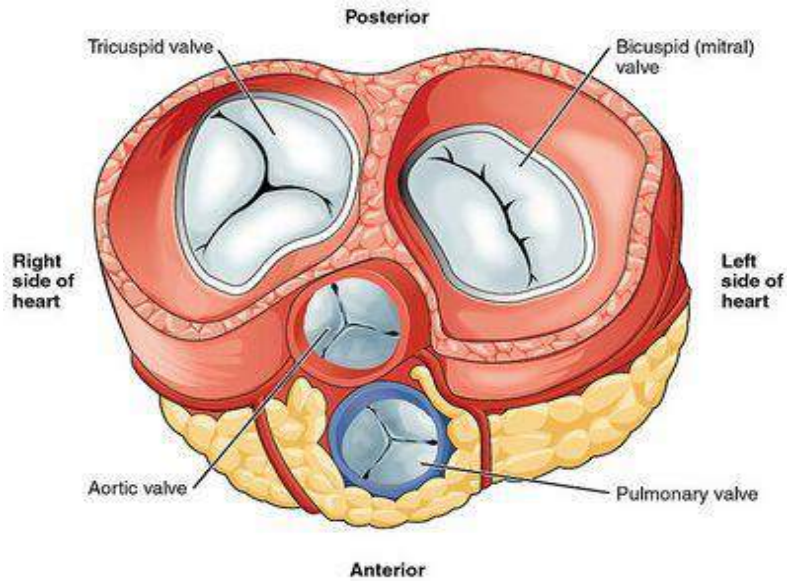


Heart Valves

The valves of the heart maintain unidirectional flow of the blood and prevent its regurgitation in the opposite direction. There are two pairs of valves in the heart, a pair of atrioventricular valves and a pair of semilunar valves. Apart, it has four valves. All four valves of the heart have a singular purpose: allowing forward flow of blood but preventing backward flow. The outflow of each chamber is guarded by a heart valve:

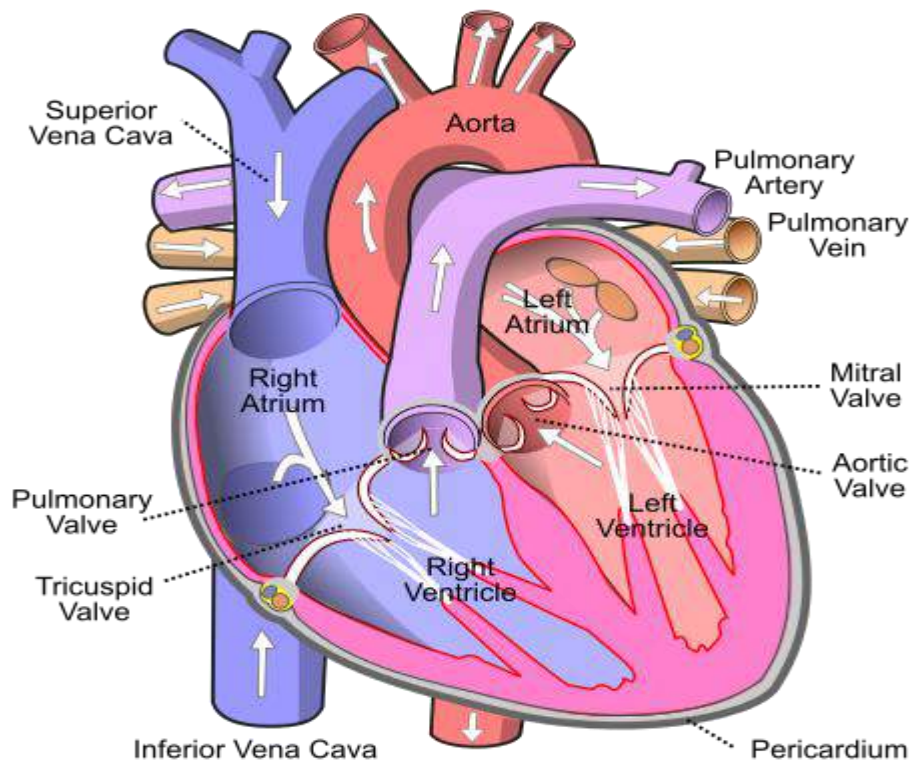
Atrioventricular valves between the atria and ventricles

1. tricuspid valve (R side of the heart)
2. mitral valve/bicuspid valve (left side of the heart)

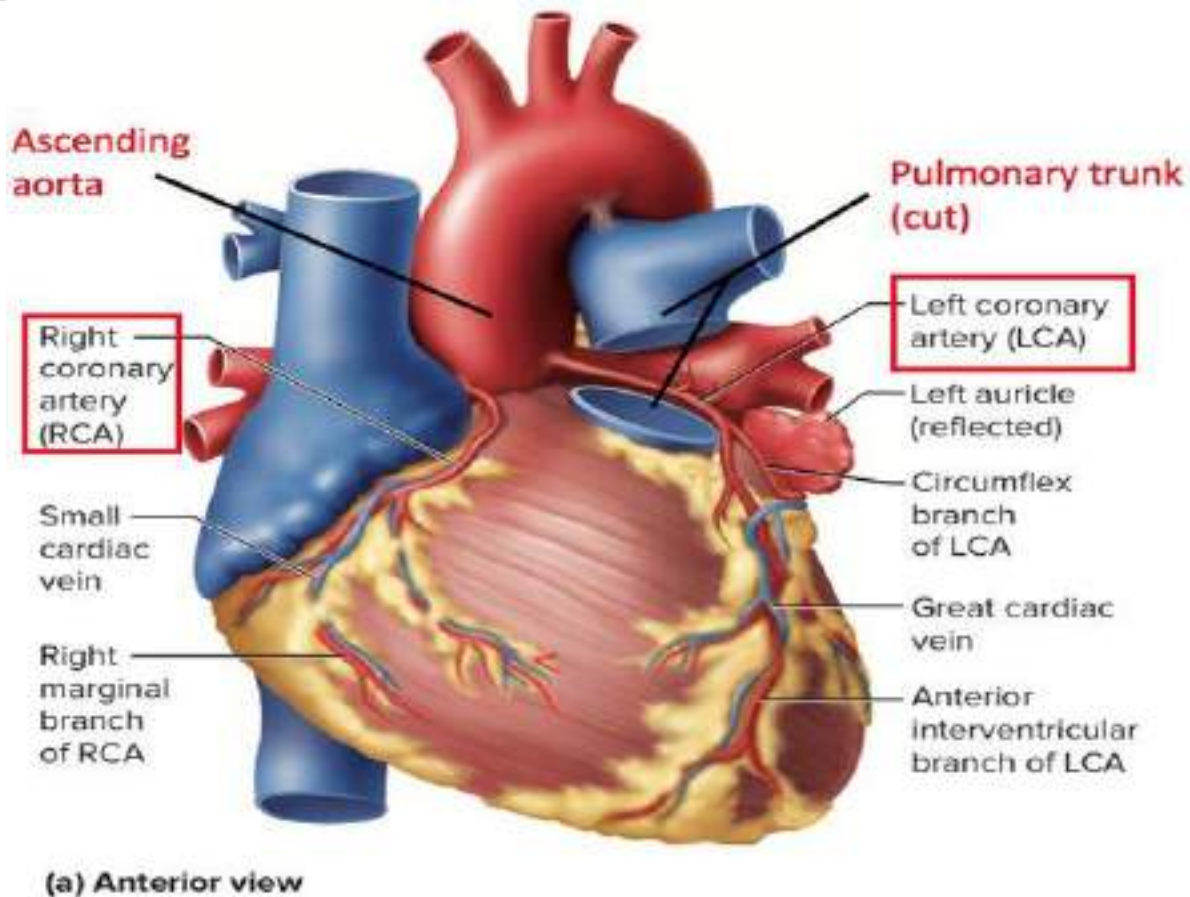


Semilunar valves which are located in the outflow tracts of the ventricles

1. aortic valve (L side heart)
2. pulmonary valve (R side heart)



Blood Supply



The heart is supplied by two coronary arteries:

1. Left main coronary artery carries 80% of the flow to the heart muscle. It is a short artery that divides into two branches

*Left anterior descending artery that supplies anterior two-thirds of the inter-ventricular septum and adjoining part of the left ventricular anterior wall

*Circumflex coronary artery that supplies blood to the lateral and posterior portions of the left ventricle.

2. Right coronary artery: branches supply the right ventricle, right atrium, and left ventricle's inferior wall.

Coronary arteries and veins course over the surface of the heart. Most coronary veins coalesce into the coronary sinus that runs in the left posterior atrioventricular groove and opens into the right atrium. Other small veins, called the besian veins, open directly into all four chambers of the heart.

Venous drainage and Lymphatics

Venous drainage is via the variable coronary veins and the coronary sinus.

The lymphatic vessels drain mainly into:

1. Brachiocephalic nodes, in front of brachiocephalic veins
2. Tracheobronchial nodes, located at the distal end of the trachea

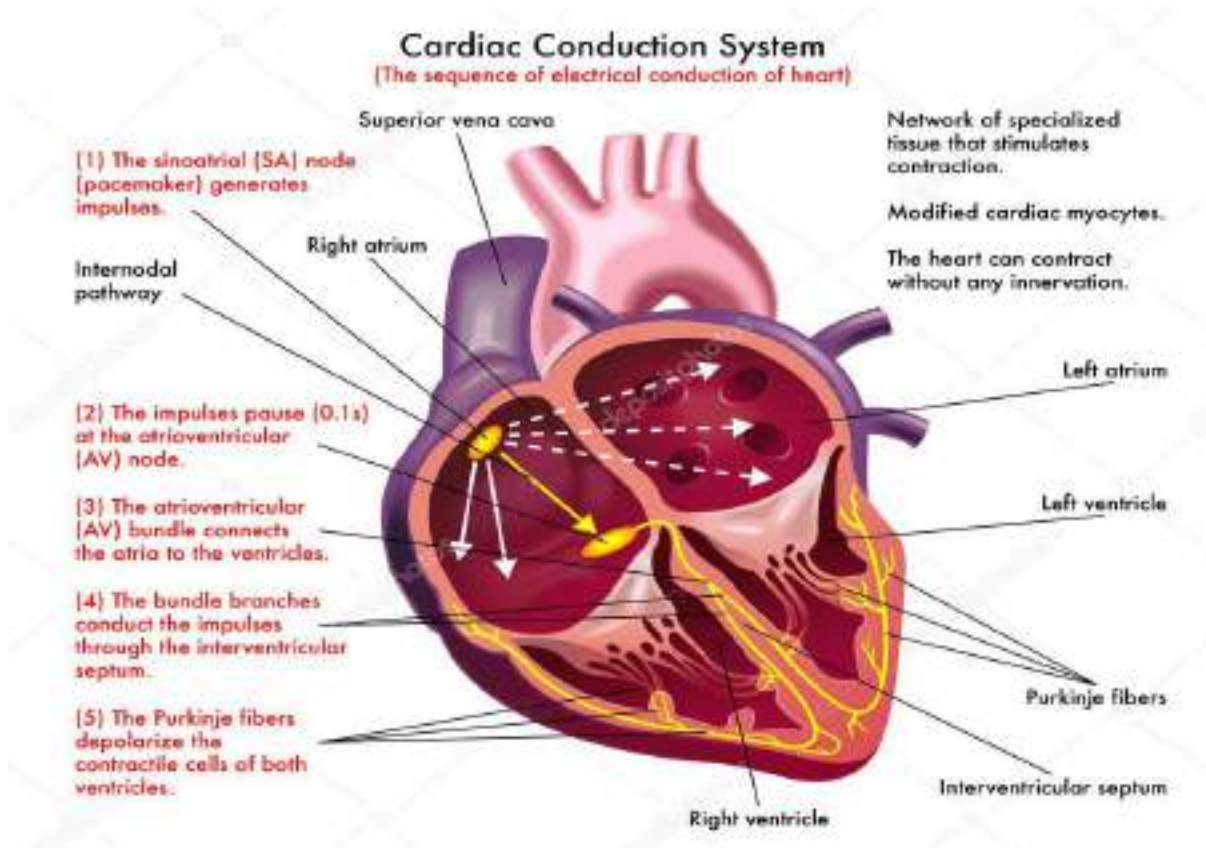
Nerve Supply

The main control of the heart resides with the medulla oblongata. There is an area called the cardio acceleratory centre, or pressor centre, in the upper part of the medulla oblongata, and an area called the cardio inhibitory centre, or depressor centre, in the lower part. Together they are called the cardio regulatory centre, since they interact to control heart rate, etc.

The nervous supply to the heart is autonomic, consisting of both sympathetic and parasympathetic parts. The sympathetic fibres arise from the pressor centre, while the parasympathetic fibres arise in the depressor centre.

- The sympathetic nervous system acts on the sinoatrial node, speeding up the depolarisation rate, and therefore increasing the heart rate.

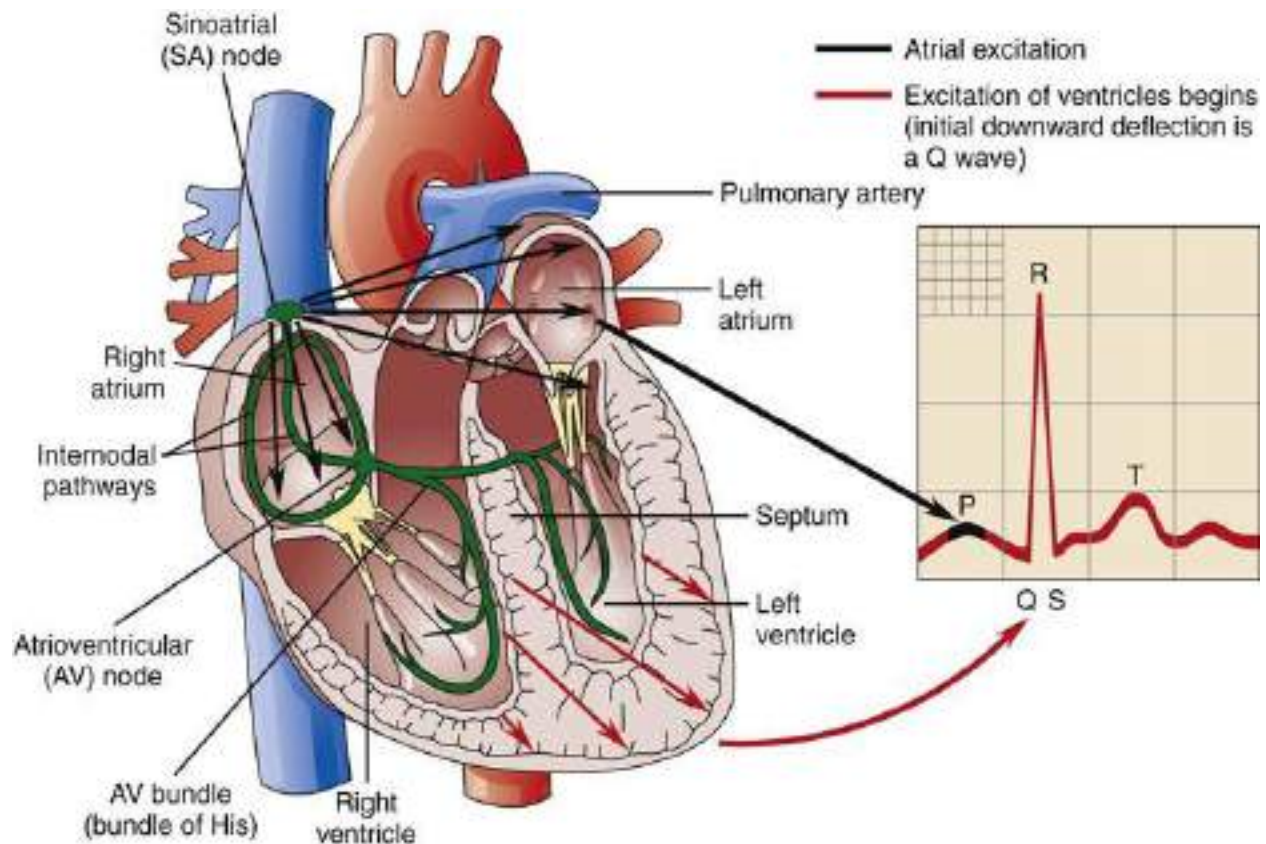
- The parasympathetic system works in reverse in order to slow the heart rate down.
- The heart itself has a natural pacemaker, the sinoatrial node, which does not need a nervous supply to function. If you sever all the nerves to the heart, then it will continue to beat. In fact, it will beat faster than normal, since there is normally a parasympathetic supply slowing the heart down.



Heart Conduction System

An electrical conduction system regulates the pumping of the heart and timing of contraction of various chambers. Heart muscle contracts in response to the electrical stimulus received system generates electrical impulses and conducts them throughout the muscle of the heart, stimulating the heart to contract and pump blood. Among the major elements in the

cardiac conduction system are the sinus node, atrioventricular node, and the autonomic nervous system.



ECG – Electrocardiogram

- The cardiac cycle can be monitored using an electrocardiograph, which measures electric signals and produces an ECG
- PQRST model:
- P: Contraction of atria
- QRS: Contraction of ventricles
- T: Recovery period; heart is preparing for the next contraction

circulatory system

Your heart and blood vessels make up the circulatory system. The main function of the circulatory system is to provide oxygen, nutrients and hormones to muscles, tissues and organs throughout your body. Another

part of the circulatory system is to remove waste from cells and organs so your body can dispose of it. Your heart pumps blood to the body through a network of arteries and veins (blood vessels). Your circulatory system can also be defined as your cardiovascular system. Cardio means heart, and vascular refers to blood vessels.

Control of Heart Rate

- Though the SA node sets the tempo for the heartbeat, the brain and hormones influence the frequency of the heartbeats
- Two sets of nerves, “sympathetic” and “parasympathetic” nerves from the brain connect to the SA node
- During stress, the sympathetic nervous system increases heart rate.
- During times of relaxation, the parasympathetic nervous system functions to decrease heart rate
- Hormones and body activity also affects heart rate
- Athletes have a lower resting heart rate than the average person because their heart is trained to pump more blood in one contraction so there is no need to pump as many times.

Function

The circulatory system’s function is to move blood throughout the body. This blood circulation keeps organs, muscles and tissues healthy and working to keep you alive.

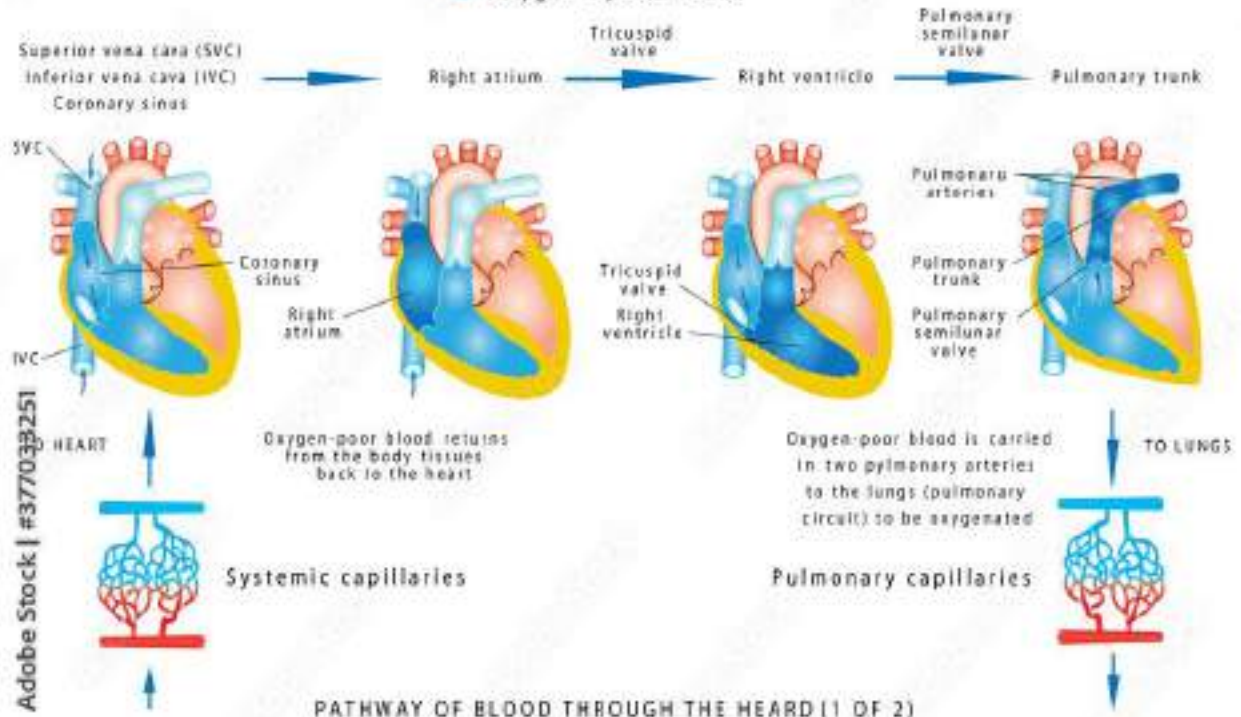
The circulatory system also helps your body get rid of waste products. This waste includes:

- 1-Carbon dioxide from respiration (breathing).
- 2-Other chemical byproducts from your organs.
- 3-Waste from things you eat and drink.

The heart is a double pump

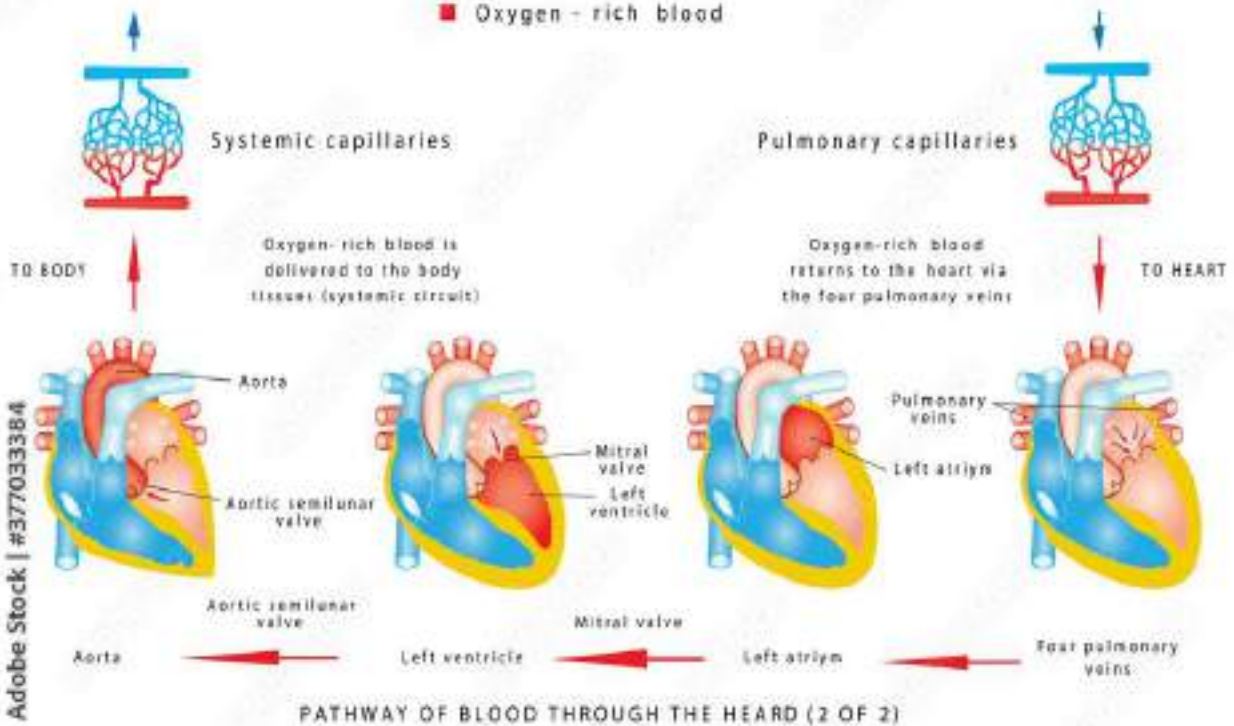
The heart is a double pump, each side supplying its own circuit (1 of 2)

■ Oxygen - poor blood



The heart is a double pump, each side supplying its own circuit (2 of 2)

■ Oxygen - rich blood



Your circulatory system functions with the help of blood vessels that include arteries, veins and capillaries. These blood vessels work with your heart and lungs to continuously circulate blood through your body. Here's how:

1. The heart's bottom right pumping chamber (right ventricle) sends blood that's low in oxygen (oxygen-poor blood) to the lungs. Blood travels through the pulmonary trunk (the main pulmonary artery).
2. Blood cells pick up oxygen in the lungs.
3. Pulmonary veins carry the oxygenated blood from the lungs to the heart's left atrium (upper heart chamber).
4. The left atrium sends the oxygenated blood into the left ventricle (lower chamber). This muscular part of the heart pumps blood out to the body through the arteries.
5. As it moves through your body and organs, blood collects and drops off nutrients, hormones and waste products.
6. The veins carry deoxygenated blood and carbon dioxide back to the heart, which sends the blood to the lungs.
7. Your lungs get rid of the carbon dioxide when you exhale.

Anatomy

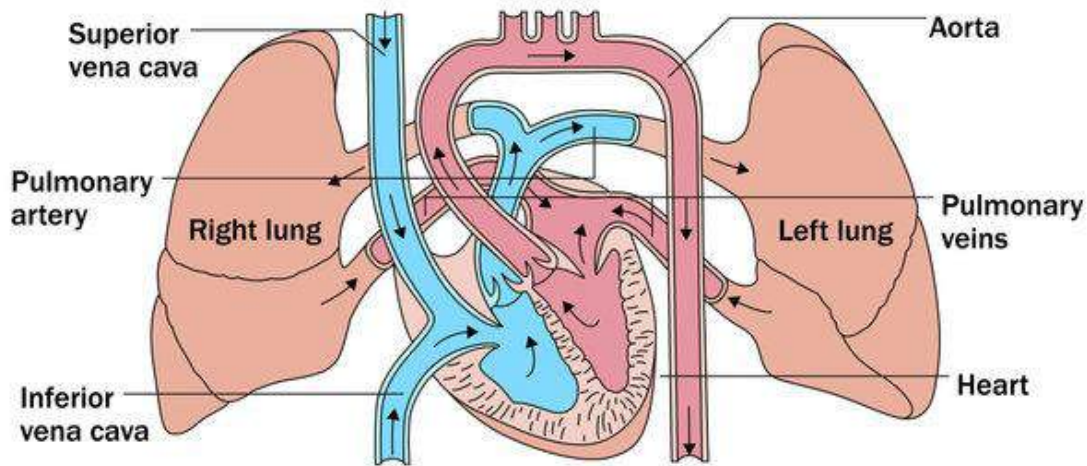
The parts of your circulatory system are your:

- **Heart**, a muscular organ that pumps blood throughout your body.
- **Blood vessels**, which include your arteries, veins and capillaries.
- **Blood**, made up of red and white blood cells, plasma and platelets.

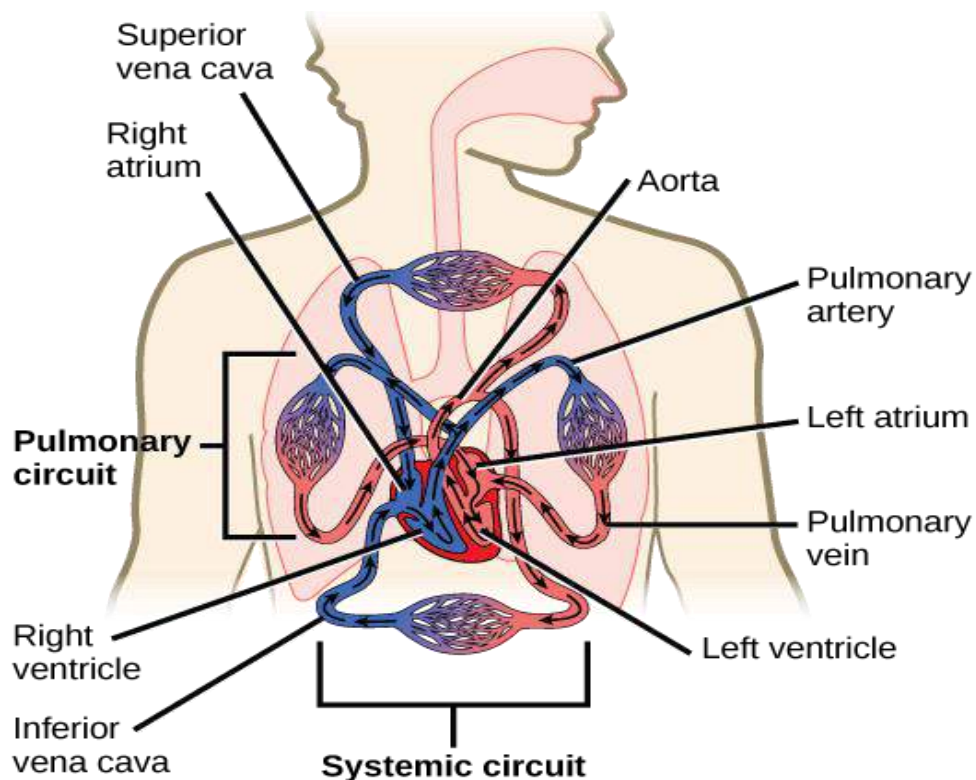
Your circulatory system has three circuits. Blood circulates through your heart and through these circuits in a continuous pattern:

- **The pulmonary circuit:** This circuit carries blood without oxygen from the heart to the lungs. The pulmonary veins return oxygenated blood to the heart.

Pulmonary circulation



- **The systemic circuit:** In this circuit, blood with oxygen, nutrients and hormones travels from the heart to the rest of the body. In the veins, the blood picks up waste products as the body uses up the oxygen, nutrients and hormones.



- **The coronary circuit:** Coronary refers to your heart's arteries. This circuit provides the heart muscle with oxygenated blood. The coronary circuit then returns oxygen-poor blood to the heart's right upper chamber (atrium) to send to the lungs for oxygen.

There are three main types of blood vessels:

- **Arteries:** Arteries are thin, muscular tubes that carry oxygenated blood away from the heart and to every part of your body. The aorta is the body's largest artery.

It starts at the heart and travels up the chest (ascending aorta) and then down into the stomach (descending aorta). The coronary arteries branch off the aorta, which then branch into smaller arteries (arterioles) as they get farther from your heart.

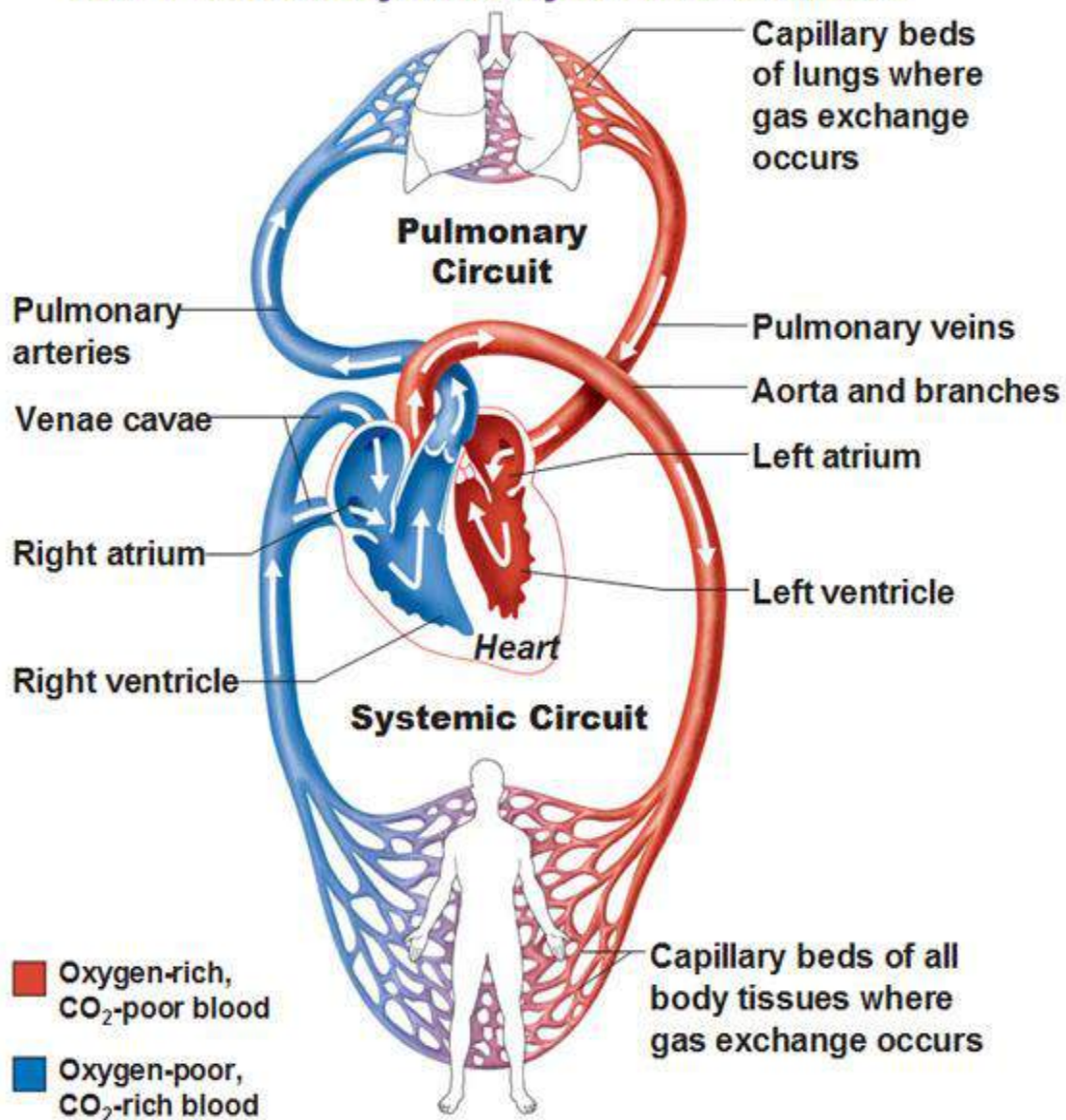
- **Veins:** These blood vessels return oxygen-depleted blood to the heart. Veins start small (venules) and get larger as they approach your heart. Two central veins deliver blood to your heart. The superior vena cava carries blood from the upper body (head and arms) to the heart. The inferior vena cava brings blood up from the lower body (stomach, pelvis and legs) to the heart. Veins in the legs have valves to keep blood from flowing backward.
- **Capillaries:** These blood vessels connect very small arteries (arterioles) and veins (venules). Capillaries have thin walls that allow oxygen, carbon dioxide, nutrients and waste products to pass into and out of cells.

circulatory system organs

Your heart is the only circulatory system organ. Blood goes from the heart to the lungs to get oxygen. The lungs are part of the respiratory system. Your heart then pumps oxygenated blood through arteries to the rest of the body.

The Heart as a Double Pump

The Pulmonary and Systemic Circuits



Conditions and Disorders

Many conditions can affect the health of your circulatory system, including:

- **Aneurysms:** Aneurysms occur when an artery wall weakens and enlarges. The weak spot can bulge as blood moves through the artery. The weak spot may tear, causing a life-threatening rupture. Aneurysms can affect any artery, but aortic aneurysms, abdominal aortic aneurysms and brain aneurysms are the most common.
- **High blood pressure:** Your arteries work hard to circulate blood throughout the body. When the pressure (force of blood against the blood vessel walls) gets too high, you develop high blood pressure. When the arteries become less elastic (stretchy), less blood and oxygen reaches organs like the heart. High blood pressure puts you at risk for cardiovascular disease, heart attacks and strokes.
- **Plaque deposits:** High cholesterol and diabetes can lead to fat and other substances collecting in the blood. These substances form deposits called plaques on artery walls. This condition is atherosclerosis, or narrowed or hardened arteries. Atherosclerosis increases the risk of blood clots and strokes, coronary artery disease, peripheral artery disease (and other artery diseases), heart attacks and kidney disease.
- **Venous disease:** Venous diseases tend to affect veins in the lower body. Problems like chronic venous insufficiency and varicose veins occur when blood can't flow back to the heart and pools in **leg veins**. Deep vein thrombosis (DVT), a blood clot in the legs, can lead to a life-threatening pulmonary embolism.

Blood vessels of the heart

The blood vessels of the heart include:

- **coronary arteries** – like any other organ or tissue, the heart needs oxygen. The coronary arteries sit on the surface of the heart and supply the heart muscle with blood and oxygen

- **aorta** – this is the largest artery in the body. Oxygen-rich blood is pumped into the aorta from the left ventricle. The aorta divides into various branches that deliver blood all around the body.
-
- **pulmonary arteries** – blood low in oxygen is pumped by the right ventricle into the pulmonary arteries that link to the lungs.
-
- **pulmonary veins** – the pulmonary veins return oxygen-rich blood from the lungs to the left atrium of the heart.
-
- **venae cavae** – blood low in oxygen is delivered to the right atrium by two veins. One (superior vena cava) carries blood from the head and upper torso, while the other (inferior vena cava) carries blood from the lower body

Common heart conditions

There are many different types of heart conditions. Some common heart conditions include:

1-coronary heart disease – coronary heart disease happens when the coronary arteries supplying blood to the heart muscle become blocked or narrowed by a build-up of fatty deposits (plaque). Coronary heart disease can cause angina and heart attacks.

2-angina – a type of chest pain caused by a build-up of plaque in the coronary arteries. Part of the heart muscle may not receive enough blood and oxygen. This causes chest tightness, discomfort or pain.. Pain or discomfort may also be felt in the arms, neck, jaw, shoulders or back

3-heart attack – happens when something, usually a blood clot, cuts off the flow of blood to the heart. Without oxygen and nutrients, the heart muscle begins to die. A heart attack may not be fatal, especially if you receive immediate medical treatment, but it can still cause lasting damage to the heart.

4-*heart failure* – a condition where the heart is not able to pump blood and oxygen around the body as well as it should

5-*abnormal heart rhythms* (arrhythmias) - a range of conditions where there is a fault in the heart's electrical system, which affects your heart's pumping rhythm. Atrial fibrillation is the most common type of abnormal heart rhythm, where the heart beats irregularly and often fast

6-*heart valve disease* – when the heart valve or valves don't open or close properly. Damage to the heart valves can make it harder for the heart to pump blood around the body

7-*congenital heart disease* – problems with the heart or blood vessels that you are born with. Problems include the blockage of blood flow inside the heart or blood vessels, abnormal flow of blood within the heart, or the heart may not have developed properly.

8-*heart inflammation* – includes pericarditis (inflammation of the outer lining of the heart) and myocarditis (inflammation of the heart muscle)

9-*rheumatic heart disease* - damage to the valves in the heart that develops after acute rheumatic fever. Rheumatic heart disease affects more Aboriginal and/or Torres Strait Islander Peoples, Maori and Pacific Islander Peoples, and those who have migrated to Australia from low to middle income countries where this disease remains common.

Symptoms of heart disease

'Heart disease' is a broad term for different conditions affecting the heart. Different heart conditions can have different symptoms.

It's important to be aware of the following symptoms, which can be a warning sign of a medical emergency, including a heart attack:

1-Chest discomfort or pain. This can feel like uncomfortable pressure, aching, numbness, squeezing, fullness or pain in your chest. This discomfort can spread to your arms, neck, jaw, shoulders or back. It can last for several minutes or come and go.

2-Shortness of breath or difficulty breathing (with or without chest discomfort)

3-Racing heart or a feeling of your heart pounding or fluttering in your chest (palpitations)

4-Light headedness, dizziness, feeling faint

5-Feeling anxious

6-Nausea, indigestion, vomiting

7-Sweating or a cold sweat.