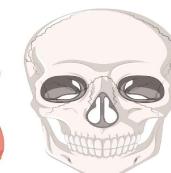
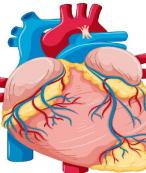
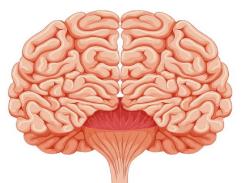
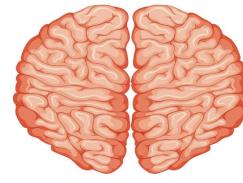


Human Body systems

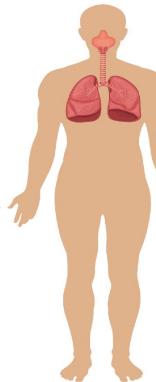
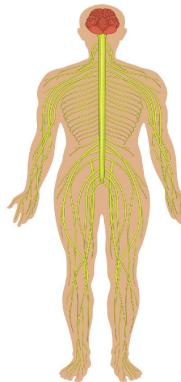
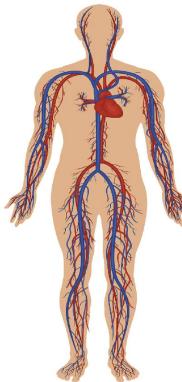
Human Body Systems



Nervous System

Digestive System

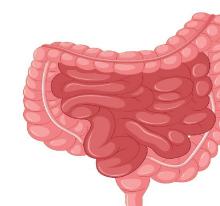
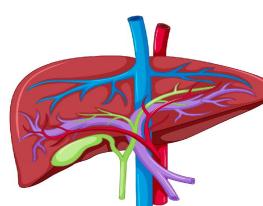
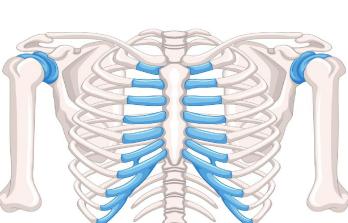
Muscular System



Circulatory System

Respiratory System

Skeletal System



- ❖ The human body is a biological machine made of body systems; groups of organs that work together to produce and sustain life.
- ❖ This topic page will provide you with a quick introduction to the systems of the human body.
- ❖ The action potential signal travels through motor neurons to reach the neuromuscular junction, the site of contact between the motor nerve and the muscle.

Human body systems

- ❖ 1. Skeletal system
- ❖ 2. Muscular system
- ❖ 3. Respiratory system
- ❖ 4. Cardiovascular system
(Circulatory system)
- ❖ 5. Digestive system
- ❖ 6. Nervous system
- ❖ 7. Endocrine system
- ❖ 8. Reproductive system
- ❖ 9. Urinary system
- ❖ 10. The lymphatic system
(Humeral system)

Human Musculoskeletal System



Human Musculoskeletal System

- ❖ The human musculoskeletal system (also known as the human locomotor system) is an organ system that gives humans the ability to move using their muscular and skeletal systems.
- ❖ It is made up of the bones of the skeleton, muscles, cartilage, tendons, ligaments, joints, and other connective tissue that supports and **binds tissues and organs together**.
- ❖ The musculoskeletal system's **primary functions** include supporting the body, allowing motion, and protecting vital organs.
- ❖ The skeletal portion of the system serves as the **main storage system** for calcium and phosphorus and contains critical components of the hematopoietic system.

- ❖ This system describes how bones are connected to other bones and muscle fibers via connective tissue such as tendons and ligaments.
- ❖ The bones **provide stability** to the body.
- ❖ Muscles keep bones in place and also play a role in the **movement of bones**. To allow motion, different bones are connected by joints.
- ❖ **Cartilage prevents** the bone ends from rubbing directly onto each other.
- ❖ Muscles **contract to move** the bone attached at the joint.
- ❖ Complex issues and injuries involving the musculoskeletal system are usually handled by a **physiatrist** (specialist in physical medicine and rehabilitation) or an **orthopaedic surgeon**.

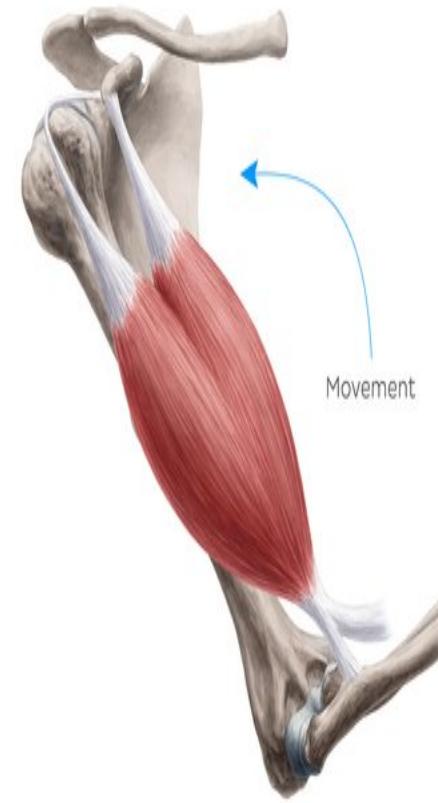
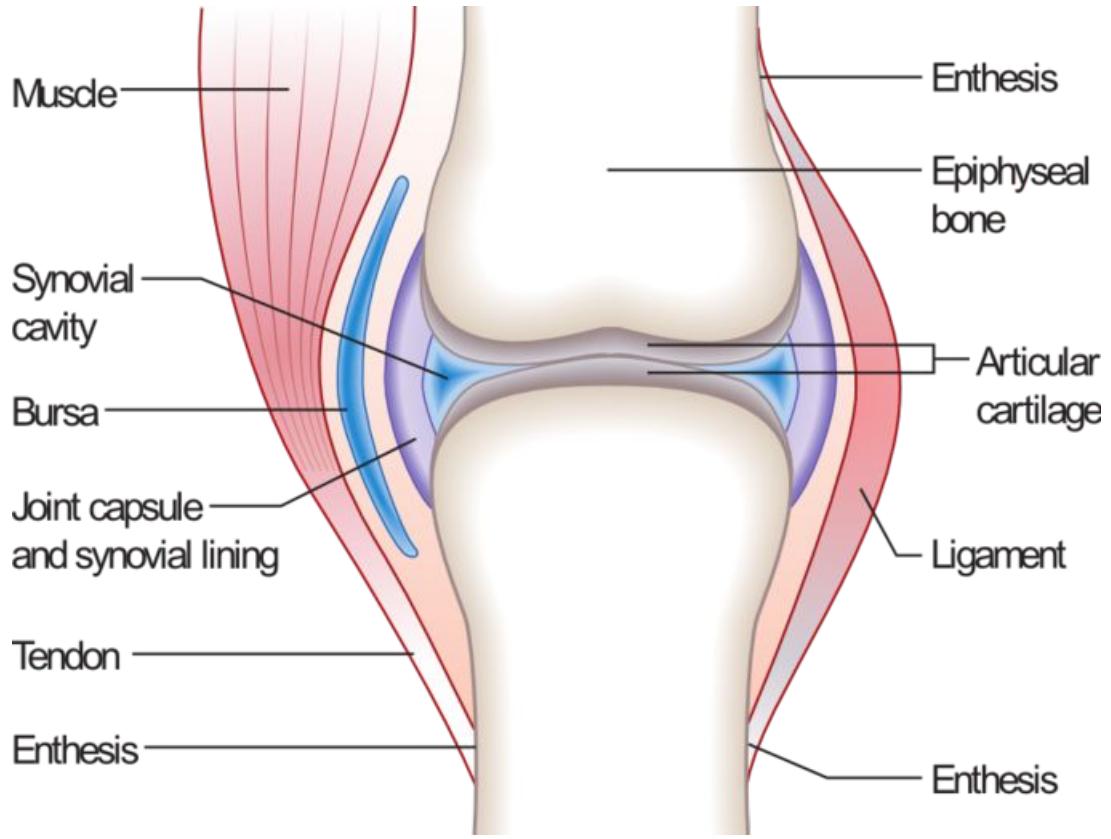


Figure : Joints, tendons, and ligaments: To allow motion, different bones are connected by joints. Within these joints, bones are connected to other bones and muscle fibers via connective tissue such as tendons and ligaments.

Key Points

- ❖ The skeleton, muscles, cartilage, tendons, ligaments, joints, and other connective tissues are all part of the musculoskeletal system, which work together to provide the body with support, protection, and movement.
- ❖ The bones of the skeletal system protect the body's internal organs, support the weight of the body, and serve as the main storage system for calcium and phosphorus.
- ❖ The muscles of the muscular system keep bones in place; they assist with movement by contracting and pulling on the bones.
- ❖ To allow motion, different bones are connected by joints which are connected to other bones and muscle fibers via connective tissues such as tendons and ligaments.
- ❖ Cartilage prevents the bone ends from rubbing directly on each other.
- ❖ Malnutrition and **arthritis** are examples of disorders and diseases in the body that can severely impair the function of the musculoskeletal system.

- ❖ The **musculoskeletal system (locomotor system)** is a human body system that provides our body with movement, stability, shape, and support.
- ❖ It is subdivided into two broad systems:
 - ❖ **Muscular system**, which includes all types of muscles in the body. Skeletal muscles, in particular, are the ones that act on the body joints to produce movements.
 - ❖ Besides muscles, the muscular system contains the tendons which attach the muscles to the bones.
 - ❖ **Skeletal system**, whose main component is the bone. Bones articulate with each other and form the joints, providing our bodies with a hard-core, yet mobile, skeleton.
- ❖ The integrity and function of the bones and joints is supported by the accessory structures of the skeletal system; articular cartilage, ligaments, and bursae.

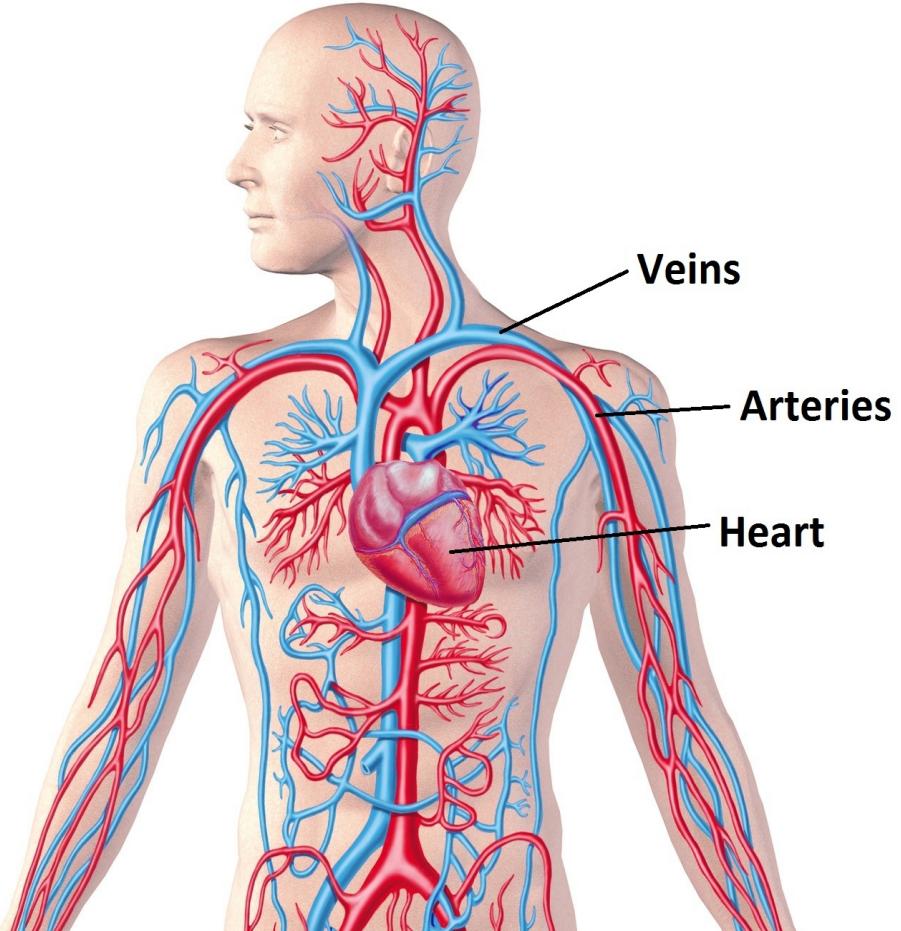
Functions:

- ❖ **Muscles:** Movement production, joint stabilization, maintaining posture, body heat production.
- ❖ **Bones:** Mechanical basis for movements, providing framework for the body, vital organs protection, **blood cells** production, **storage of minerals**
- ❖ Besides its main function to provide the body with stability and mobility.
- ❖ It has also many other functions; the skeletal part plays an important role in other **homeostatic functions** such as storage of minerals (e.g., calcium) and hematopoiesis.
- ❖ While the muscular system stores the majority of the body's carbohydrates in the form **of glycogen**.



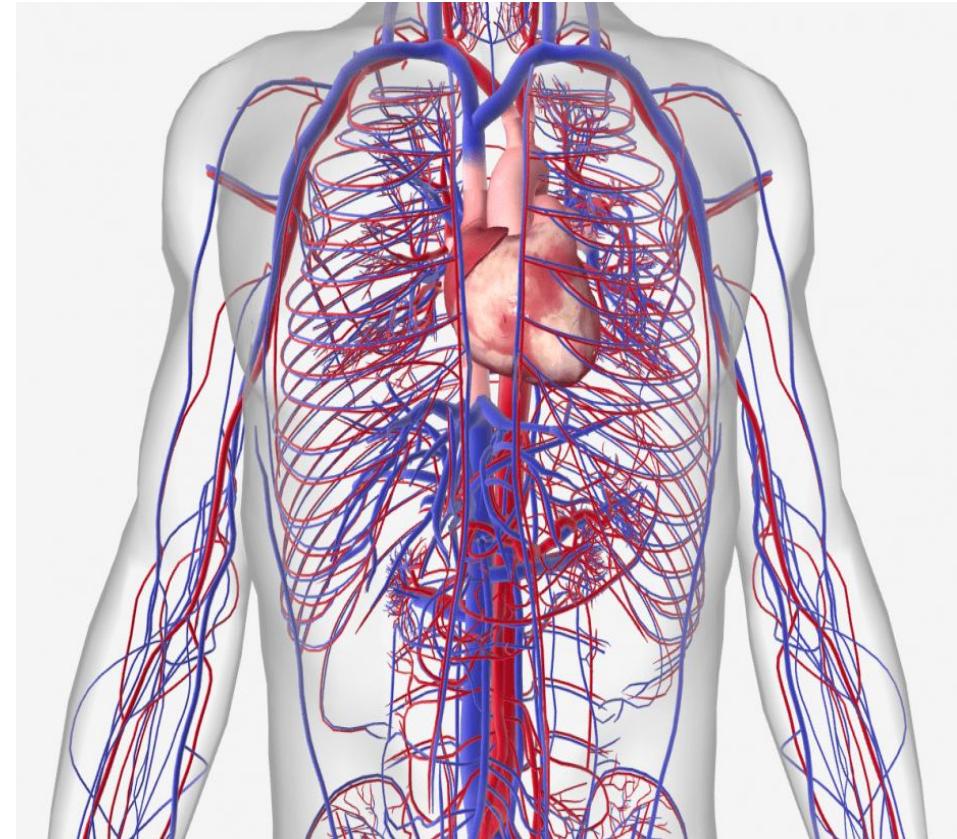
- ❖ The muscular system is an organ system composed of specialized contractile tissue called the muscle tissue.
- ❖ There are **three types** of muscle tissue, based on which all the muscles are classified into three groups:
 - ❖ **Cardiac muscle**, which forms the muscular layer of the heart (myocardium)
 - ❖ **Smooth muscle**, which comprises the walls of blood vessels and hollow organs
 - ❖ **Skeletal muscle**, which attaches to the bones and provides voluntary movement.

Cardiovascular System



Components of the cardiovascular system:

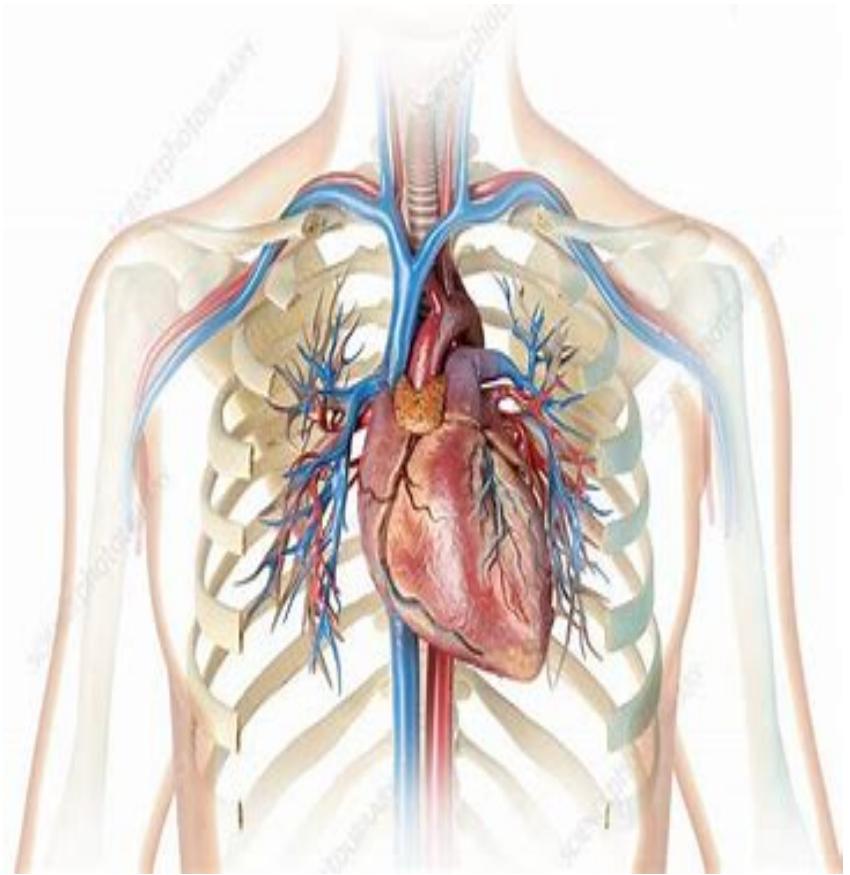
- ❖ The cardiovascular system is the system responsible for delivering blood to different parts of the body.
- ❖ It consists of the following organs and tissues:
 - **The heart:** A muscular pump that forces blood around the body.
 - A closed system of **blood vessels:** These vessels include:
 - Arteries: Vessels that carry blood away from the heart.
 - Veins: Vessels that bring blood back to the heart.
 - Capillaries: Tiny vessels that branch off from arteries to deliver blood to all body tissues



Cardiovascular system contd....

- ❖ The cardiovascular system (**circulatory system**) is a system of organs that includes the **heart, blood vessels**, and blood which is circulated throughout the entire body.
- ❖ Approximately 5 liters of blood that the blood vessels transport.
- ❖ Its primary function is to transport nutrients, hormones and oxygen-rich blood to all parts of the body and to carry deoxygenated blood back to the lungs.
- ❖ Also removes carbon dioxide and other wastes. It is a closed tubular system in which the blood is propelled by a muscular heart.
- ❖ Several functions of the cardiovascular system can **control blood pressure**.
- ❖ **Hemostasis**, or the clotting of blood and formation of scabs, is managed by the platelets of the blood.

- ❖ The adult **Human Heart** with average dimensions of about $13 \times 9 \times 6$ cm and weight approximately 300 grams.
- ❖ It is cone-shaped and is located in the chest (thoracic) cavity behind the breastbone (sternum), in front of the windpipe (trachea), the esophagus, and the descending aorta, between the lungs, and above the diaphragm (the muscular partition between the chest and abdominal cavities).
- ❖ About two-thirds of the heart lies to the left of the midline.



The Heart

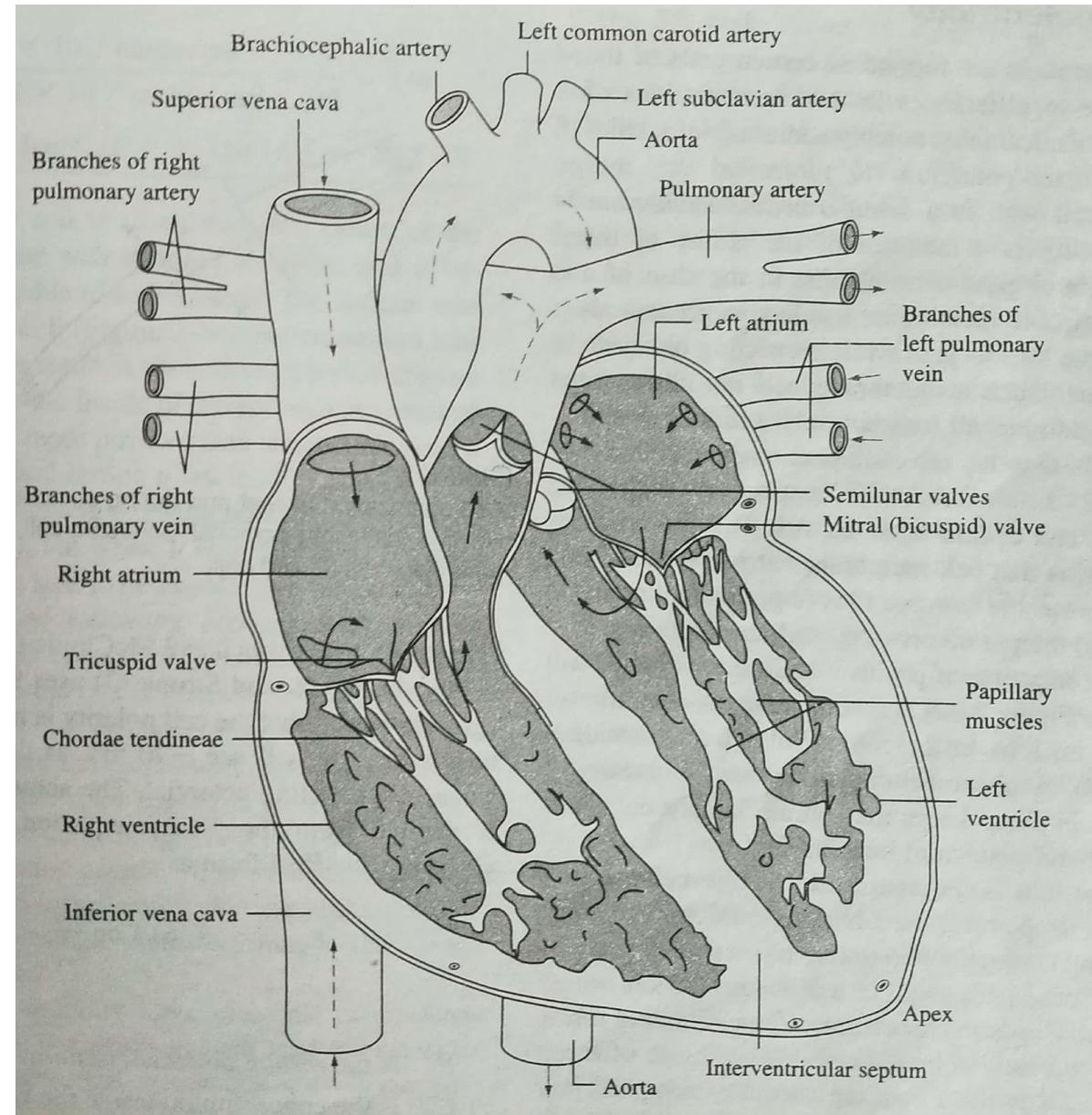
- The primary function of the heart, to pump blood through the circulatory system, is fundamentally mechanical.

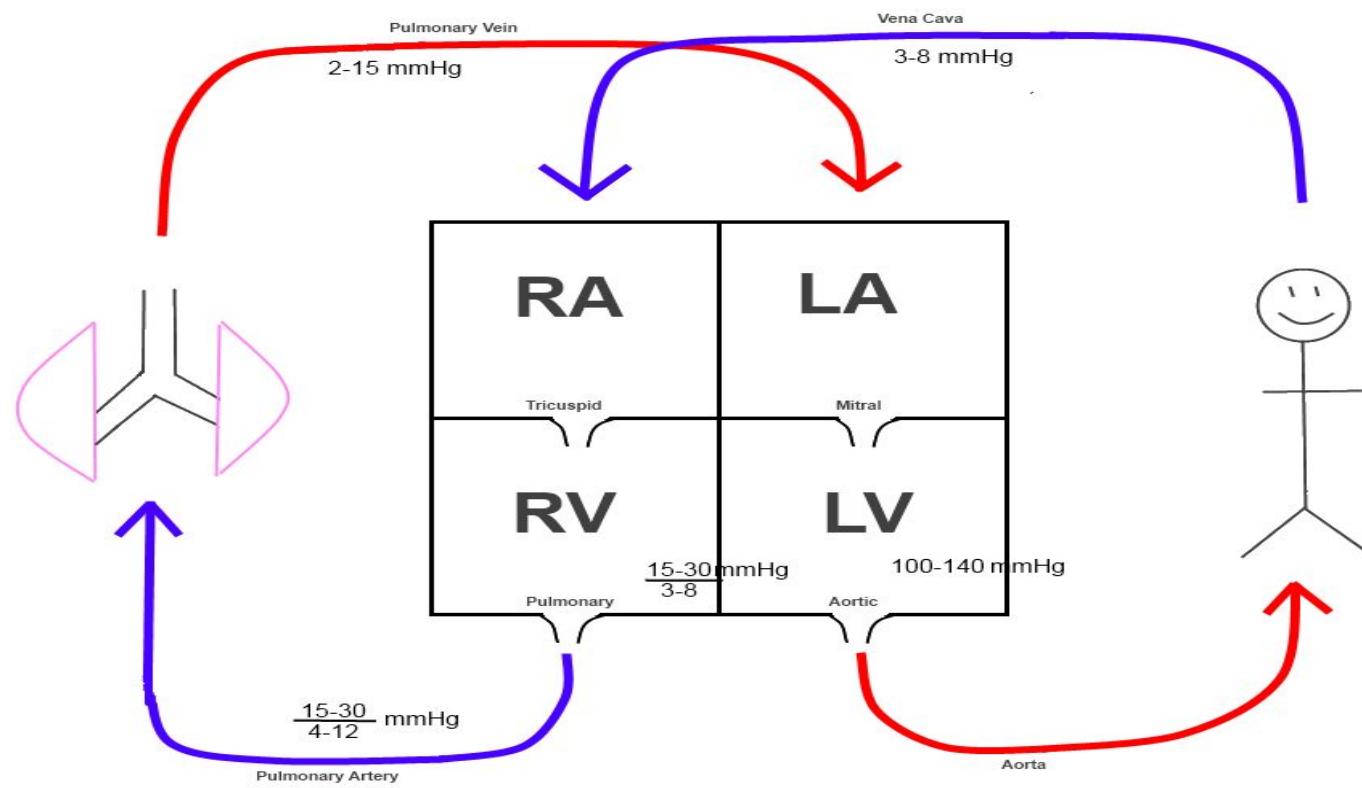
Structure of the heart

- The heart consists of four distinct chambers: two upper chambers called “atria” and two lower chambers called “ventricles.”
- A wall or “septum” separates the atria and ventricles. Valves control the flow of blood within the different chambers.
- The *heart* is a cone-shaped, muscular organ located between the lungs behind the sternum.
- The heart muscle forms the *myocardium*, with tightly interconnect cells of *cardiac muscle* tissue.
- The *pericardium* is the outer membranous sac with lubricating fluid.

Cardiovascular system contd....

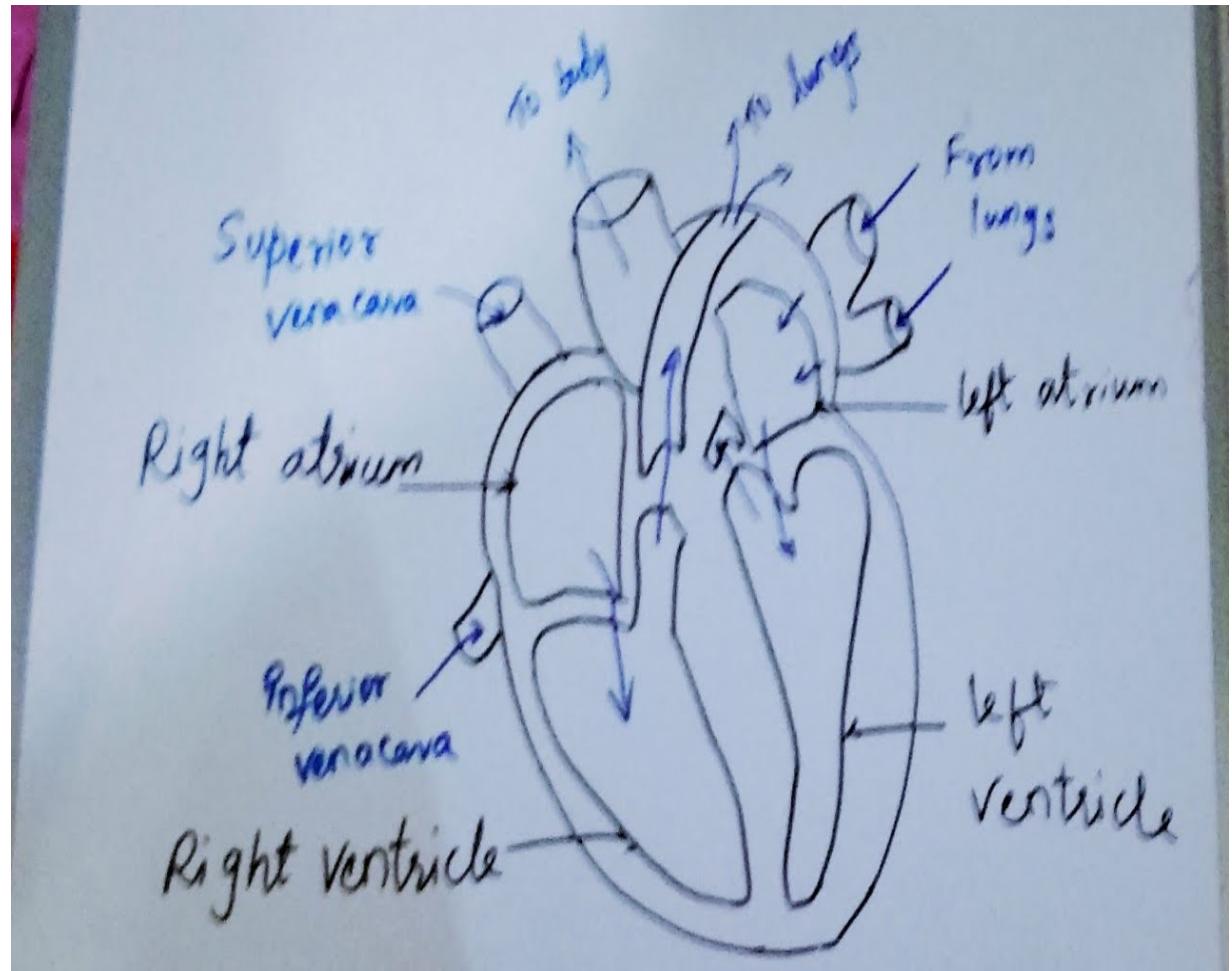
- ❖ The branching system of arteries—terminates in short, narrow, muscular vessels called arterioles, from which blood enters simple endothelial tubes known as capillaries.
- ❖ The right side of the heart pumps deoxygenated blood into the pulmonary circulation of the lungs, where the blood is reoxygenated again.
- ❖ While the left side of the heart simultaneously pumps oxygenated blood into the systemic circulation, distributing it to the peripheral tissues.
- ❖ The regular pumping, or heartbeat, is controlled by the conduction system of the heart.





The Heart

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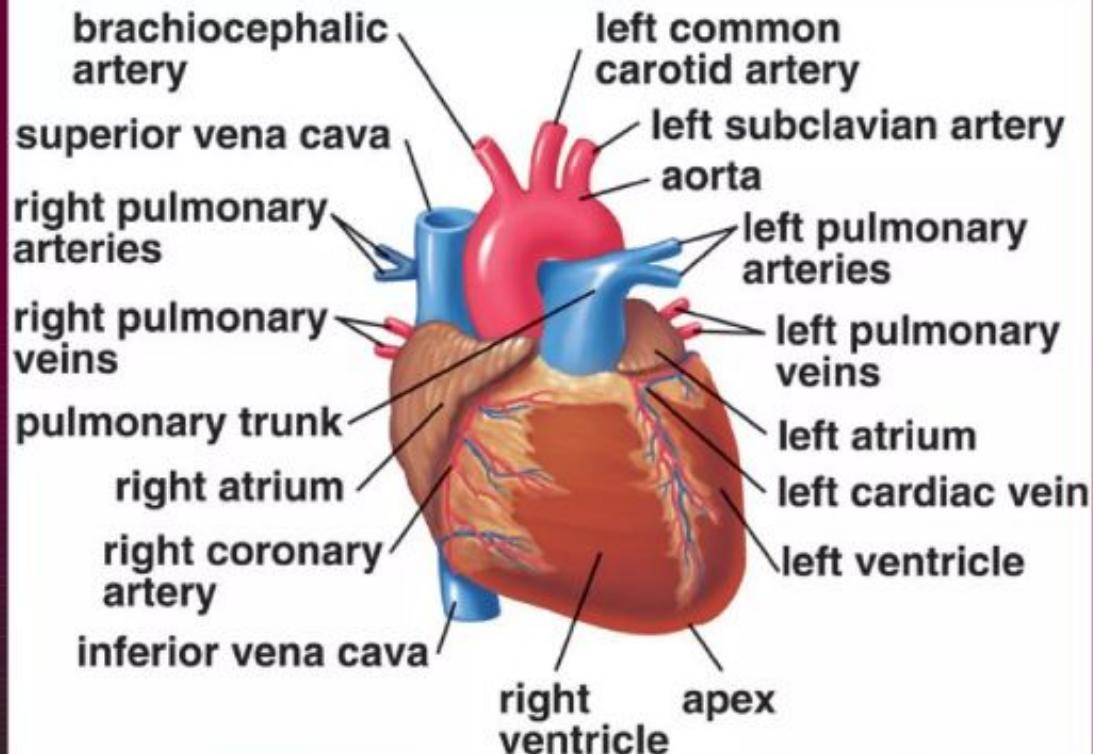
The Heart

- Is about 4.8 inches tall and 3.35 inches wide
- Weighs about .68 lb. in men and .56 lb. in women
- Beats about 100,000 times per day
- Beats 2.5 billion time in an average 70 yr. lifetime
- Pumps about 2000 gallons of blood each day
- Circulates blood completely 1000 times each day
- Pumps blood through 62,000 miles of vessels
- Suffers 7.2 mil. CAD deaths worldwide each year

- 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.
- *Atrioventricular valves* occur between the atria and ventricles – the *tricuspid valve* on the right and the *bicuspid valve* on the left; both valves are reinforced by *chordae tendinae* attached to muscular projections within the ventricles.

External heart anatomy

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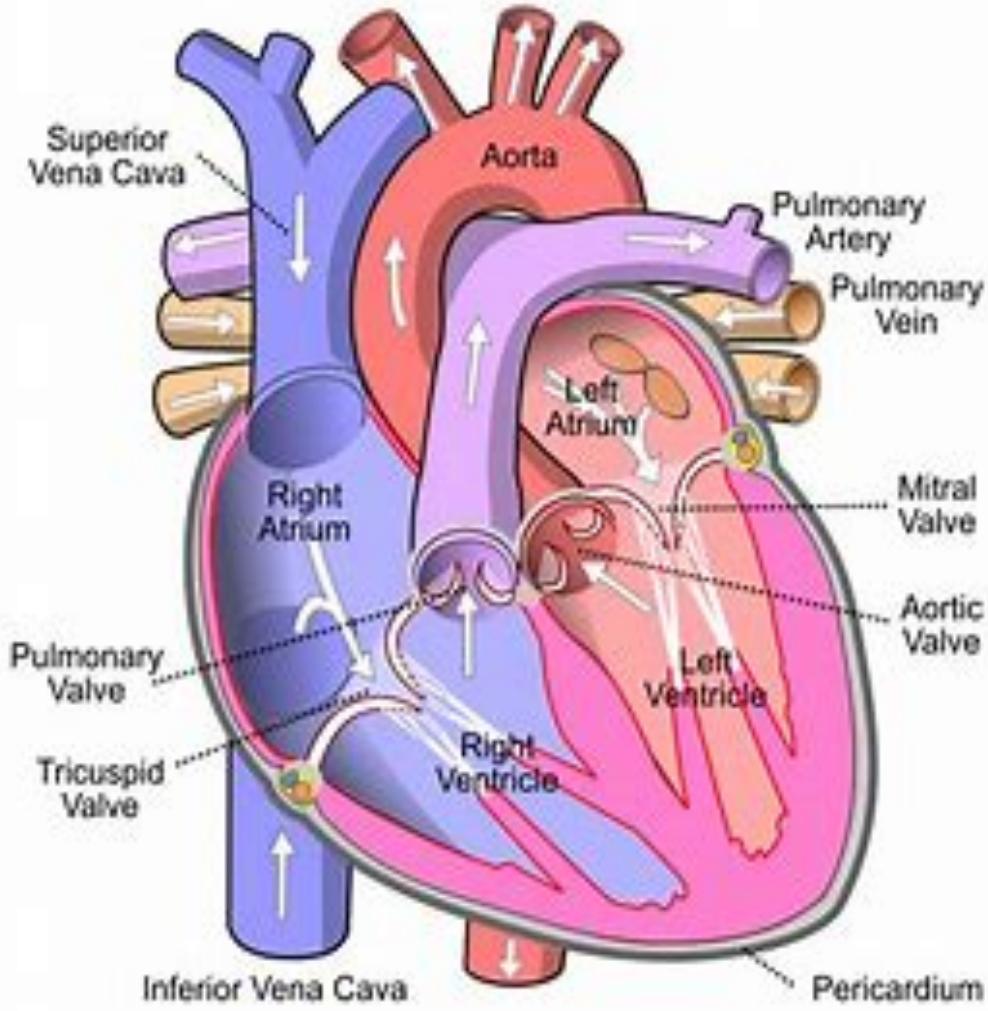


Heart Valves

- A heart valve normally allows blood flow in only one direction through the 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.
- The two atrioventricular (AV) valves, which are between the atria and the ventricles, are the mitral valve and the tricuspid valve.
- The two semilunar (SL) valves, which are in the arteries leaving the heart, are the aortic valve and the pulmonary valve.

Function

- Blood lacking oxygen returns from the body and enters the right atrium (upper right chamber) via the inferior vena cava and superior vena cava veins.
- Blood flows through the tricuspid valve and enters the right ventricle (lower right chamber).
- The right ventricle pumps blood through the pulmonary valve and out of the heart via the main pulmonary artery.

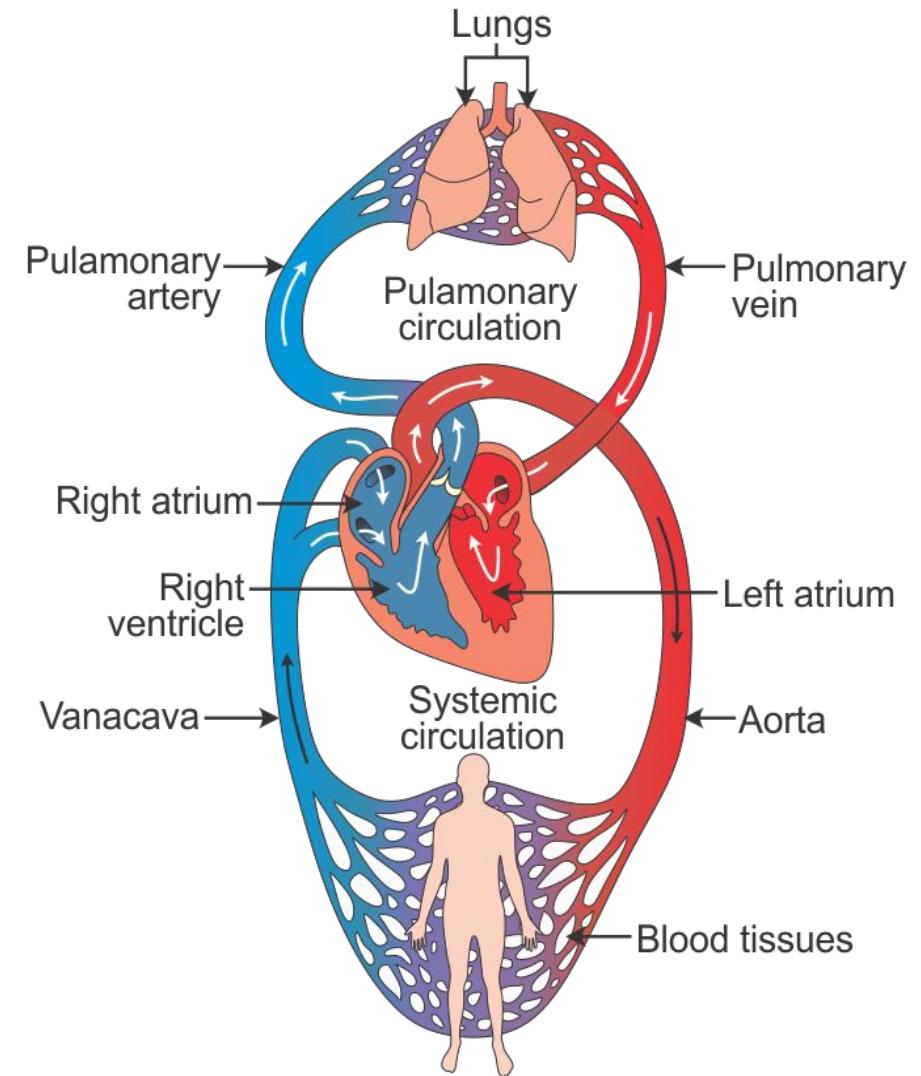


Function of the heart contd

- The blood then flows through the left and right pulmonary arteries into the lungs. Here, the process of breathing draws oxygen into the blood and removes carbon dioxide. As a result, the blood is now rich in oxygen.
- The blood returns to the heart and flows into the left atrium (upper left chamber) via four pulmonary veins.
- Blood flows through the mitral valve and enters the left ventricle (lower left chamber).
- The left ventricle pumps the blood through the aortic valve into a large artery called the “aorta.” This artery delivers blood to the rest of the body.

Cardiovascular system contd....

- ❖ It is comprised of the heart and the circulatory system of blood vessels.
- ❖ The heart is composed of four chambers; two atria and two ventricles.
- ❖ Blood enters the heart through the upper chambers of the left and right atria and exits via the left and right ventricles.
- ❖ The heart acts as a two-way pump



Functions of the Cardiovascular System

- ❖ The cardiovascular system has three major functions: transportation of materials, protection from pathogens, and regulation of the body's homeostasis.

The Circulatory Pump

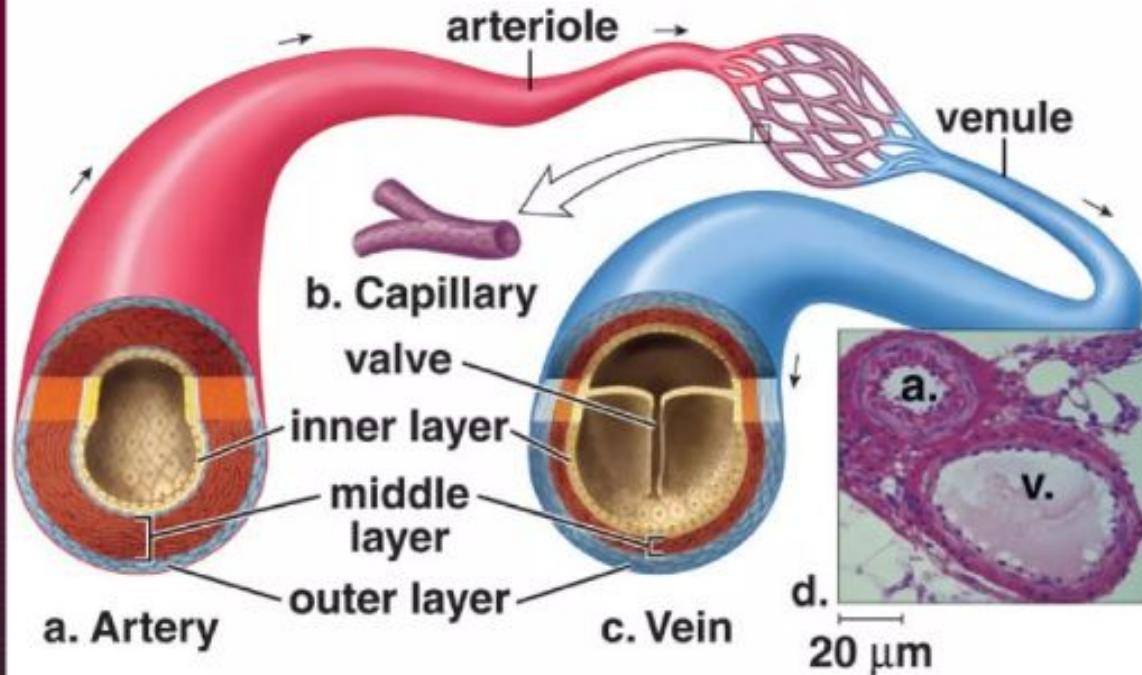
- The heart is a four-chambered “double pump,” where each side (left and right) operates as a separate pump.
- The left and right sides of the heart are separated by a muscular wall of tissue known as the septum of the heart.
- The right side of the heart receives deoxygenated blood from the systemic veins and pumps it to the lungs for oxygenation.
- The left side of the heart receives oxygenated blood from the lungs and pumps it through the systemic arteries to the tissues of the body.
- Each heartbeat results in the simultaneous pumping of both sides of the heart, making the heart a very efficient pump.

Circulatory Loops

- ❖ There are 2 primary circulatory loops in the human body: the pulmonary circulation loop and the systemic circulation loop.
- ❖ **Pulmonary circulation** transports deoxygenated blood from the right side of the heart to the lungs, where the blood picks up oxygen and returns to the left side of the heart.
- ❖ The pumping chambers of the heart that support the pulmonary circulation loop are the right atrium and right ventricle.
- ❖ **Systemic circulation** carries highly oxygenated blood from the left side of the heart to all of the tissues of the body (with the exception of the heart and lungs).
- ❖ Systemic circulation removes wastes from body tissues and returns deoxygenated blood to the right side of the heart.
- ❖ The left atrium and left ventricle of the heart are the pumping chambers for the systemic circulation loop.

Blood vessels

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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.

The Arteries

- *Arteries* and arterioles take blood away from the heart.
- The largest artery is the *aorta*.
- The middle layer of an artery wall consists of *smooth muscle* that can constrict to regulate blood flow and blood pressure.
- *Arterioles* can constrict or dilate, changing blood pressure.

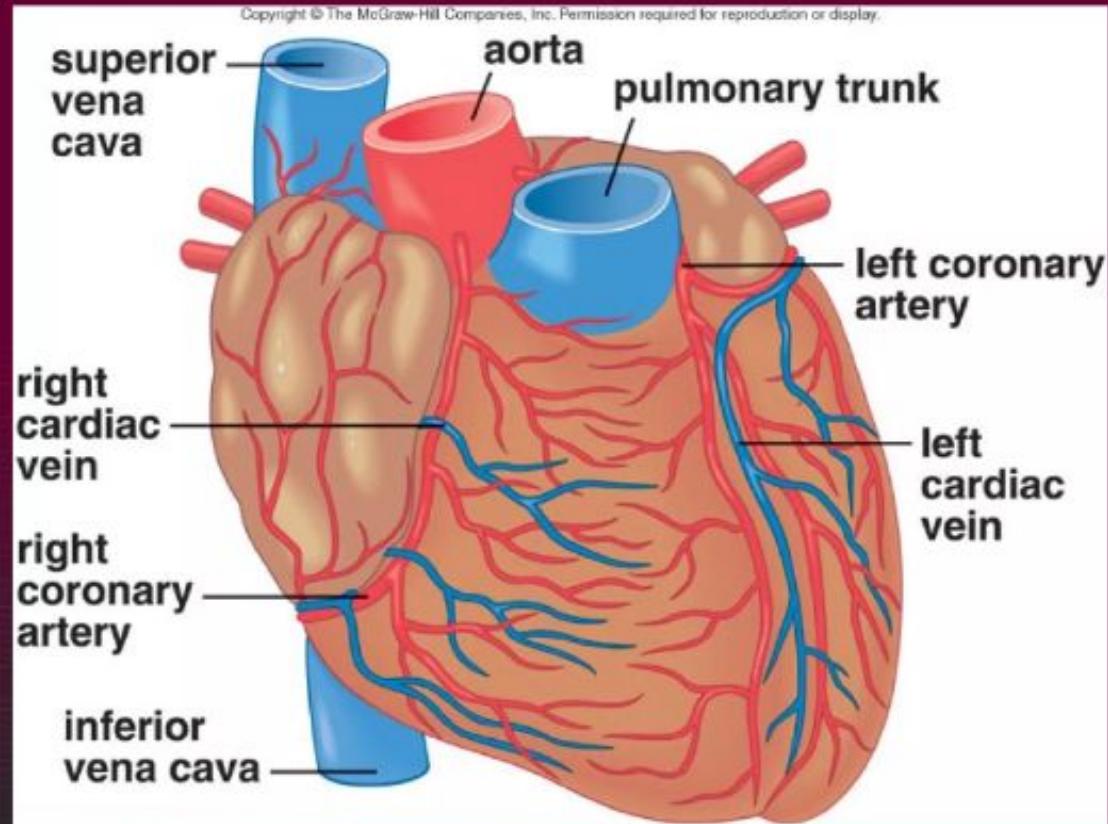
The Capillaries

- *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.
- Contraction of a *sphincter muscle* closes off a bed and blood can flow through an *arteriovenous shunt* that bypasses the capillary bed.

The 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.

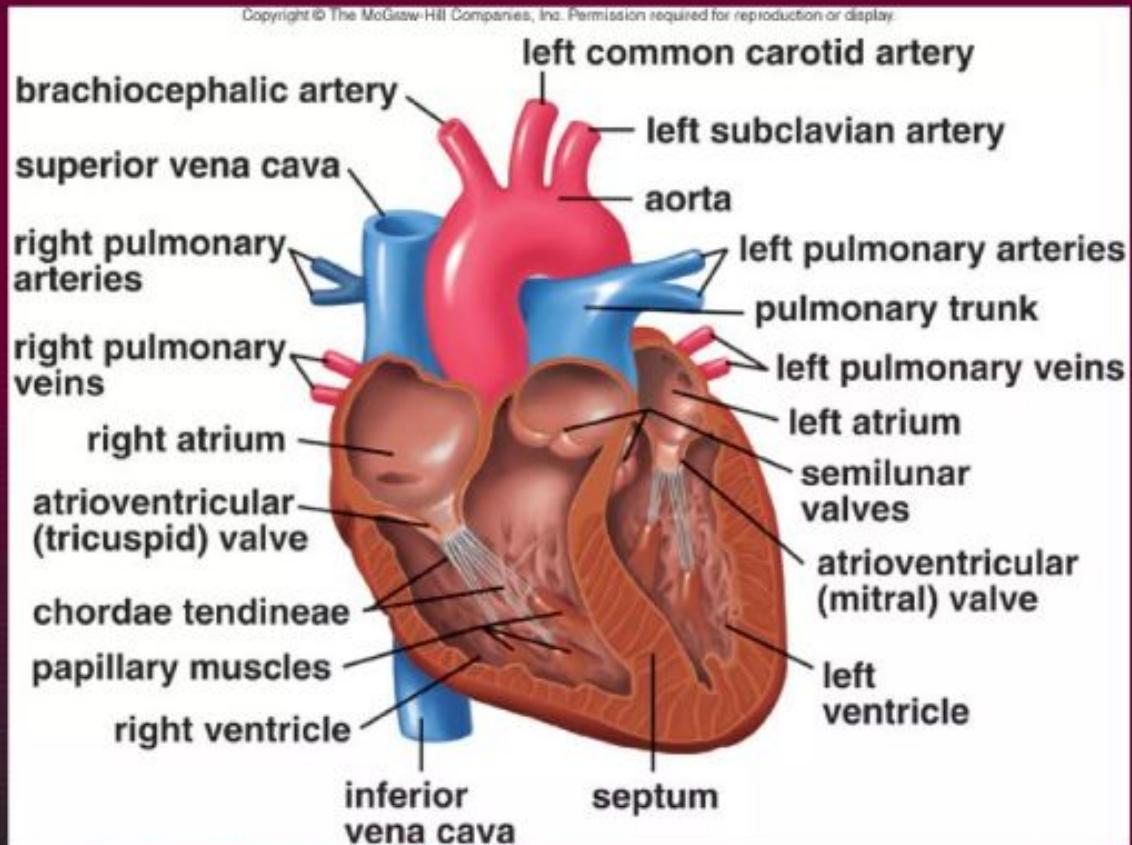
Coronary artery circulation



Passage of Blood Through the Heart

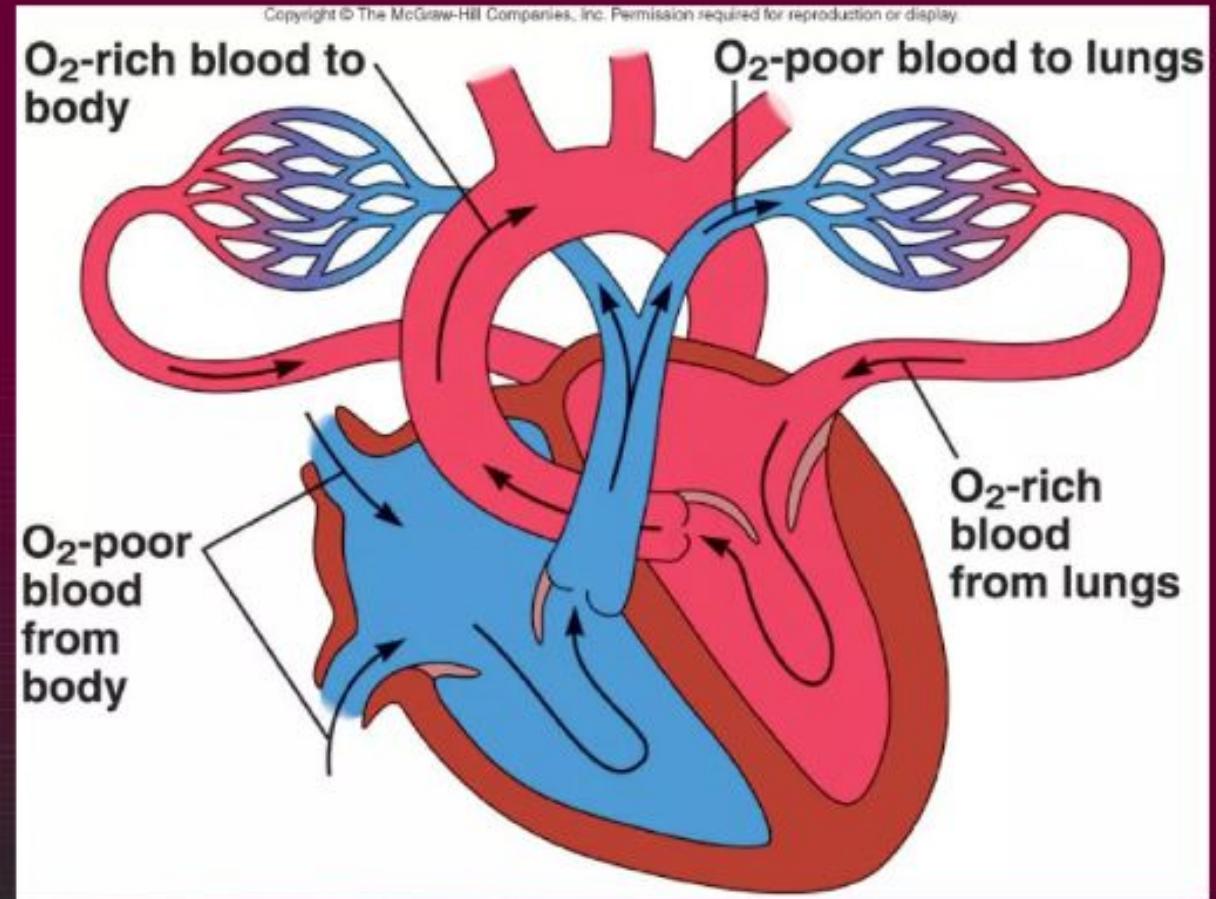
- Blood follows this sequence through the heart: superior and inferior vena cava → right atrium → tricuspid valve → right ventricle → pulmonary semilunar valve → pulmonary trunk and arteries to the lungs → pulmonary veins leaving the lungs → left atrium → bicuspid valve → left ventricle → aortic semilunar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

Internal view of the heart



- The pumping of the heart sends out blood under pressure to the arteries.
- *Blood pressure* is greatest in the aorta; the wall of the left ventricle is thicker than that of the right ventricle and pumps blood to the entire body.
- Blood pressure then decreases as the cross-sectional area of arteries and then arterioles increases.

Path of blood through the heart



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.
- *Systole* is the contraction of heart chambers; *diastole* is their relaxation.
- The *heart sounds*, lub-dup, are due to the closing of the atrioventricular valves, followed by the closing of the semilunar valves.

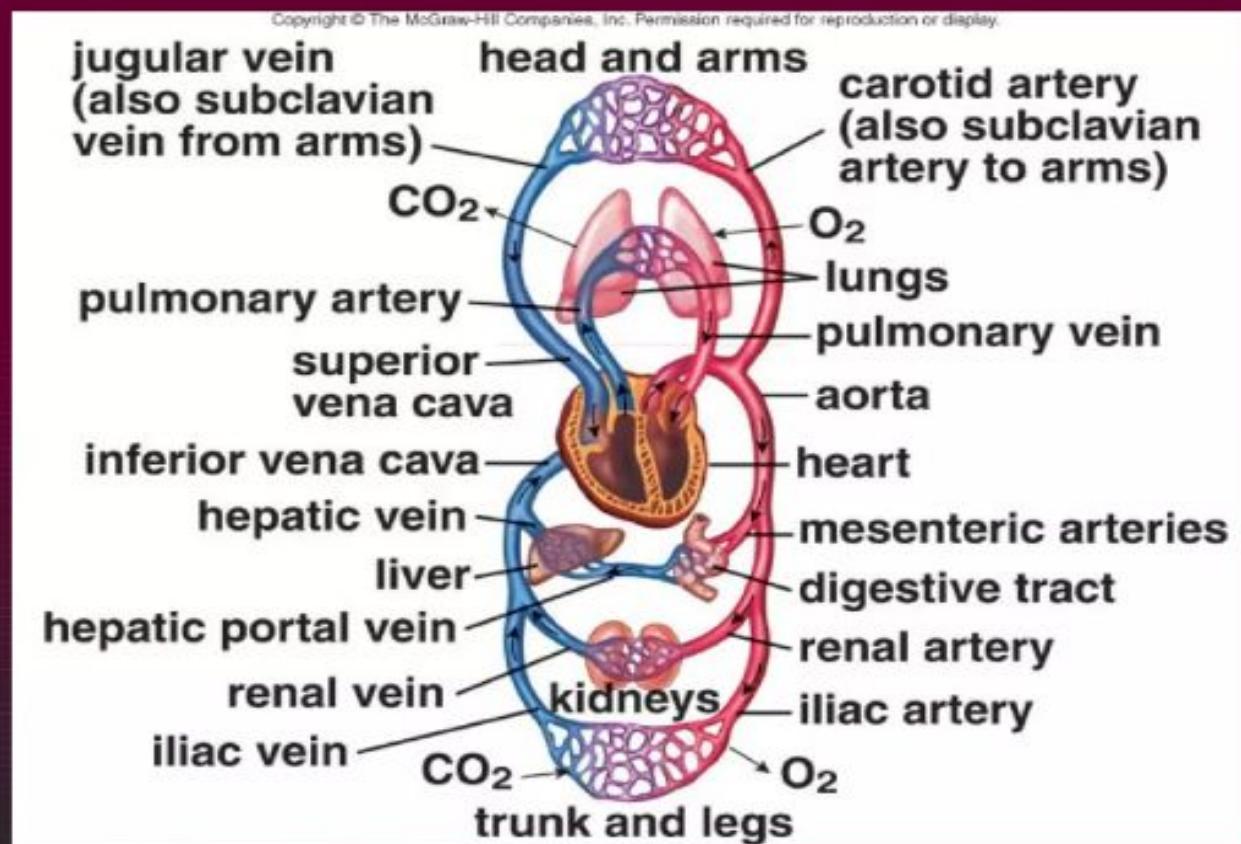
Intrinsic Control of Heartbeat

- The *SA (sinoatrial) node*, or *pacemaker*, initiates the heartbeat and causes the atria to contract on average every 0.85 seconds.
- The *AV (atrioventricular) node* conveys the stimulus and initiates contraction of the ventricles.
- The signal for the ventricles to contract travels from the AV node through the *atrioventricular bundle* to the smaller *Purkinje fibers*.

The Vascular Pathways

- The cardiovascular system includes two circuits:
 - 2) *Pulmonary circuit* which circulates blood through the lungs, and
 - 3) *Systemic circuit* which circulates blood to the rest of the body.
 - 4) Both circuits are vital to homeostasis.

Cardiovascular system diagram



The Pulmonary Circuit

- The *pulmonary circuit* begins with the *pulmonary trunk* from the right ventricle which branches into two *pulmonary arteries* that take oxygen-poor blood to the lungs.
- In the lungs, 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.

The Systemic Circuit

- The *systemic circuit* starts with the aorta carrying O₂-rich blood from the left ventricle.
- 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.
- 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 Flow

- The beating of the heart is necessary to homeostasis because it creates pressure that propels blood in arteries and the arterioles.
- Arterioles lead to the capillaries where nutrient and gas exchange with tissue fluid takes place.

Blood Flow in Arteries

- *Blood pressure* due to the pumping of the heart accounts for the flow of blood in the arteries.
- *Systolic pressure* is high when the heart expels the blood.
- *Diastolic pressure* occurs when the heart ventricles are relaxing.
- Both pressures decrease with distance from the left ventricle because blood enters more and more arterioles and arteries.

Blood

- Blood separates into two main parts: *plasma* and *formed elements*.
- Plasma accounts for 55% and formed elements 45% of blood volume.
- Plasma contains mostly water (90–92%) and plasma proteins (7–8%), but it also contains nutrients and wastes.
- *Albumin* is a large plasma protein that transports bilirubin; *globulins* are plasma proteins that transport lipoproteins.

Composition of blood

FORMED ELEMENTS
Red Blood Cells (erythrocytes)  4 million–6 million per mm ³ blood
White Blood Cells (leukocytes) 4,000–11,000 per mm ³ blood
Granular leukocytes
• Basophils  20–50 per mm ³ blood
• Eosinophils  100–400 per mm ³ blood
• Neutrophils  3,000–7,000 per mm ³ blood

FORMED ELEMENTS
Agranular leukocytes
• Lymphocytes  1,500–3,000 per mm ³ blood
• Monocytes  100–700 per mm ³ blood
• Platelets (thrombocytes)  150,000–300,000 per mm ³ blood

PLASMA
Water (90–92% of plasma)
Plasma proteins (7–8% of plasma)
Albumin
Globulins
Fibrinogen
Salts (less than 1% of plasma)
Gases
Oxygen
Carbon dioxide
Nutrients
Lipids
Glucose
Amino acids
Nitrogenous wastes
Urea
Uric acid
Other
Hormones, vitamins, etc.

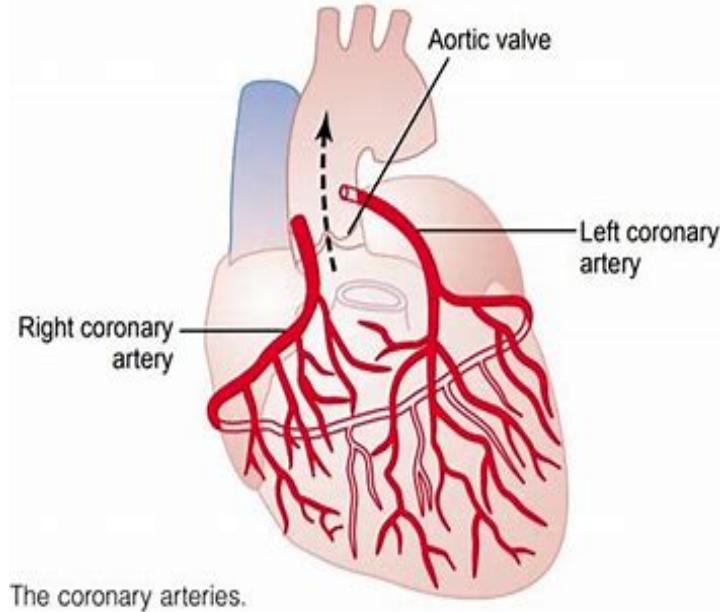


Cardiovascular Disorders

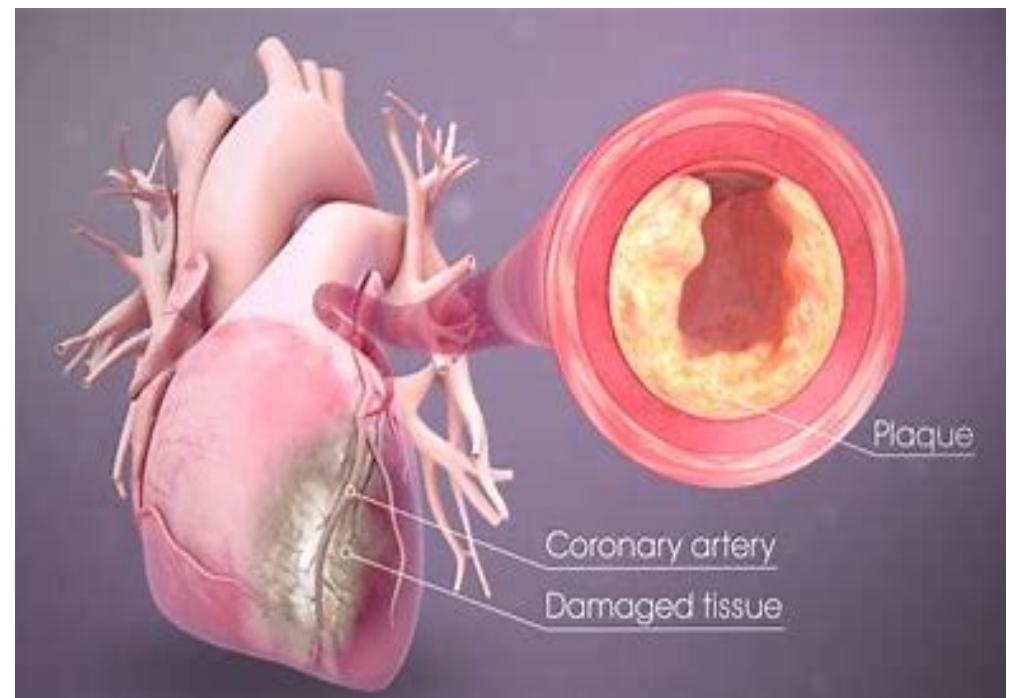
- *Cardiovascular disease (CVD)* is the leading cause of death in Western countries.
- Modern research efforts have improved diagnosis, treatment, and prevention.
- Major cardiovascular disorders include atherosclerosis, stroke, heart attack, aneurysm, and hypertension.

Coronary Circulation

- ❖ The heart has its own set of blood vessels that provide the myocardium with the oxygen and nutrients necessary to pump blood throughout the body.
 - ❖ The left and right coronary arteries branch off from the aorta and provide blood to the left and right sides of the heart.
 - ❖ The coronary sinus is a vein on the posterior side of the heart that returns deoxygenated blood from the myocardium to the vena cava.
- **Myocardial Infarction:** Commonly known as a heart attack, a Myocardial (heart muscle) infarction (tissue death).



The coronary arteries.



Hypertension

- About 20% of Americans suffer from *hypertension (high blood pressure)*.
- Hypertension is present when systolic pressure is 140 or greater or diastolic pressure is 100 or greater; diastolic pressure is emphasized when medical treatment is considered.
- A genetic predisposition for hypertension occurs in those who have a gene that codes for *angiotensinogen*, a powerful vasoconstrictor.

Stroke, Heart Attack, and Aneurysm

- A *cerebrovascular accident*, or *stroke*, results when an embolus lodges in a cerebral blood vessel or a cerebral blood vessel bursts; a portion of the brain dies due to lack of oxygen.
- A *myocardial infarction*, or *heart attack*, occurs when a portion of heart muscle dies due to lack of oxygen.

Clearing Clogged Arteries

- *Angioplasty* uses a long tube threaded through an arm or leg vessel to the point where the coronary artery is blocked; inflating the tube forces the vessel open.
- Small metal *stents* are expanded inside the artery to keep it open.
- Stents are coated with *heparin* to prevent blood clotting and with chemicals to prevent arterial closing.

Dissolving Blood Clots

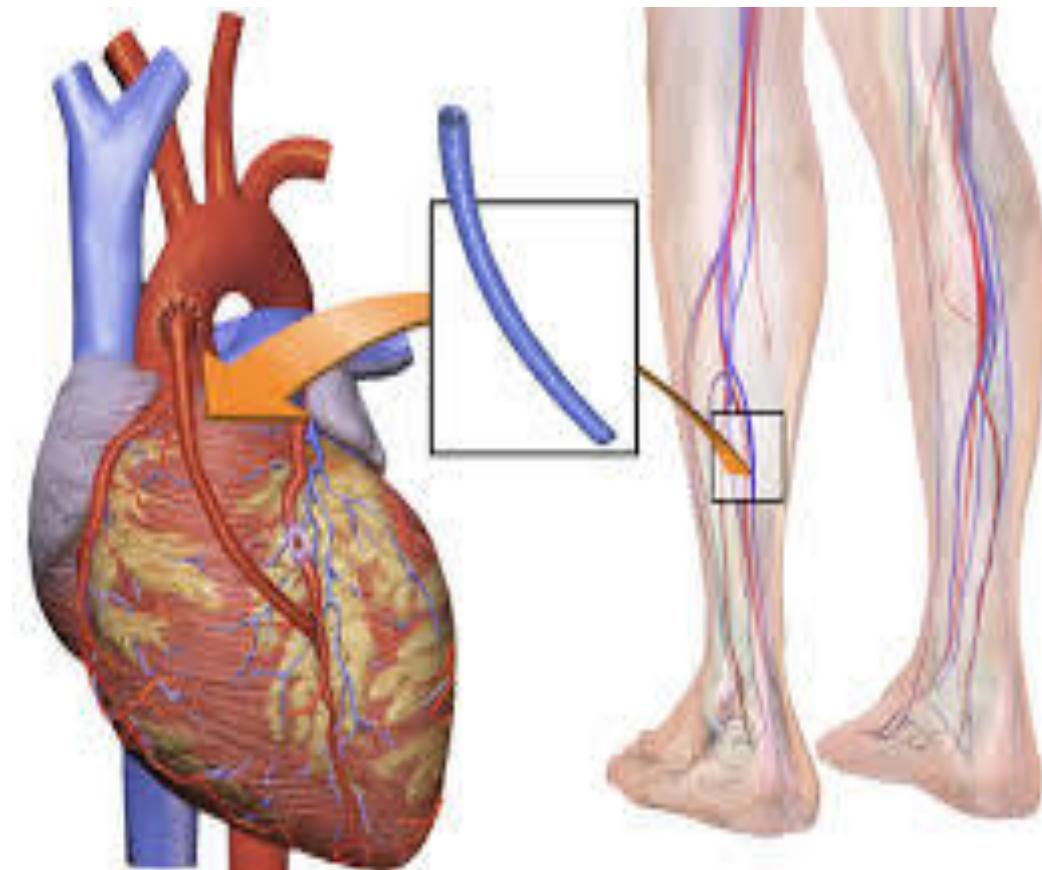
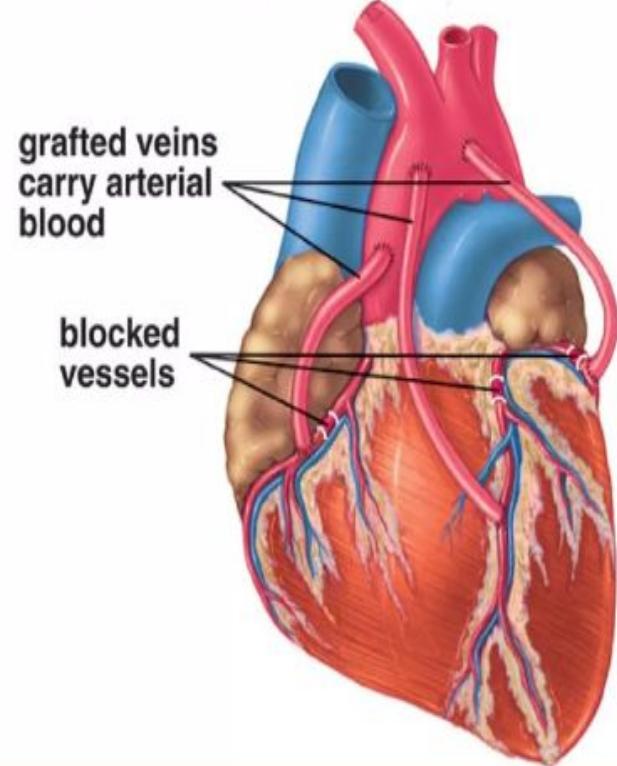
- Medical treatments for dissolving blood clots include use of *t-PA* (*tissue plasminogen activator*) that converts plasminogen into plasmin, an enzyme that dissolves blood clots, but can cause brain bleeding.
- *Aspirin* reduces the stickiness of platelets and reduces clot formation and lowers the risk of heart attack.

Coronary Bypass Operations

- A *coronary bypass operation* involves removing a segment of another blood vessel and replacing a clogged coronary artery.
- It may be possible to replace this surgery with *gene therapy* that stimulates new blood vessels to grow where the heart needs more blood flow.

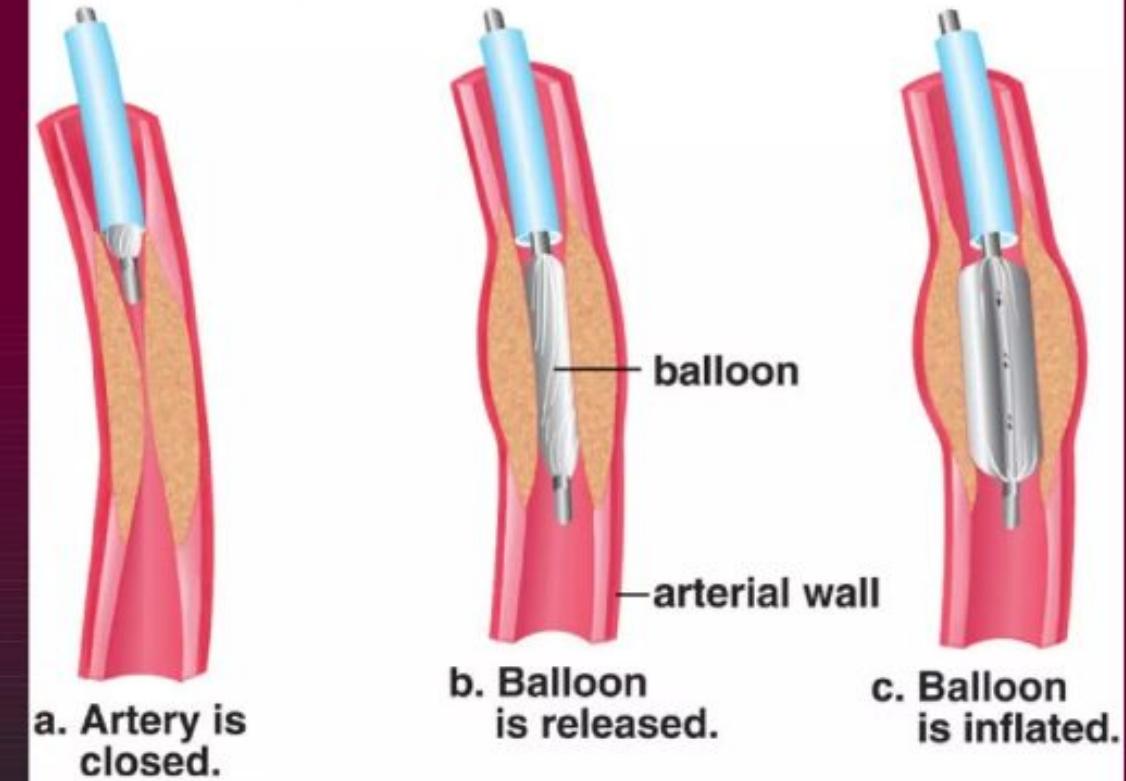
Coronary bypass operation

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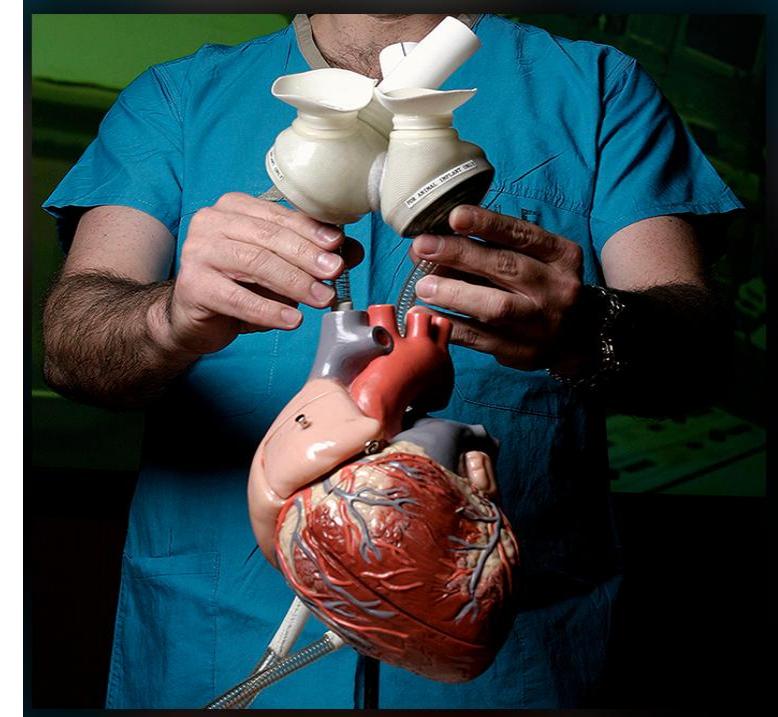


Angioplasty

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- A **heart transplant** is an operation in which a failing heart is replaced with a healthier donor heart.
- A heart transplant, or a cardiac transplant, is a surgical transplant procedure performed on patients with end-stage heart failure or severe coronary artery disease when other medical or surgical treatments have failed.
- As of 2018 , the most common procedure is to take a functioning heart, with or without both lungs, from a recently deceased organ donor (brain death is the standard) and implant it into the patient. Their family members elect to donate their organs.
- In the meantime, heart patients awaiting a transplant must rely on mechanical devices, which can increase the risk of infection, blood clots and bleeding in the patient.
- A proposed alternative has been to use animal hearts in human patients, which is known as “**xenotransplantation.**” **pig heart**



Heart Transplants and Artificial Hearts

- *Heart transplants* are routinely performed but immunosuppressive drugs must be taken thereafter.
- There is a shortage of human organ donors.
- Work is currently underway to improve self-contained *artificial hearts*, and muscle cell transplants may someday be useful.