University of Al- Mustaqbal

College Of Nursing First stage/2nd semester

Physiology of Circulatory System

Lecture 5

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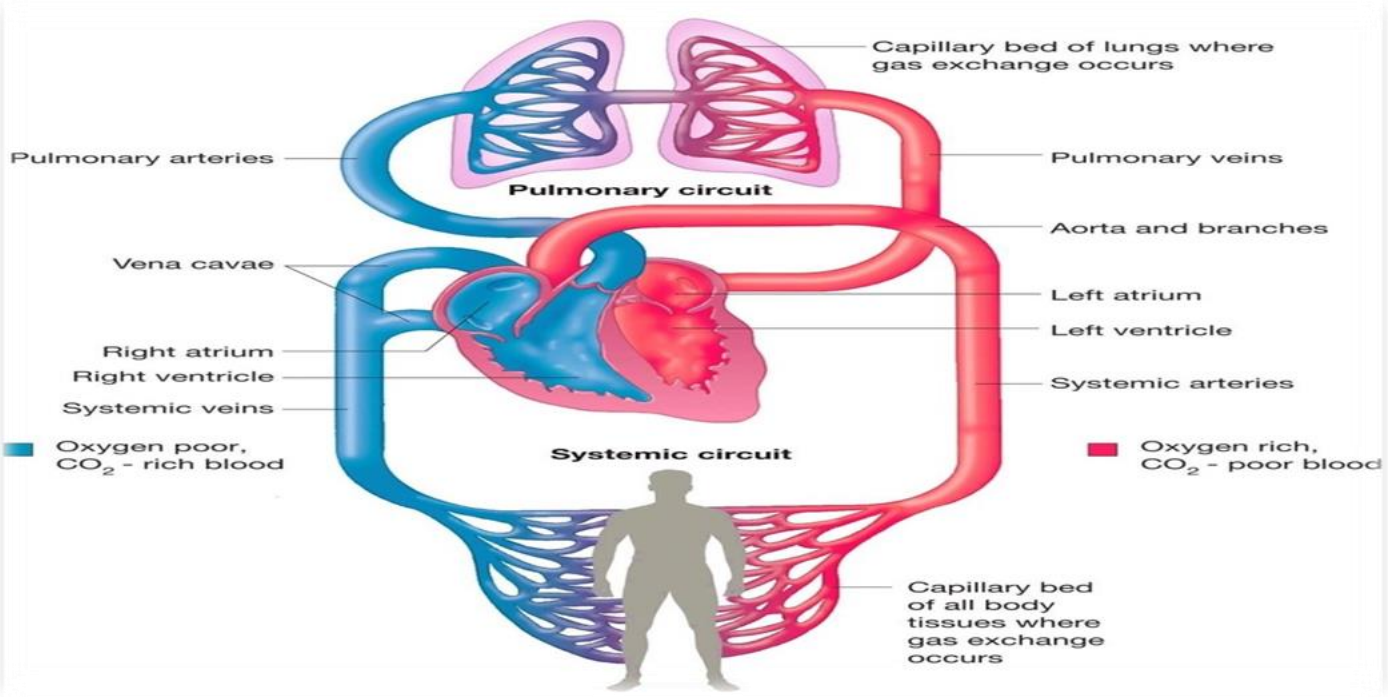
Physiology of circulatory system

Introduction

The circulatory system is considered as the transport system of the body. This system has three main components: the heart, the blood vessels and the blood itself.



Blood vessels

Blood vessels are part of the circulatory system. There are three main types of blood vessels: arteries, veins and capillaries.

- ***Arteries***

Transport blood from the heart to the tissue under high pressure. It has a thicker, more muscular wall with extensive development of elastic tissue when compared with a vein, to cope with the extra pressure from the force of the heart's pumping.

- ***Arterioles***

They are the smallest branches of the arteries. Their walls have less elastic tissue than arteries. They are the site of the highest resistance to the blood flow.

Blood vessels

Capillaries

- Capillaries are the smallest of blood vessels. They serve to distribute oxygenated blood from arteries to the tissues of the body and to feed deoxygenated blood from the tissues back into the veins.

Venules and veins

- The venules collect blood from the capillaries and coalesce to larger veins.
- Veins drain blood back from the body to the heart. It has thin, flexible walls when compared to an artery.

Volume of blood in the different parts of the circulation

1. About 16 % is in the heart and lungs.

Approximately:

a) 7 % in the heart.

b) 9 % in the pulmonary vessels(pulmonary circulation).

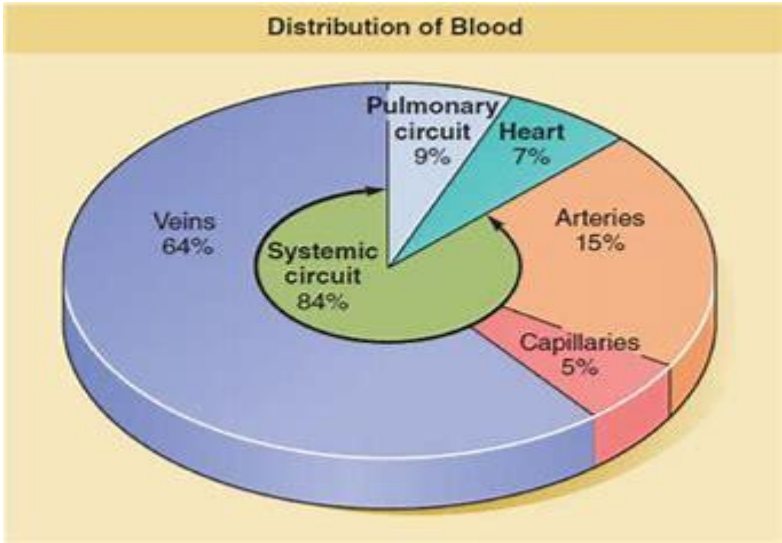
2. 84 % of the blood volume in the systemic circulation.

Approximately:

a) 64 % is in the veins.

b) 15 % is in the arteries.

c) 5% is in the arterioles and capillaries.



Blood flow(cardiac out put):

- Blood flow means the quantity of blood that passes to a given point in the circulation in a given period of time.
- The overall all blood flow in the total circulation abut 5000ml/min.
- This is called cardiac out put because it is the amount of blood pumped into the aorta by the heart each minute.

Function of circulatory system :

1-Transfer of oxygen and nutrition to all body cells.

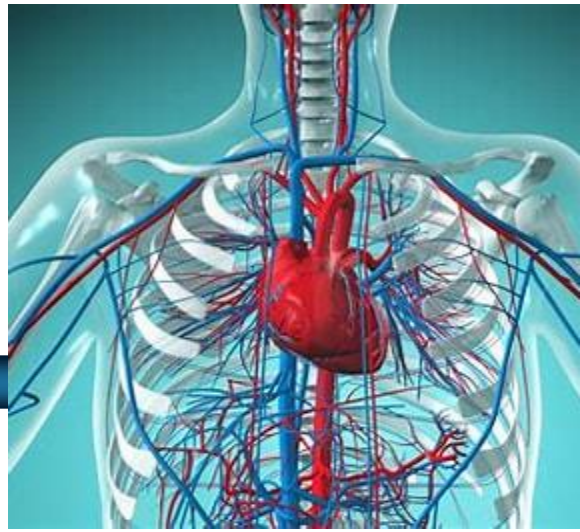
2- Transfer of waste product and carbon dioxide from all body cells to kidneys and lungs for excretion.

3- Regulation of heat.

4- Distribution of hormones.

5- Aid the body for defense by immunity.

The Heart



- It is the central component of the circulatory system.
- The heart is a cone-shaped, hollow, muscular pump.
- The heart located in the mediastinum between the lungs. Slightly left of the sternum. Enclosed by double layer called pericardial (fibrous outer pericardial layer attach to organ surround the heart, serous inner pericardial layer attach to heart muscle).
- A coating of fluid separated the two layers of membrane, letting the heart move as it beats.
- The adult heart has a mass of between 250- 350 gram and is about the size of a clenched fist.
- The average of heart beats 100,000 times/days. Pumping 7,571 liters of blood

Heart Anatomy

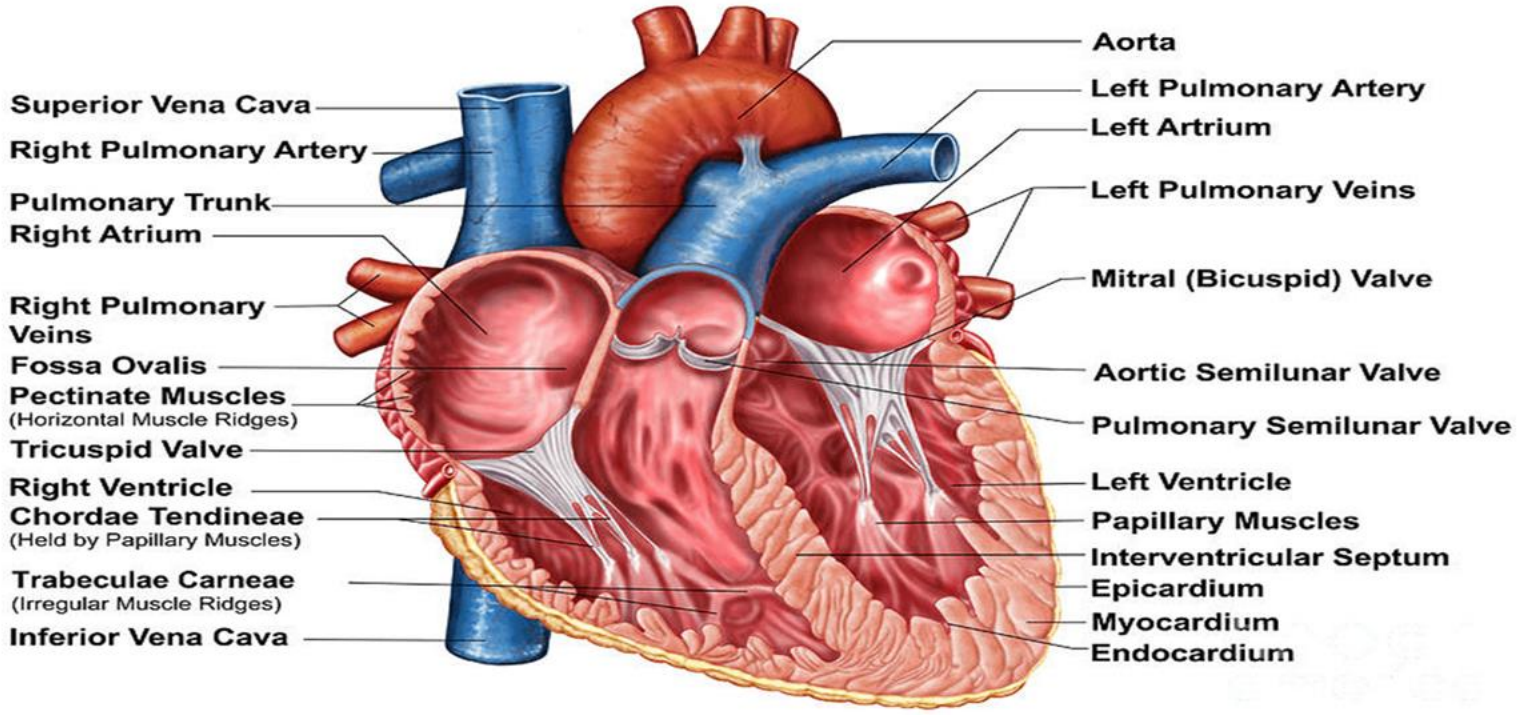


image via: wikipedia.com

Layers:.

The heart wall consists of three layers:

1. Epicardium: Outer layer (visceral pericardium) with adipose tissue and coronary vessels.

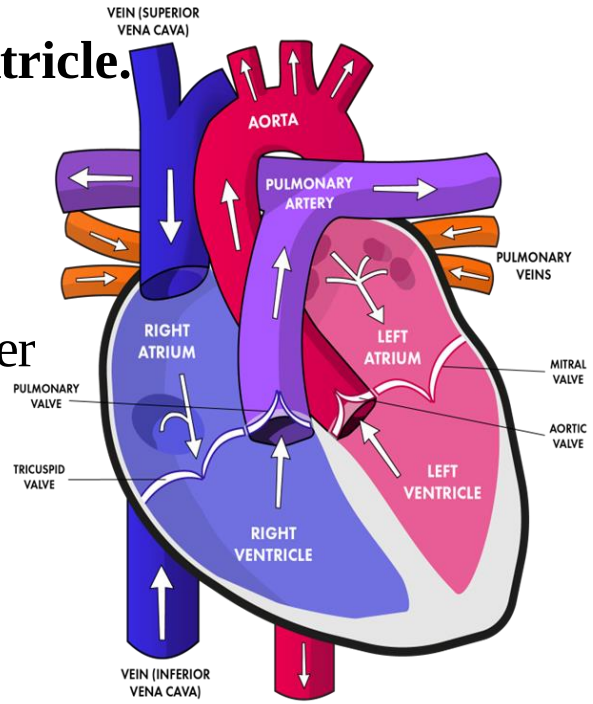
2. Myocardium: middle layer (gap junctions for electrical coupling) its composed of cardiac muscle tissue. The myocardium is the thickest of the three heart wall layers.

3. Endocardium: Inner Endothelial lining of heart. Its continuous with blood vessels and covers the surface of valves.

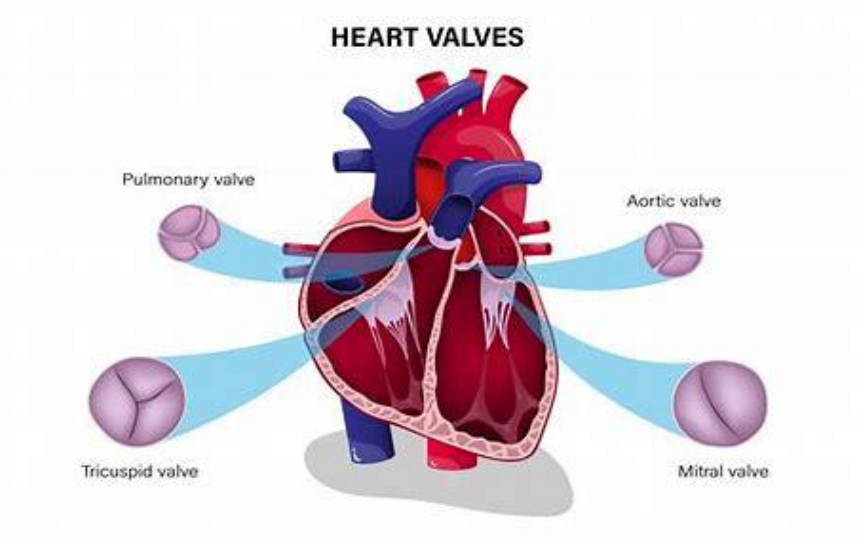
Heart Chambers functions :

The heart acts as two separate pumps, right and left sides that is composed of an atrium and a ventricle.

- Upper champers are called left and right **Atria.**
- The lower chambers called the left and right **Ventricle.**
- A wall of muscle called septum separates the left
- and right atria and ventricles.
- The left ventricles is largest and strongest chamber in the heart.



Valves:



There are four valves in the heart:

1 - Atrioventricular (AV) valves: Tricuspid (right), Mitral (left).

-Tricuspid Valve (Right AV): Has three cusps (flaps).

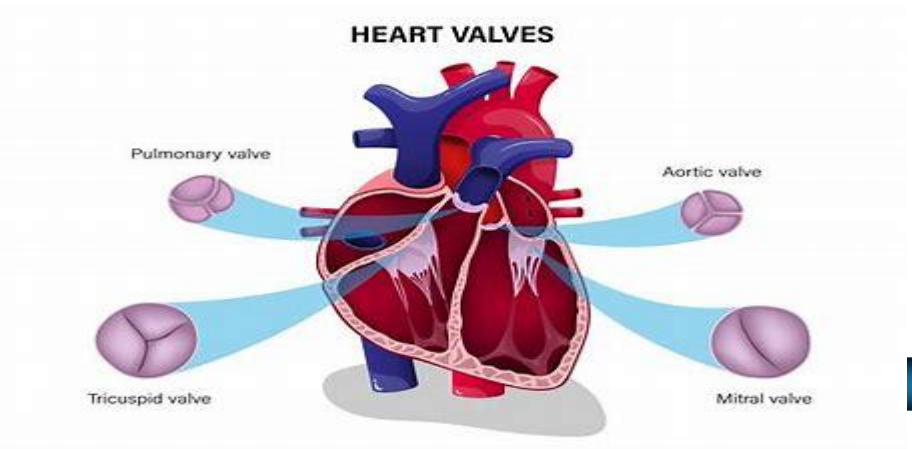
Located between the right atrium and the right ventricle. Prevents backflow of blood into the right atrium.

-Mitral Valve (Left AV or Bicuspid Valve): Has two cusps.

Located between the left atrium and the left ventricle.

Prevents backflow of blood into the left atrium.

VALVES ....



2. Semilunar valves: Pulmonary (right), Aortic (left).

-Pulmonary Valve : Has three crescent-shaped cusps. Located between the right ventricle and the pulmonary artery.

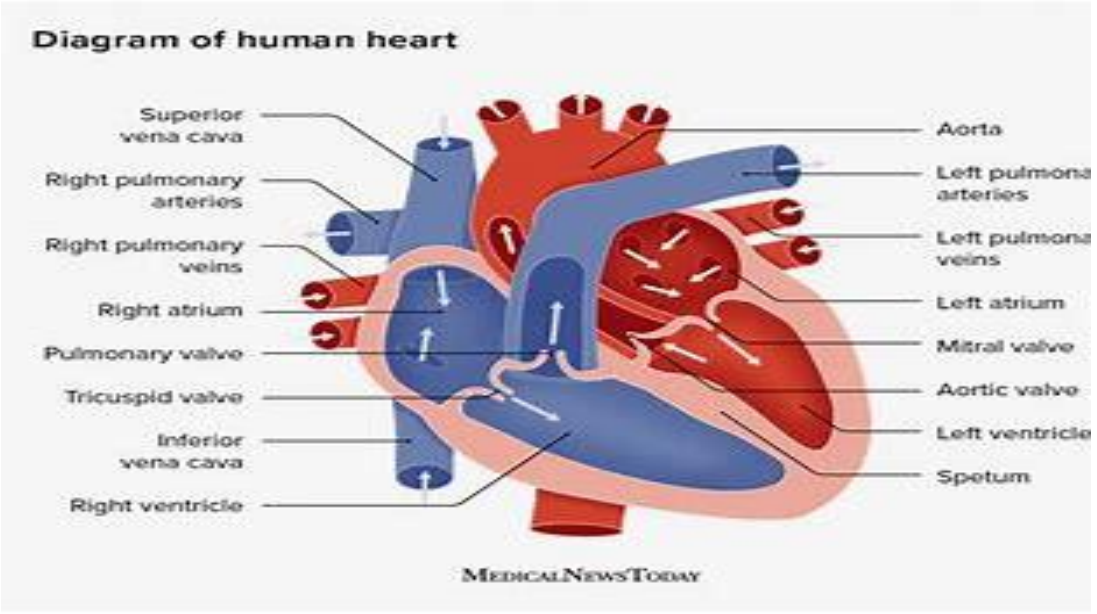
Prevents blood from flowing back into the right ventricle after it is pumped into the pulmonary artery.

-Aortic Valve: Also has three cusps. Located between the left ventricle and the aorta.

Prevents blood from flowing back into the left ventricle after it is pumped into the aorta.

Heart as a pump:

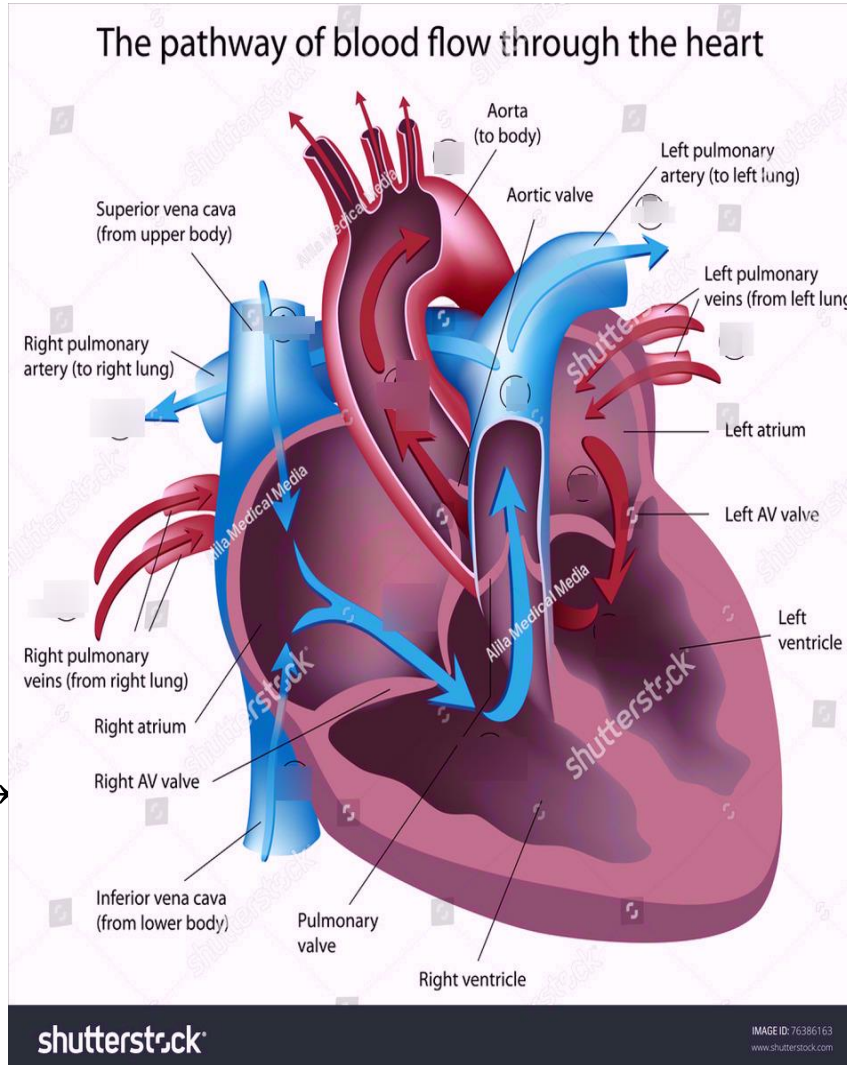
- The right heart pumps the blood through the lungs.
- The left heart pumps blood through the systemic circulation that provides blood flow to the organs and tissues of the body.
- Each side is a pulsatile two-chamber pump.



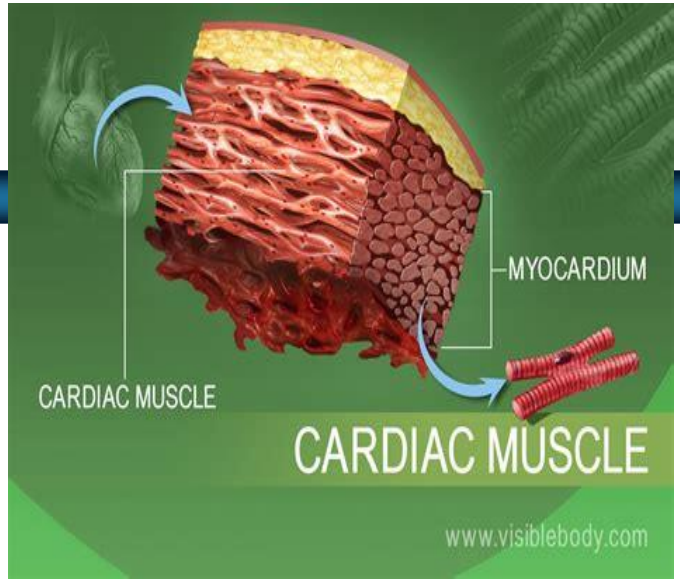
Heart as a pump:

The heart pumps blood through two main circuits:

- **Pulmonary circulation** (right heart):
  - Deoxygenated blood flows from the body → right atrium → right ventricle → pulmonary artery → lungs for oxygenation.
- **Systemic circulation** (left heart):
  - Oxygenated blood from the lungs → left atrium → left ventricle → aorta → distributed to the body.



Cardiac muscle:



The heart is composed of three major types of cardiac muscle:

1. Atrial muscle.
2. Ventricular muscle.

   Contract in much the same way as skeletal muscle.

3. Specialized excitatory and conductive muscle fibers.

Exhibit either automatic rhythmical electrical discharge in the form of action potentials or conduction of the action potentials through the heart, providing an excitatory system that controls the rhythmical beating of the heart.

Cardiac Muscles Properties

1-Excitability :

- The ability of cardiac cells to respond to stimuli (usually electrical signals).

2. Automaticity:

- The heart's ability to generate its own electrical impulses without external stimuli.

3-Conductivity:

- The ability of cardiac cells to transmit electrical impulses from one cell to another.

4. Contractility:

- The ability of cardiac muscle fibers to shorten and generate force in response to electrical stimulation.

Electrical Conduction System

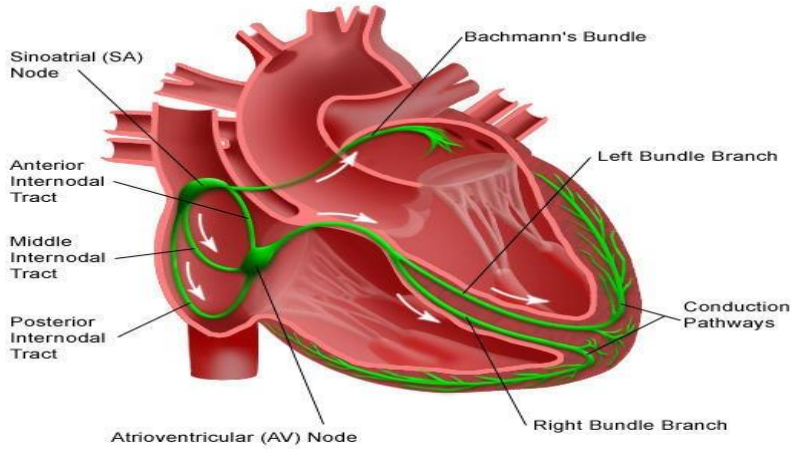
1-The sino-atrial node (SA node) .

2- The internodes atrial pathway .

3- The atrio-ventricular node (AV node)

4-The bundle of His and its branches .

5- Purkinje fibers.



- **SA Node (sinus node, pacemaker):** Located in the right atrium .
- generate a normal rhythmical impulses(cardiac action potential) pass through the atrial pathways to the **AV node.**
- determining the rate at which the heart beats **(~60–100 bpm).**

Electrical Conduction System

- **AV Node:** Located at the junction between the atria and ventricles. Receives the impulse from the SA node.

Delays the impulse about 0.1 second to allow atrial contraction before ventricular activation.

This delay is shortened by stimulation of sympathetic nerves to heart.

-Bundle of His:

•Located in the septum between the ventricles. Transmits the electrical impulse from the AV node to the ventricles.

Electrical Conduction System

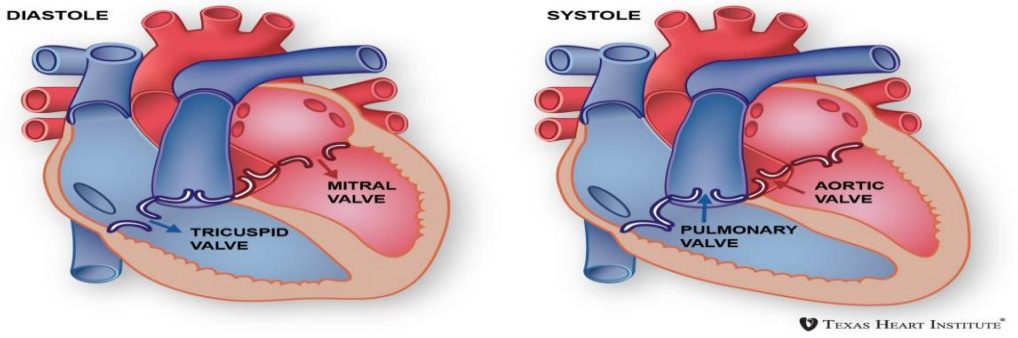
- Right and Left Bundle Branches:

•Carry the impulse down the interventricular septum. Direct the impulse towards the apex of the heart.

- Purkinje Fibers:

•Conduct the impulse rapidly to the ventricular muscle, causing it to contract.

Cardiac Cycle



- It is the inclusive period of time from the start of one heartbeat to the initiation of the next.
- In each cardiac cycle, there are alternate contractions and relaxation of all chambers.

- Systole (Contraction Phase): a period of contraction.

- Diastole (Relaxation Phase): during which the heart fills with blood.

Chambers relax, allowing blood to fill the heart (coronary arteries perfuse during this phase).

- Duration of the cardiac cycle ,if the HR is 72b/m the duration of cardiac cycle is1/72 about 0,833second per minute.

Heart Sounds

Heart sounds are produced by valve closures:

•**S1 (Lub)**: Closure of the atrioventricular valves (tricuspid and mitral) during ventricular systole.

•**S2 (Dub)**: Closure of the semilunar valves (pulmonary and aortic) during ventricular diastole.

Regulation of Heart pumping

at rest, the heart pumps only 4 to 6 liters of blood each minute.

During strenuous exercise, the heart may be required to pump **four to seven times this amount.**

The basic means by which the volume pumped by the heart is regulated are:

(1) Intrinsic cardiac regulation of pumping in response to changes in volume of blood flowing **(venous return)** into the heart.

(2) Control of heart rate and strength of heart pumping by the autonomic nervous system.

Blood supply to the heart

The heart is supplied by two coronary arteries (right and left) distal to the aortic valve.

1 - **Left Coronary Artery: it gives the following branches:**

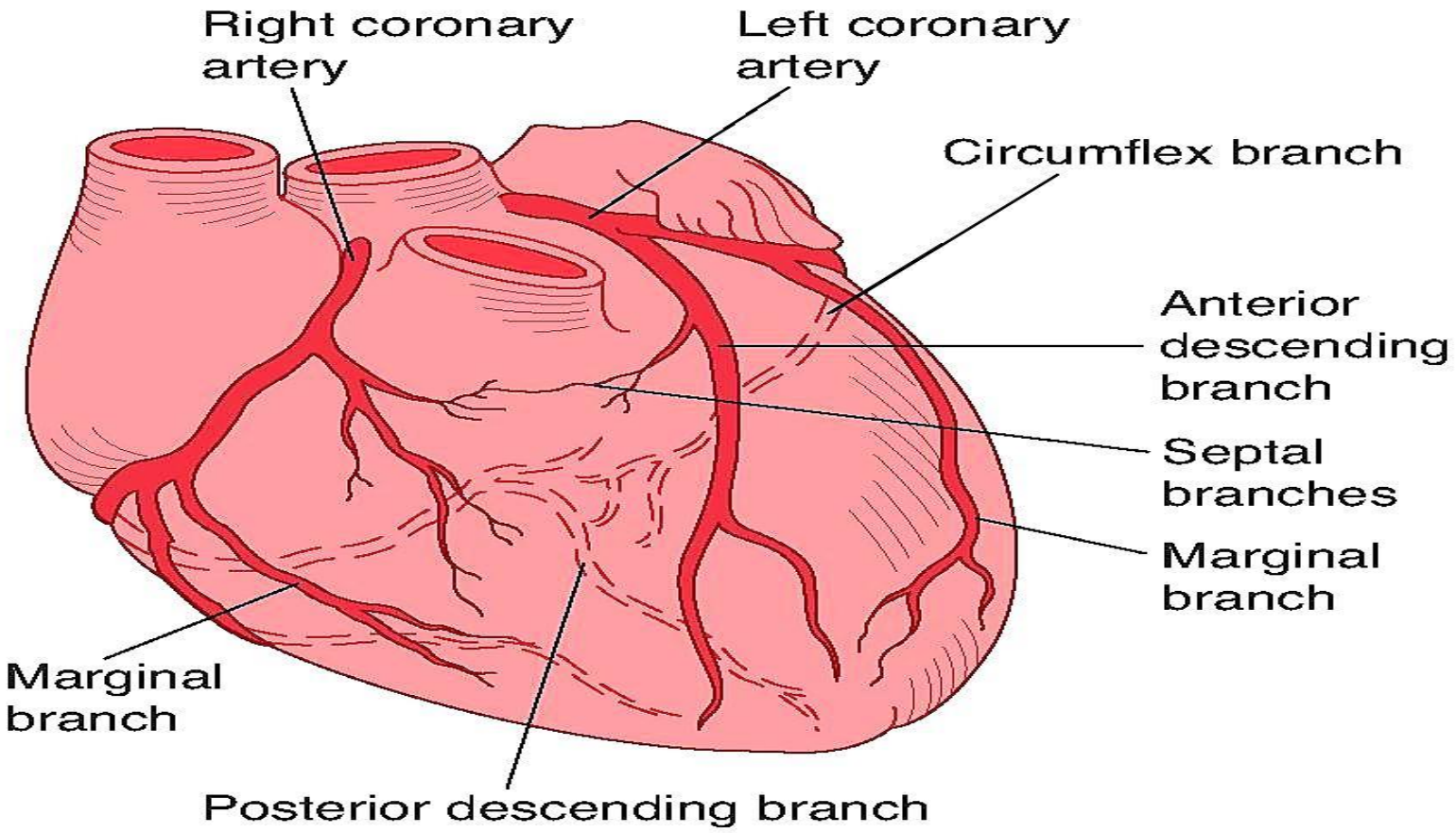
- Left Anterior Descending (LAD): Supplies LV anterior wall and septum.

- Left circumflex Artery: Supplies left atrioventricular LA and LV lateral wall.

2- Right Coronary Artery (RCA): Supplies RA, RV, SA node (60% of people), and inferior LV**.**

Coronary veins drain into a single large vein, then coronary sinus, which drain into the right atrium.

Blood supply to the heart



Thanks a lot