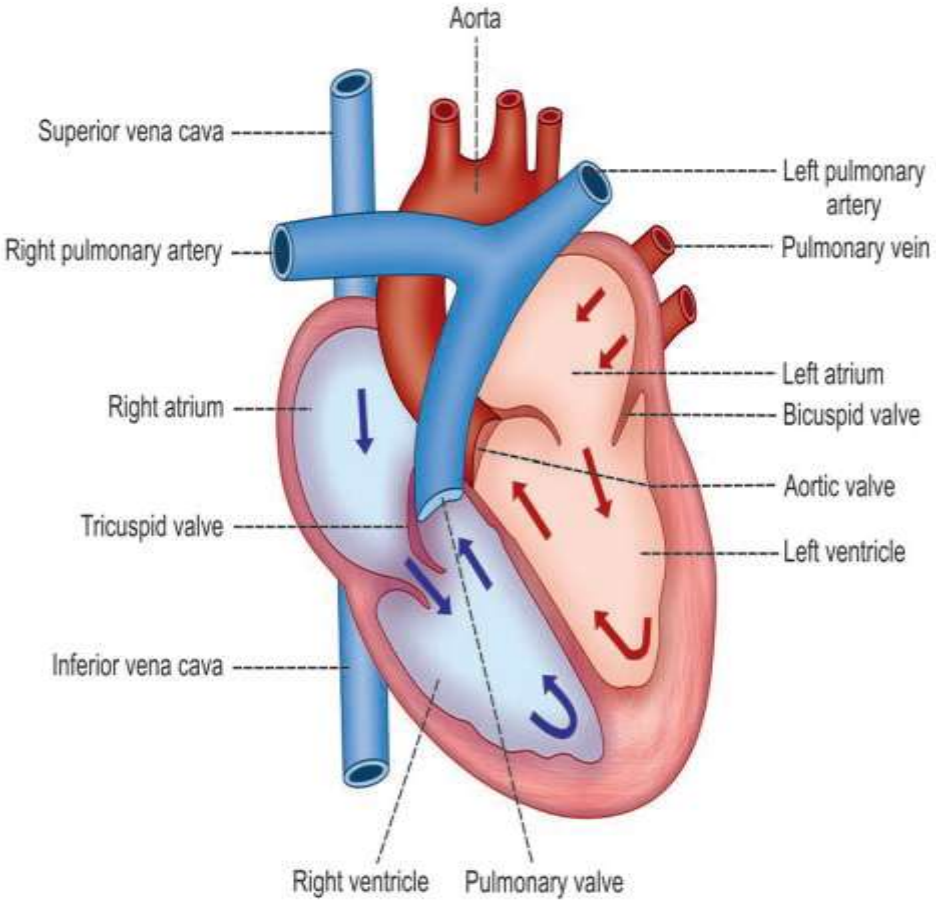
CARDIOVASCULAR SYSTEM

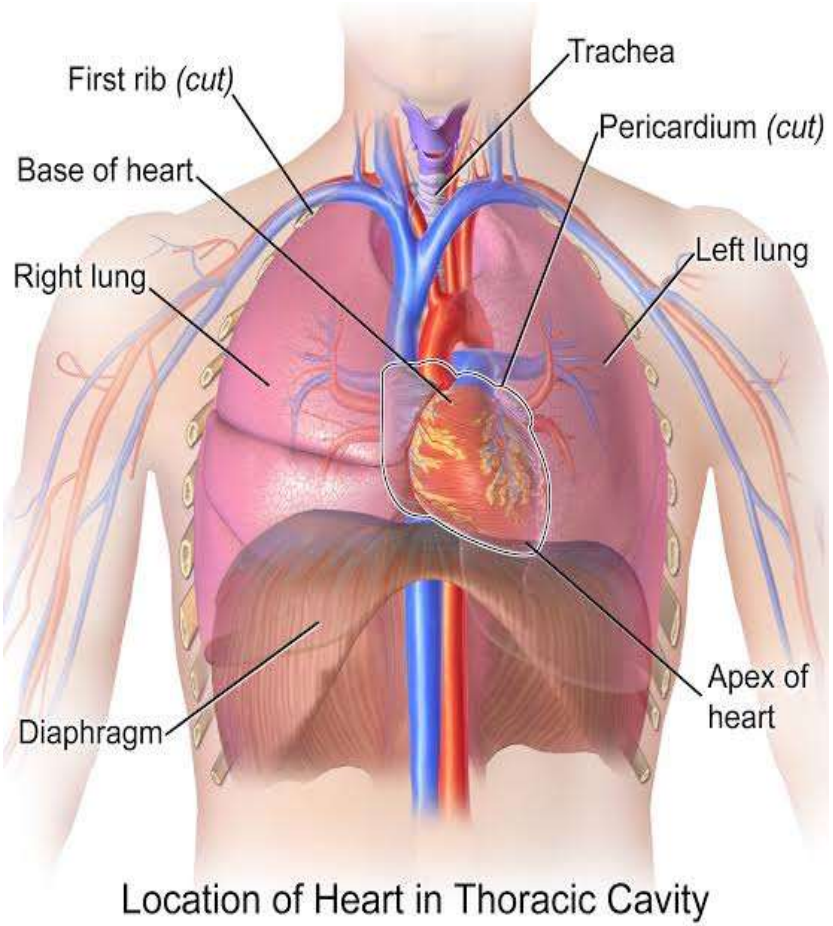
- Heart – anatomy of heart
- Blood circulation
- Blood vessels, structure and functions of artery, vein and capillaries
- Conduction system of heart
- Cardiac output,
- Cardiac cycle.
- Regulation of blood pressure, pulse, electrocardiogram and disorders of heart

Cardio-heart :Vascular-blood vessels

CARDIOVASCULAR SYSTEM:

- ✓ In order to pump blood through the body, the heart is connected to the vascular system of the body.
- ✓ It is the closed system designed to transport oxygen and nutrients to the cells of the body and remove carbondioxide and metabolic products from the body.





Location of Heart in Thoracic Cavity

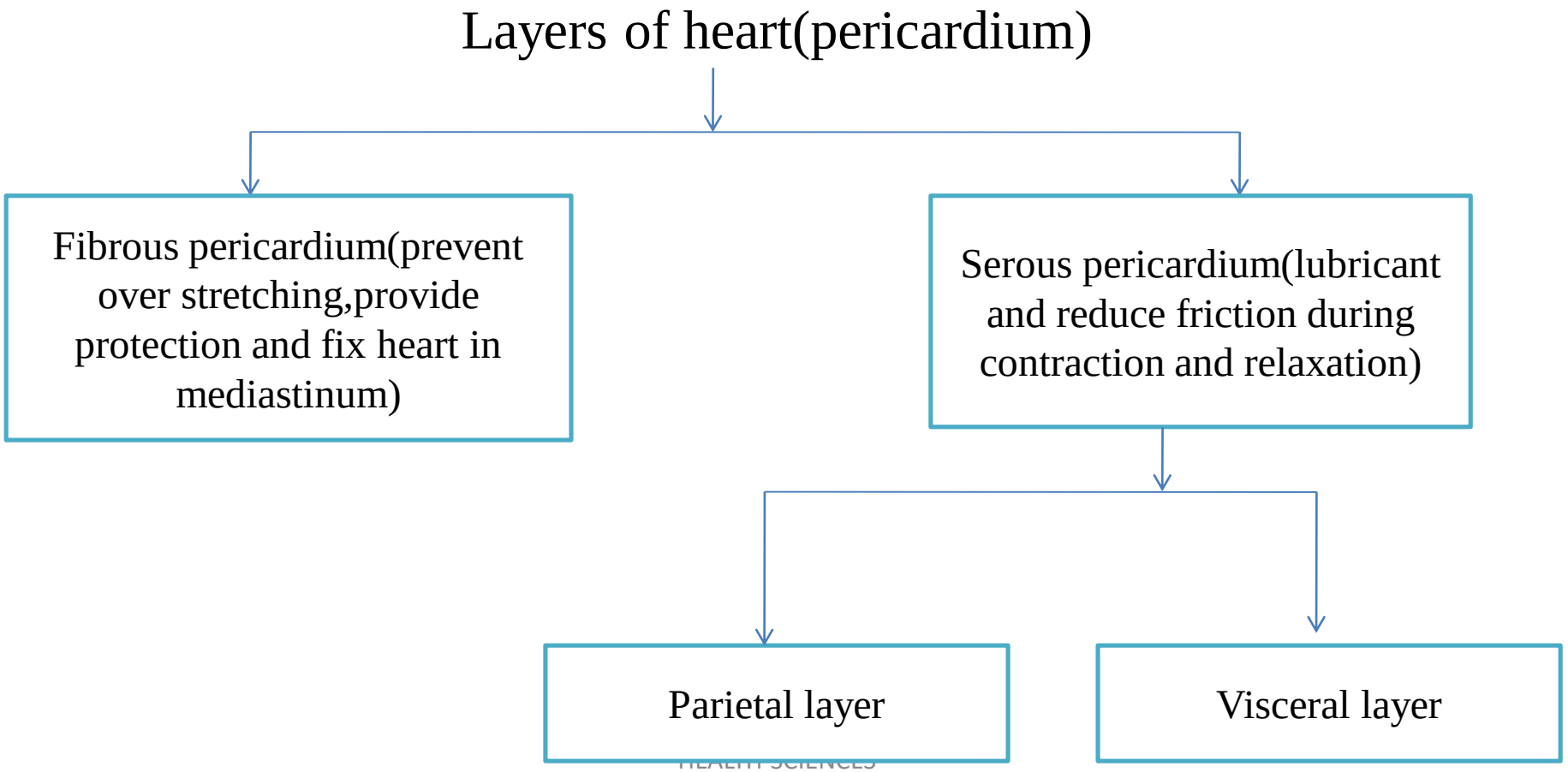
LOCATION

- Cone shaped heart is relatively small, about the same size of closed fist of person.
- It is 12 cm long, 9cm wide and 6 cm thick
- Average weight-300 gm
- It has 4 chambers- 2 atrium or atria

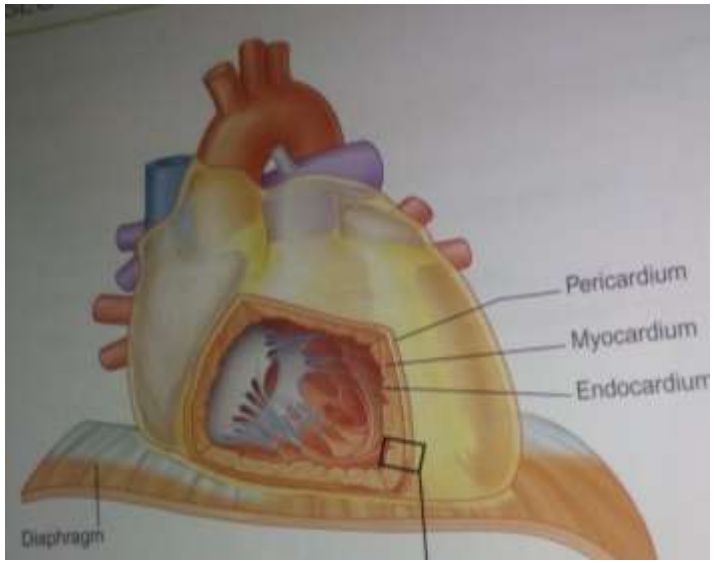
  2 ventricles
- It is located near to the middle of thoracic cavity in the mediastinum(space between lungs) and its rest on the to the diaphragm.
- About two third of the mass of the heart lies to the left of the body's midline.
- Pointed end portion tip of left ventricle apex and wide margin is called base.

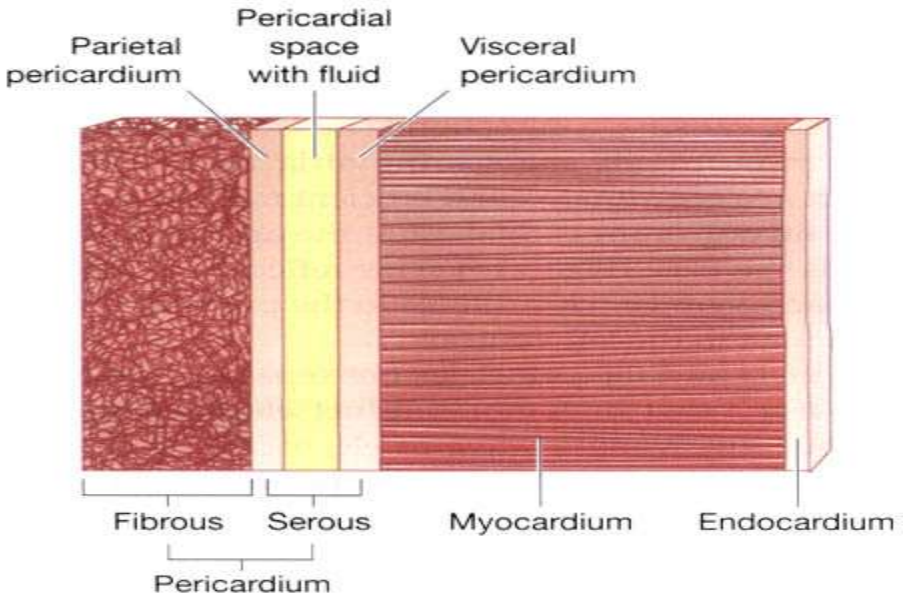
Layers of the heart:

Heart layer is formed by pericardium which is triple layered fluid filled sac that surrounds and protects the heart



WALLS OF THE HEART





Epicardium-composed of connective tissue

Myocardium-cardiac muscle tissue(responsible for pumping action of heart)

Endocardium-Epithelial tissue

INTERIOR OF THE HEART

- The heart is divided into right and left side by partition known as the septum(interatrial septum and inter ventricular septum) made up of myocardium covered by epithelium.

I)Chambers of heart:

- It consists of chambers –a) 2 superior chambers(right and left atrium)

  -b) 2 inferior chambers(right and left ventricles)

- The atrial wall is thin and the ventricular wall is thick
- The blood from left ventricle enters aorta and blood from right ventricle enters lungs

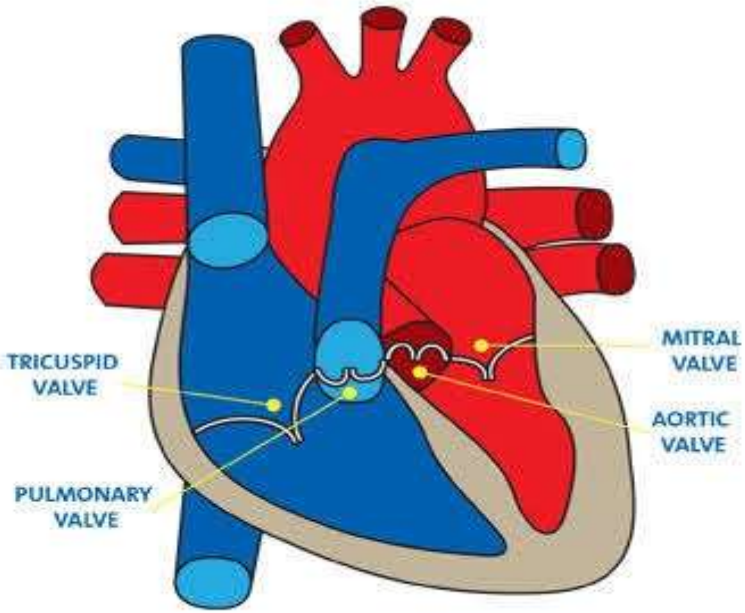
VALVES OF HEART

Atrio ventricular valve -(i) tricuspid valve (between right atrium and right ventricle).

(ii) bicuspid valve(between left atrium and left ventricle).

Semilunar valve (all are tricuspid)-(i) pulmonary valve(between right ventricle and lungs).

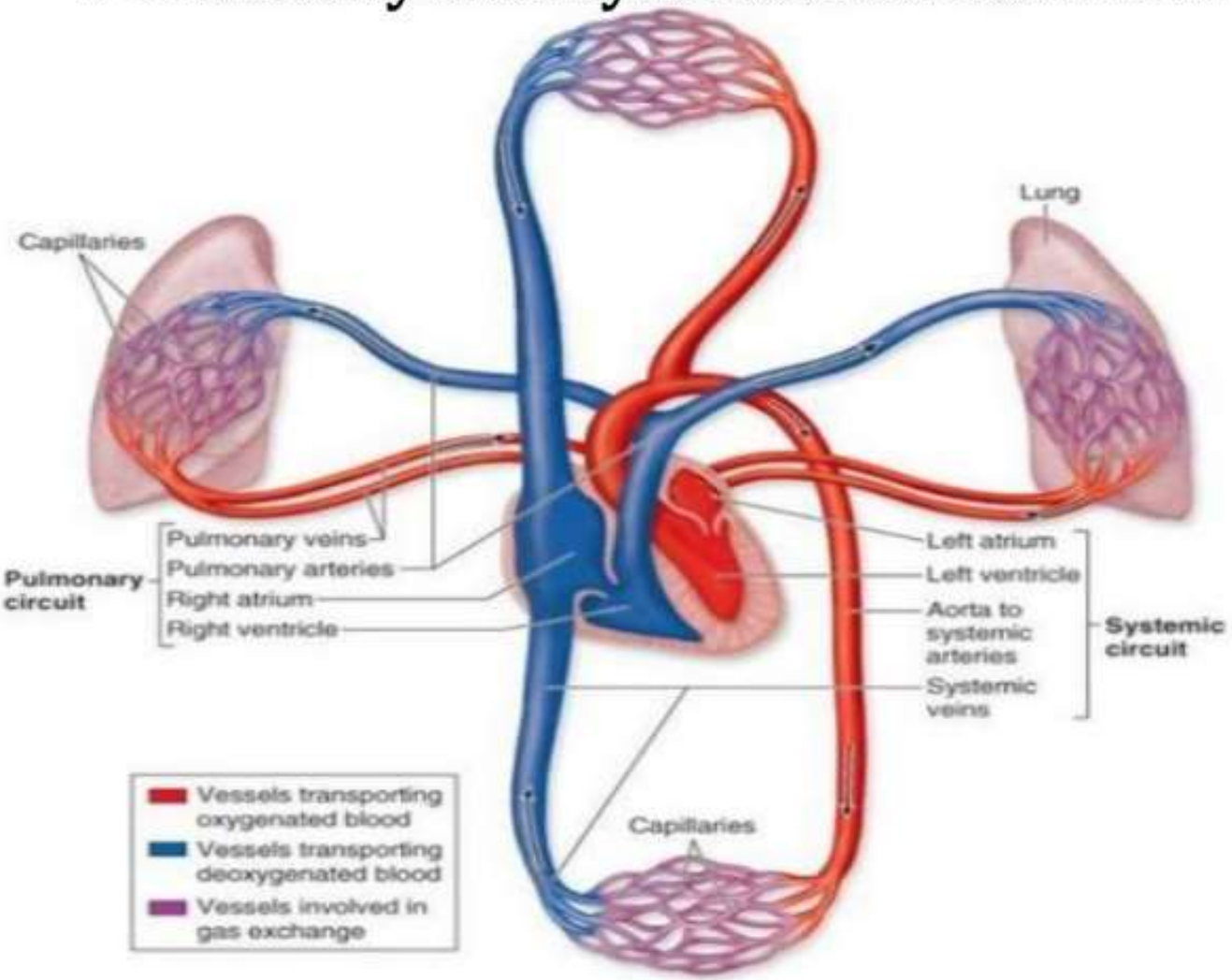
(ii)aortic(between left ventricle and aorta).



Blood circulation

- Pulmonary circulation
- Systemic circulation
- Coronary circulation
- Hepatic portal circulation

Pulmonary and Systemic Circulations



PULMONARY CIRCULATION

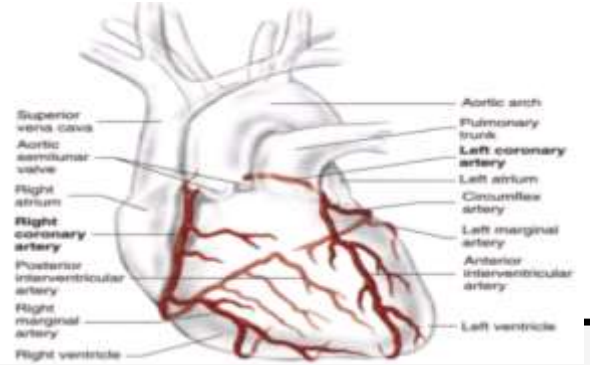
1) In the body system cells receives oxygen from blood and gives carbondioxide in to blood so blood becomes deoxygenated
2) The deoxgenated blood with the help of superior,inferior venacava and coronary sinus transfer into the right atrium
3) Right atrium flow this deoxygenated blood into the right ventricle with the help of tricuspid valves
4) Right ventricle pumps blood into pulmonary trunk via pulmonary semilunar valve
5) The pulmonary trunk divided into right and left pulmonary artery,the right pulmonary artery gives blood to right lung and left pulmonary artery gives blood to left lungs

SYSTEMIC CIRCULATION

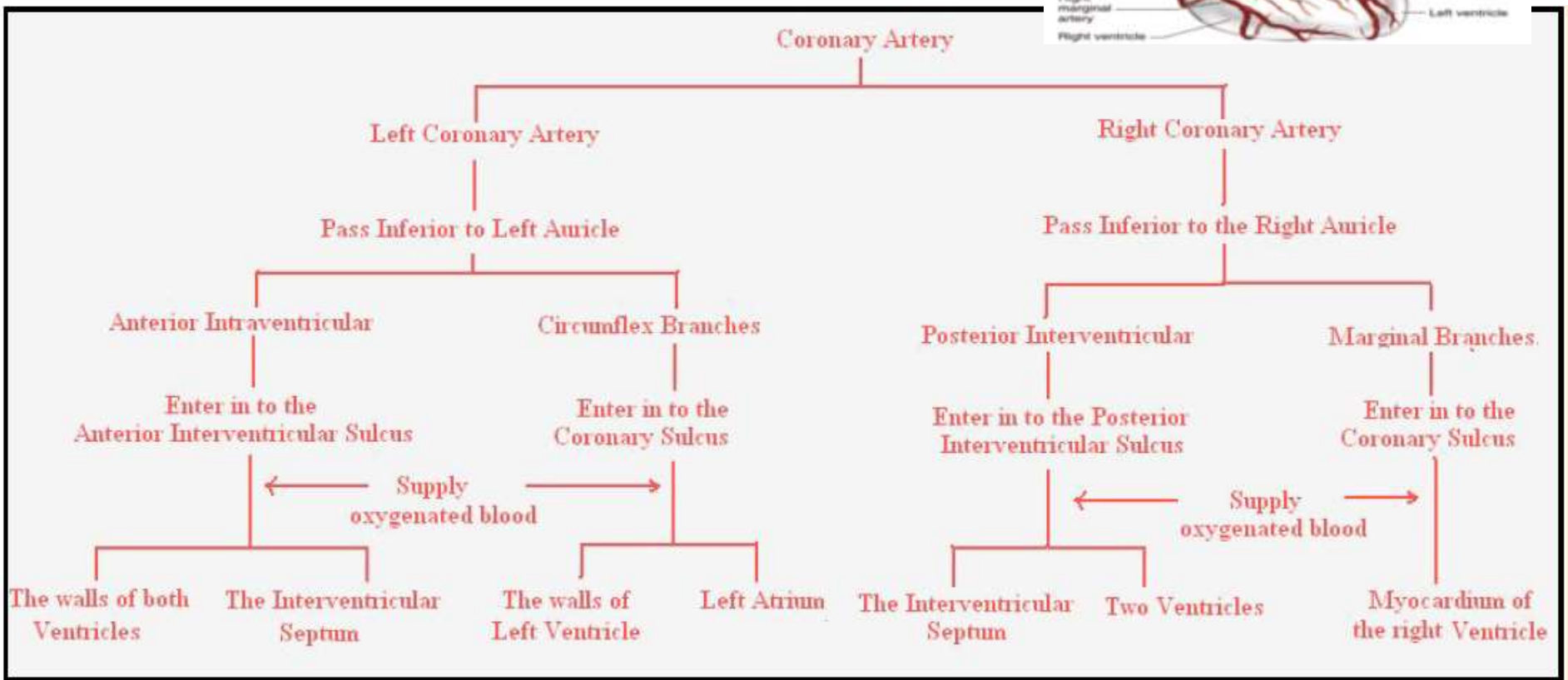
1) In the lungs blood becomes oxygenated means it gain O_2 and loss CO_2
2) now the oxygenated blood returns in to heart through pulmonary veins
3) Then pulmonary vein pass blood in the left atrium which pumps blood in to left ventricle with the help of bicuspid valve
4) Then through left ventricle blood enters into aorta with the help of aortic valve
5) Finally blood flows in systemic circulation from aorta and reach near to each and every cells of the body and gives O_2 and take CO_2
6) Again the deoxygenated blood flow through pulmonary circulation

CORONARY CIRCULATION

- It supplies oxygenated blood to the heart
- It arises from the ascending aorta and divided into left and right coronary branches

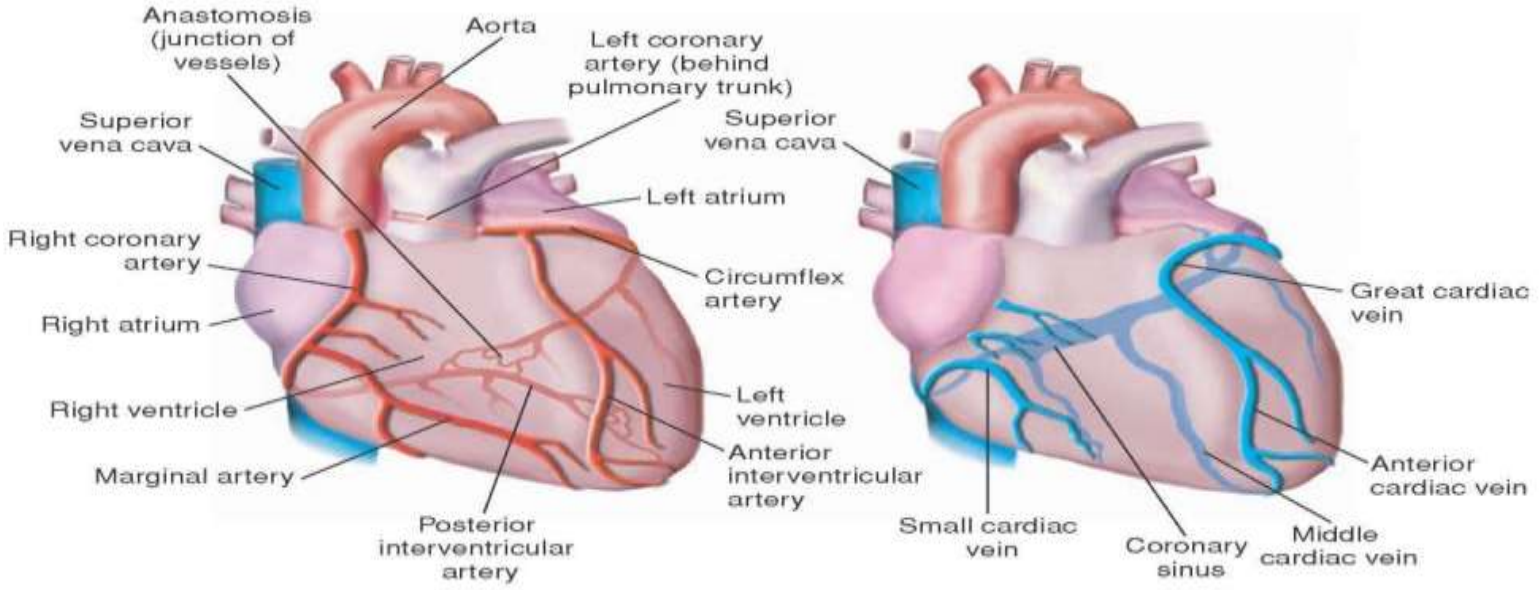


CORONARY ARTERY



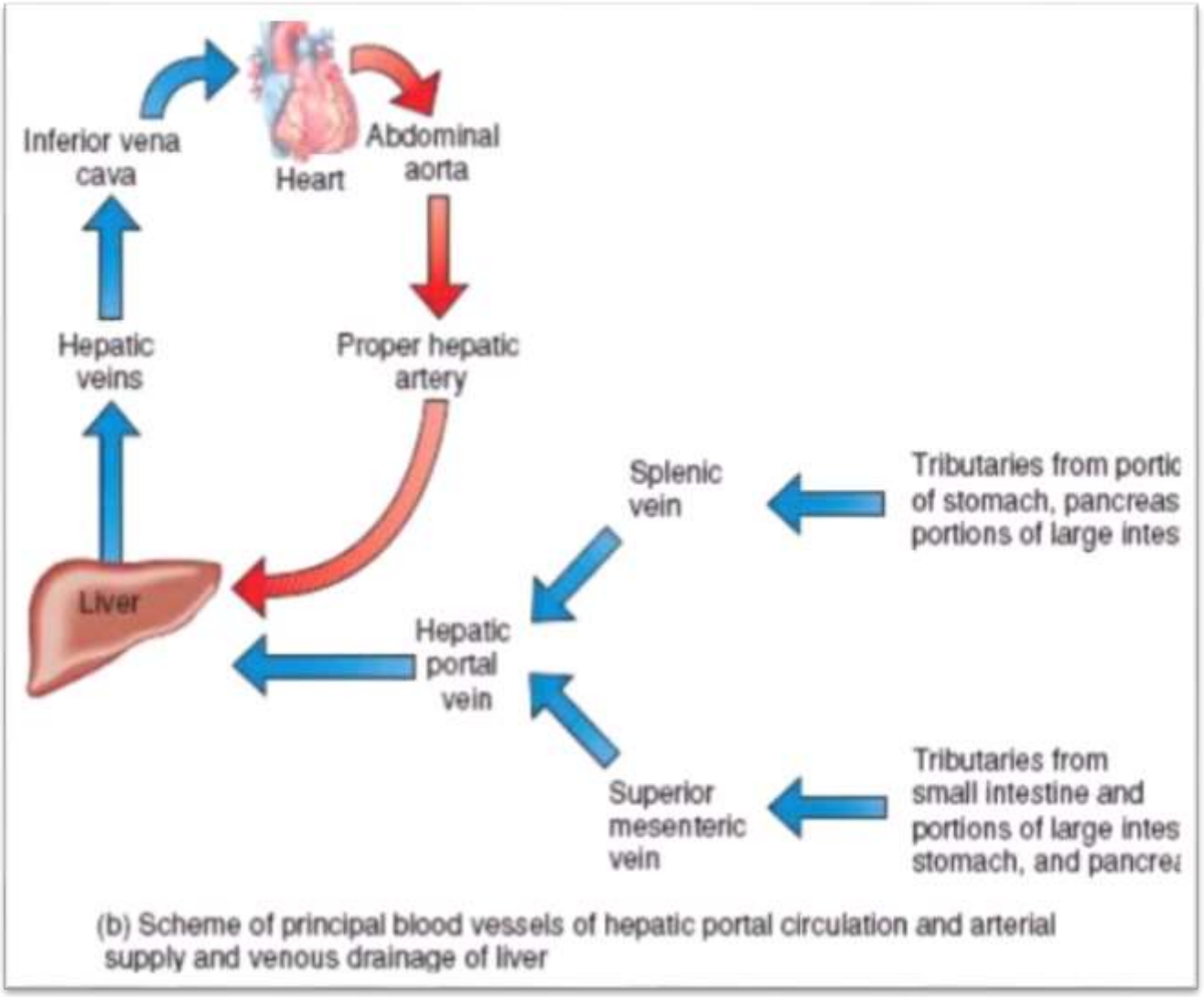
Coronary vein:

1) After delivering the oxygen and nutrients to the heart the blood receives the waste and carbon dioxide
2) It then drains into large vascular sinus or coronary sinus on the posterior surface of the heart.
3) Coronary sinus empties deoxygenated blood into the right atrium



PORTAL CIRCULATION

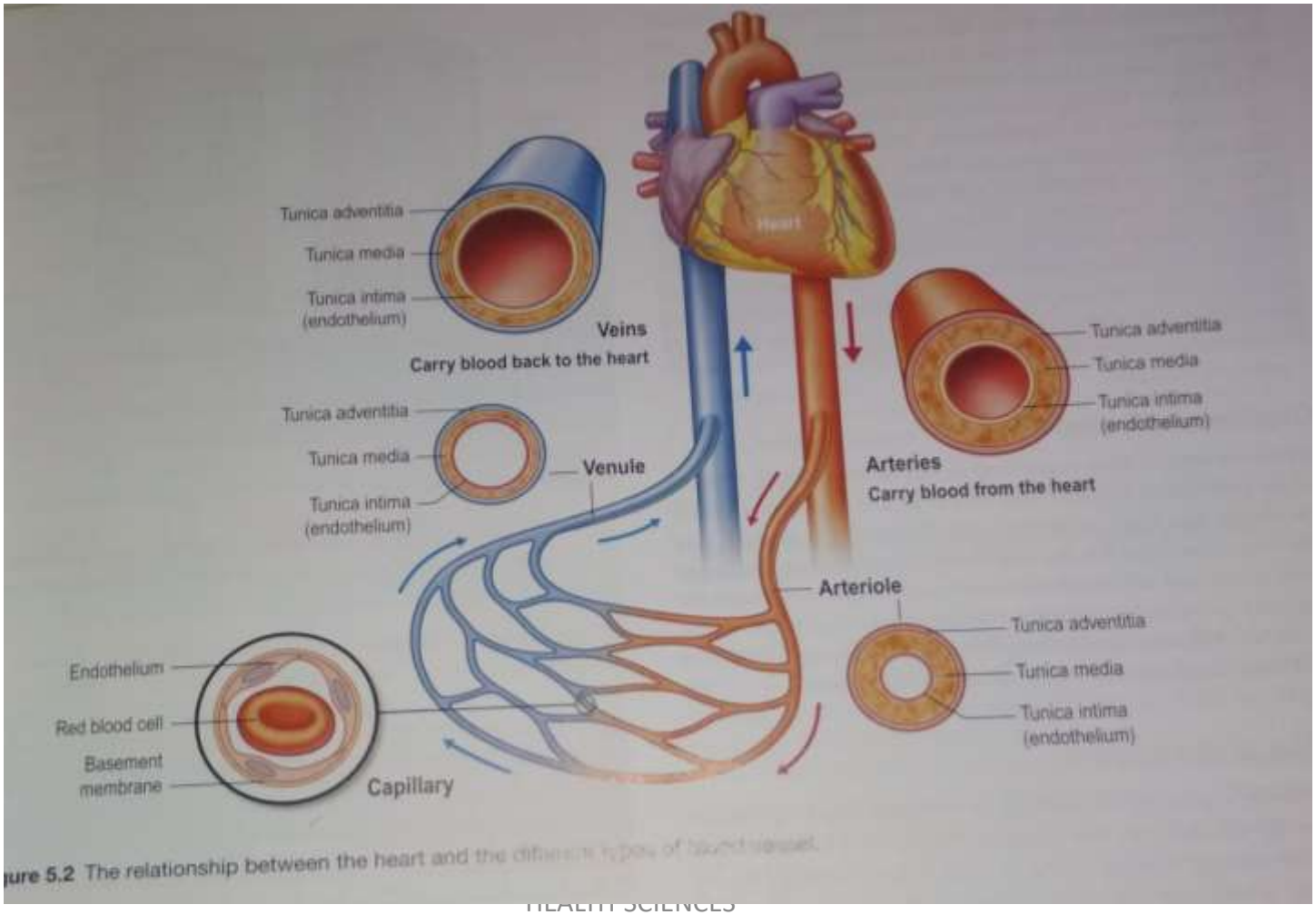
- In the portal circulation, venous blood passes from the capillary beds of the abdominal part of the digestive system, the spleen and pancreas to the liver. It passes through a second capillary bed, the hepatic sinusoids, in the liver before entering the general circulation via the inferior vena cava. In this way blood with a high concentration of nutrients, absorbed from the stomach and intestines, goes to the liver first. In the liver certain modifications take place, including the regulation of nutrient supply to other parts of the body.



(b) Scheme of principal blood vessels of hepatic portal circulation and arterial supply and venous drainage of liver

BLOOD VESSELS

- Heart pump blood through blood vessels which vary in structure, size and function



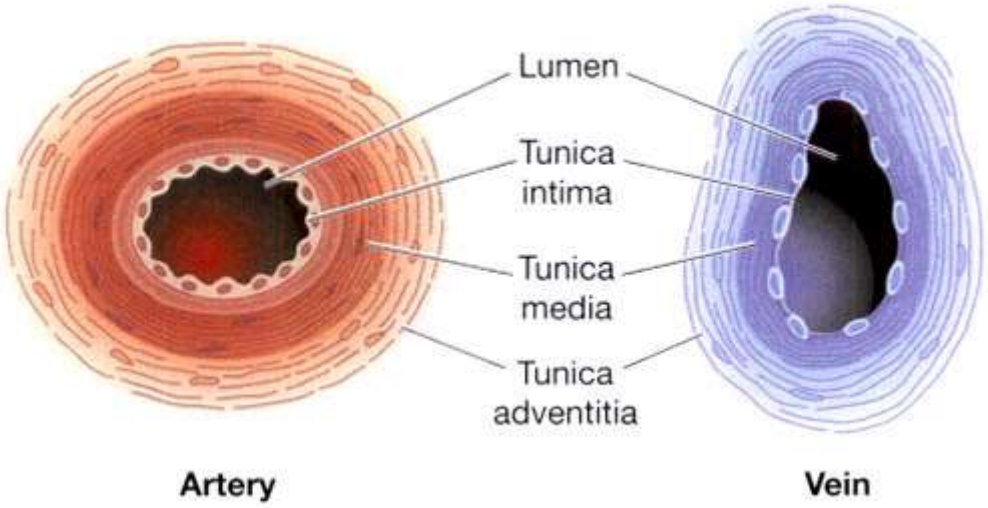
ure 5.2 The relationship between the heart and the different types of blood vessel.

Arteries:

- These are the blood vessels that transport blood away from heart
- The amount of muscle and elastic tissue vary in artereies depending on size and function
- Arteries have thicker valve than vein whic enables them to withstand high pressure of arterial blood

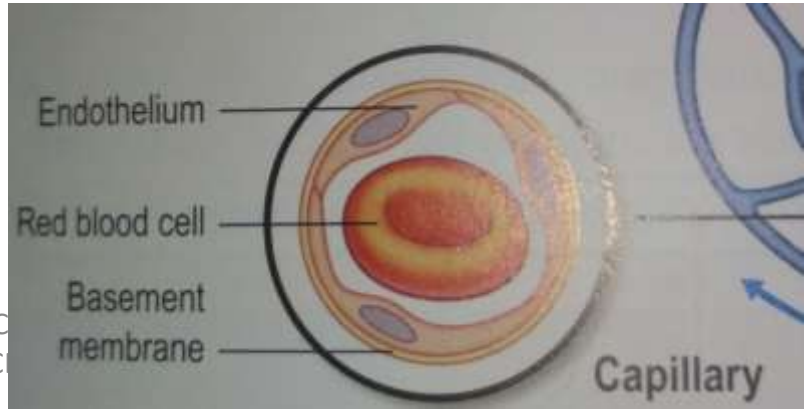
Veins:

- These are the blood vessels that carries blood back to the heart.
- Valves of veins are thinner than arteries.
- Veins are thinner as there is less muscle and elastic tissue is present tunica media and vein carry blood at low pressure than arteries .
- Some veins posses valves to prevents back flow of blood,ensuring blood flow towards the heart.
- The smallest veins are called *venules.*


Lumen
Tunica intima
Tunica media
Tunica adventitia
Artery
Vein

capillaries

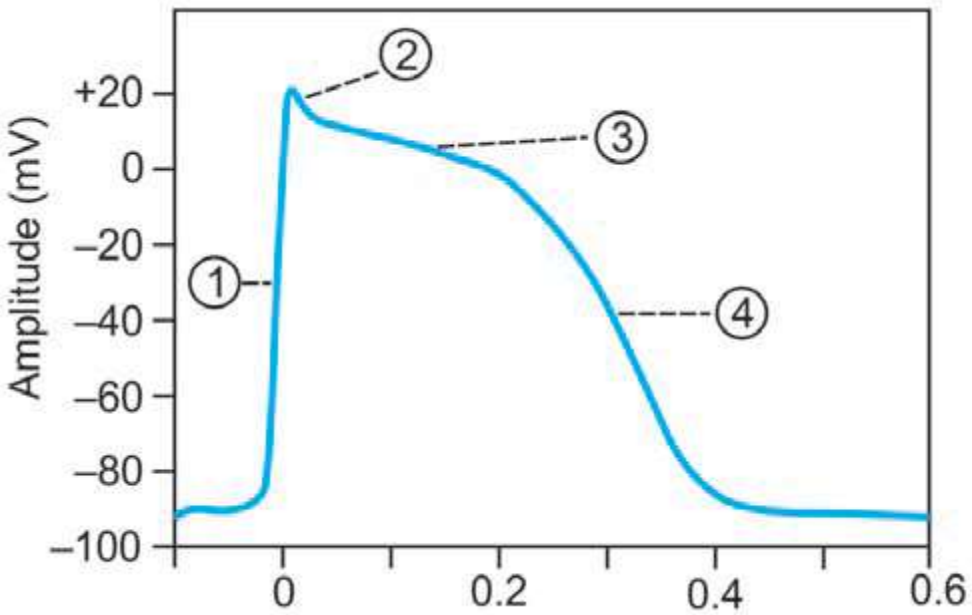
1) The smallest arterioles break up into a number of minute vessels called *capillaries.*
2) *Capillary walls consist of a single* layer of endothelial cells through which water and other small-molecule substances can pass.
3) Blood cells and large-molecule substances such as plasma proteins do not normally pass through capillary walls.
4) The capillaries form a vast network of tiny vessels which link the smallest arterioles to the smallest venules.
5) Their diameter is approximately that of an erythrocyte (7 um).
6) The capillary bed is the site of exchange of substances between the blood and the tissue fluid, which bathes the body cells.



Sinusoids:

- *Sinusoids are wider than capillaries and have extremely* thin walls separating blood from the neighbouring cells.
- Sinusoids are found in bone marrow, endocrine glands,spleen and liver.

Action potential



1. *Initial Depolarization*

Initial depolarization (first phase) is because of rapid opening of fast **sodium channels and the rapid influx of sodium ions, as in the case of skeletal muscle fiber.**

2. *Initial Repolarization*

Initial repolarization is due to the transient (short duration) opening of **potassium channels and efflux** of a small quantity of **potassium ions from the muscle** fiber. Simultaneously, the fast sodium channels close suddenly and slow sodium channels open, resulting in **slow influx of low quantity of sodium ions.**

3. *Plateau or Final Depolarization*

Plateau is due to the slow opening of **calcium channels. These channels are kept open for a longer** period and cause influx of large number of **calcium ions. Already the slow sodium channels are opened,** through which slow influx of sodium ions continues. Because of the entry of calcium and sodium ions into the muscle fiber, positivity is maintained inside the muscle fiber, producing prolonged depolarization, i.e. plateau. Calcium ions entering the muscle fiber play an important role in the contractile process.

4. *Final Repolarization*

Final repolarization is due to **efflux of potassium ions. Number of potassium ions moving out of the** muscle fiber exceeds the number of calcium ions moving in. It makes negativity inside, resulting in final repolarization. Potassium efflux continues until the end of repolarization.

Refractory period is the period in which the muscle does not show any response to a stimulus. It is of two types:

1. Absolute refractory period

2. Relative refractory period.

Absolute Refractory Period

Absolute refractory period is the period during which the muscle does not show any response at all, whatever may be the strength of the stimulus. It is because, the depolarization occurs during this period. So, a second depolarization is not possible.

Relative Refractory Period

Relative refractory period is the period during which the muscle shows response if the strength of stimulus is increased to maximum. It is the stage at which the muscle is in repolarizing state.

Conduction of heart

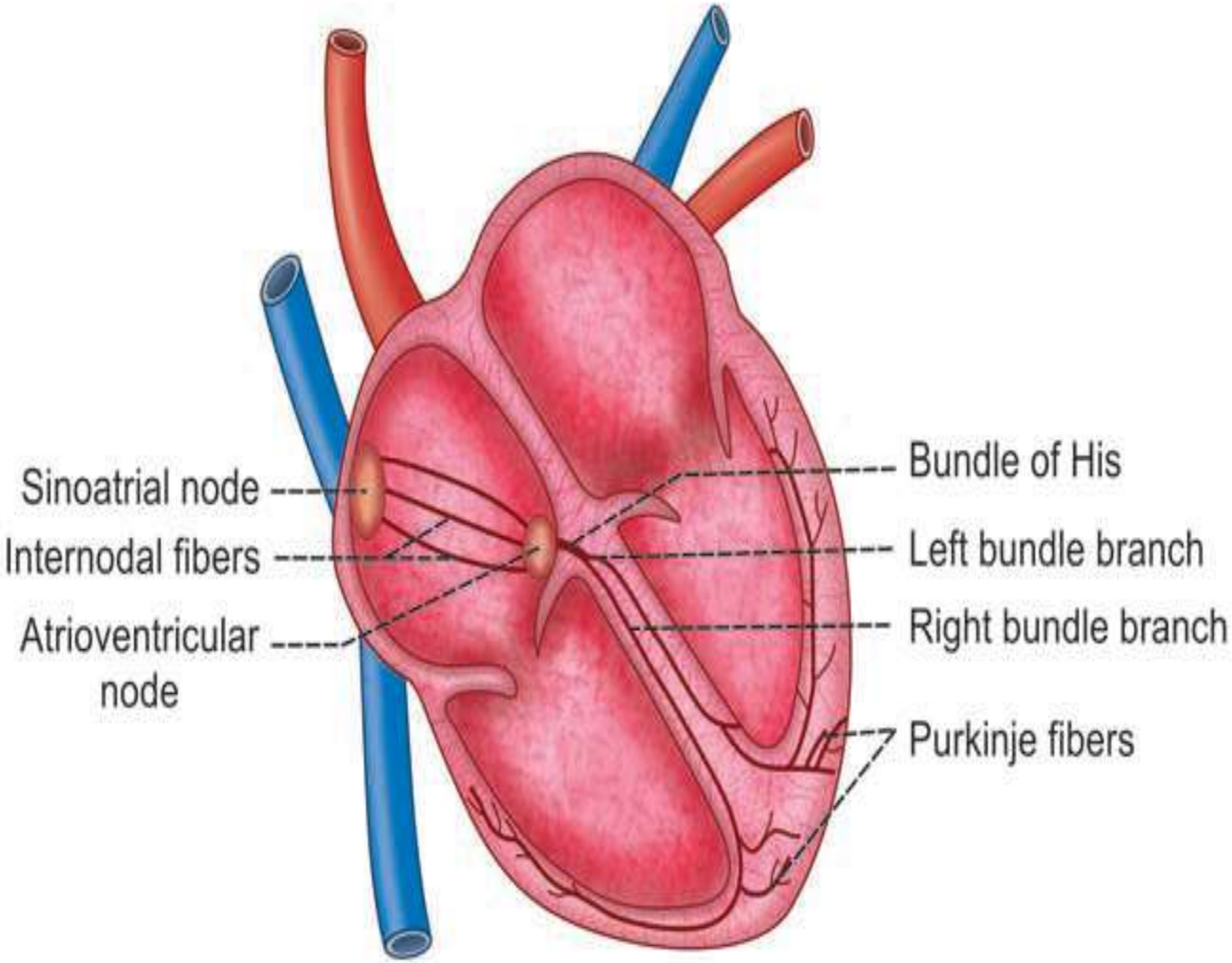
Human heart has a specialized conductive system, through which impulses from SA node are transmitted to all other parts of the heart

CONDUCTIVE SYSTEM IN HUMAN HEART

Conductive system of the heart is formed by the modified cardiac muscle fibers. These fibers are the specialized cells, which conduct the impulses rapidly from SA node to the ventricles. Conductive tissues of the heart are also called the junctional tissues.

Components of Conductive System in Human Heart

- SA node
- AV node
- Bundle of His
- Right and left bundle branches
- Purkinje fibers.


Sinoatrial node
Internodal fibers
Atrioventricular node
Bundle of His
Left bundle branch
Right bundle branch
Purkinje fibers

SA NODE:

- Sino atrial node is located in the wall of right atrium just to the right of opening of superior venacava.spontaneous rhythmical electrical impulses arise from SA node and spread in all direction
- Interatrial tract(Bachman's bundle):it is a band of specialized muscle fibres that run from SA node to left atrium.it causes simultaneous depolarisation of the left atrium
- Internodal conduction pathway:
- Three internodal conduction paths which connects SA node to AV node include

1. Anterior internodal pathway of bachman
2. middle internodal pathway of wenckbach
3. Posterior internodal pathway of thorel

AV NODE:

The atrioventricular node is located beneath the endocardium on the right side of lower part of atrial septum,near the tricuspid valve. It is stimulated by the excitation wave that travels through internodal tracts and atrial myocardium .

Atrioventricular bundle of his:

The atrioventricular bundle arises from the AV node,descends through the fibrous skeleton of the heart and divides into right bundle branch for right ventricle and left bundle branch for left ventricle.the branches break up and become continuous with plexus of purkinje fibres

Purkinje fibres:

These are spread out deep to the endocardium and reach all parts of the ventricles, including the bases of papillary muscles

Cardiac output:

The quantity of blood pumped by left ventricle to the aorta per minute.

CO=stroke volume X heart rate

=70 X 72

=5 litres/min

Stroke volume:

Volume of blood pumped out by each ventricle per heart beat.

Normal stroke volume=70ml

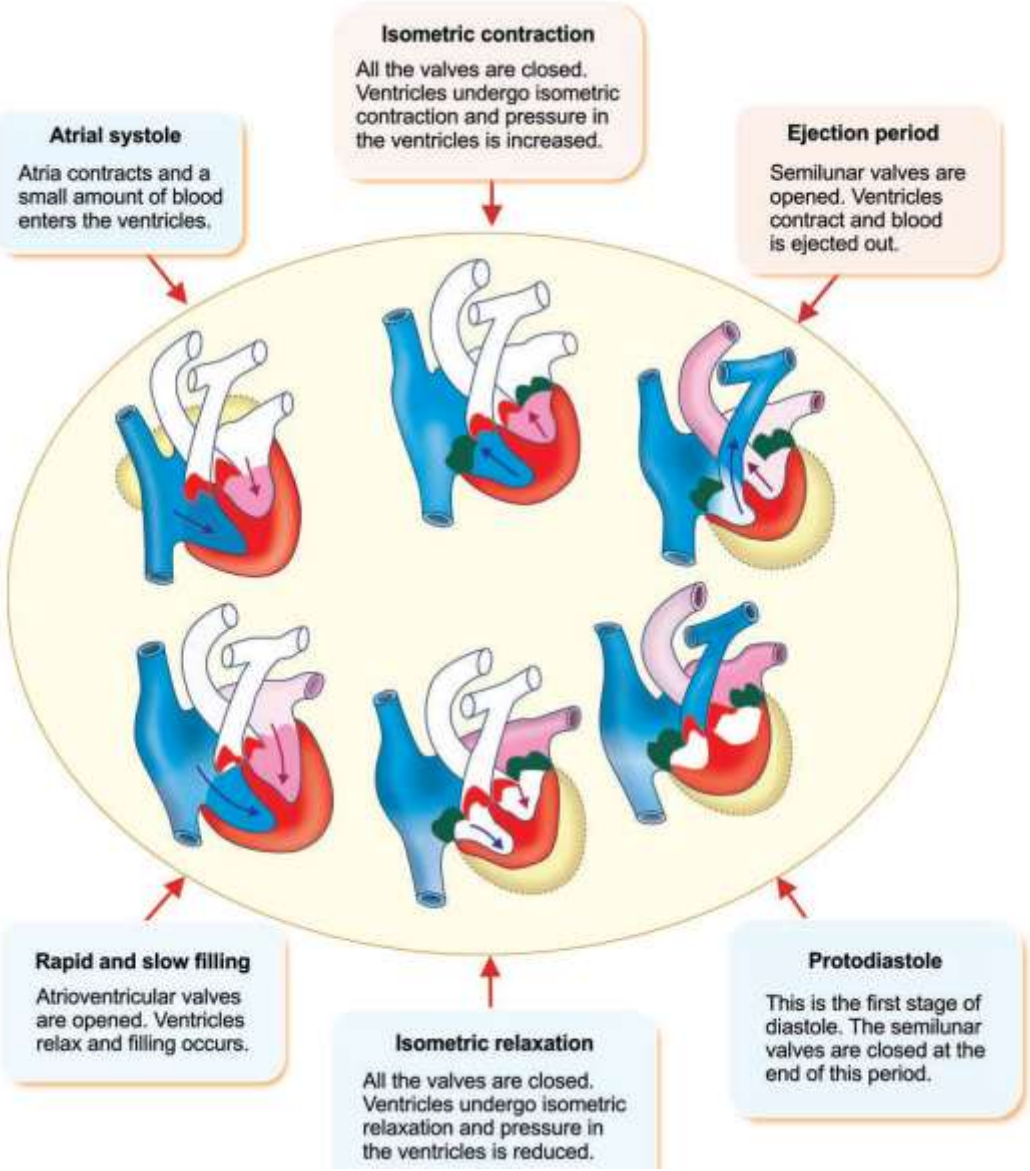
Systole and diastole:

To pump blood the heart contracts and relaxes rhythmically. The contractile phase is called systole and the relaxation phase is called diastole .

CARDIAC CYCLE

It is the series of electrical and mechanical events occurs from begnning of 1 heart beat to the begnning of next.

Duration of cardiac cycle =0.8 sec


Isometric contraction
All the valves are closed. Ventricles undergo isometric contraction and pressure in the ventricles is increased.
Atrial systole
Atria contracts and a small amount of blood enters the ventricles.
Ejection period
Semilunar valves are opened. Ventricles contract and blood is ejected out.
Rapid and slow filling
Atrioventricular valves are opened. Ventricles relax and filling occurs.
Isometric relaxation
All the valves are closed. Ventricles undergo isometric relaxation and pressure in the ventricles is reduced.
Protodiastole
This is the first stage of diastole. The semilunar valves are closed at the end of this period.

EVENTS:

Atrial systole:(0.1 sec)

- Right and left atrium contracts
- Atrioventricular valve open
- Ventricles fully relaxed

Ventricualr systole:(0.3s)

- Right and left atrium relaxed
- Ventricles filled with blood(70% filled as such and remaining filled by contraction of atria)
- Ventricles begins to contract
- Aortic and pulmonary valves open
- Ventricles fully contracted

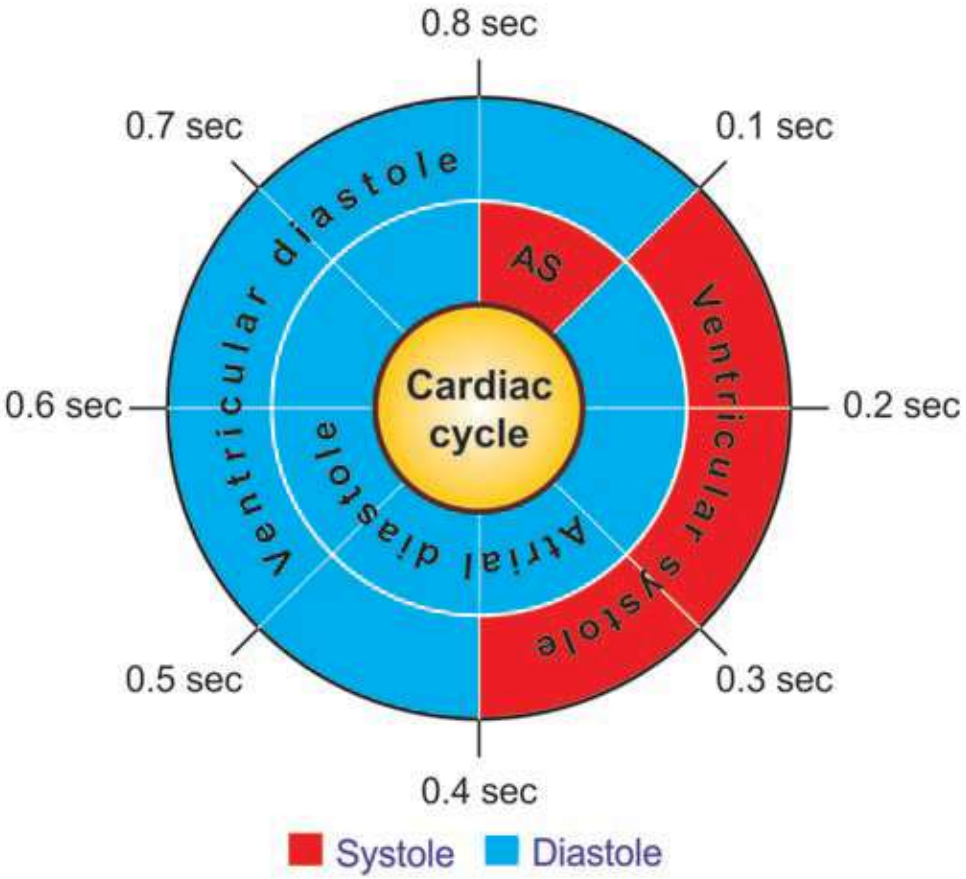
Ventricular diastole:(0.4s)

- Aotic valve closed
- Pulmonary valve closed
- Atrioventricular valve closed

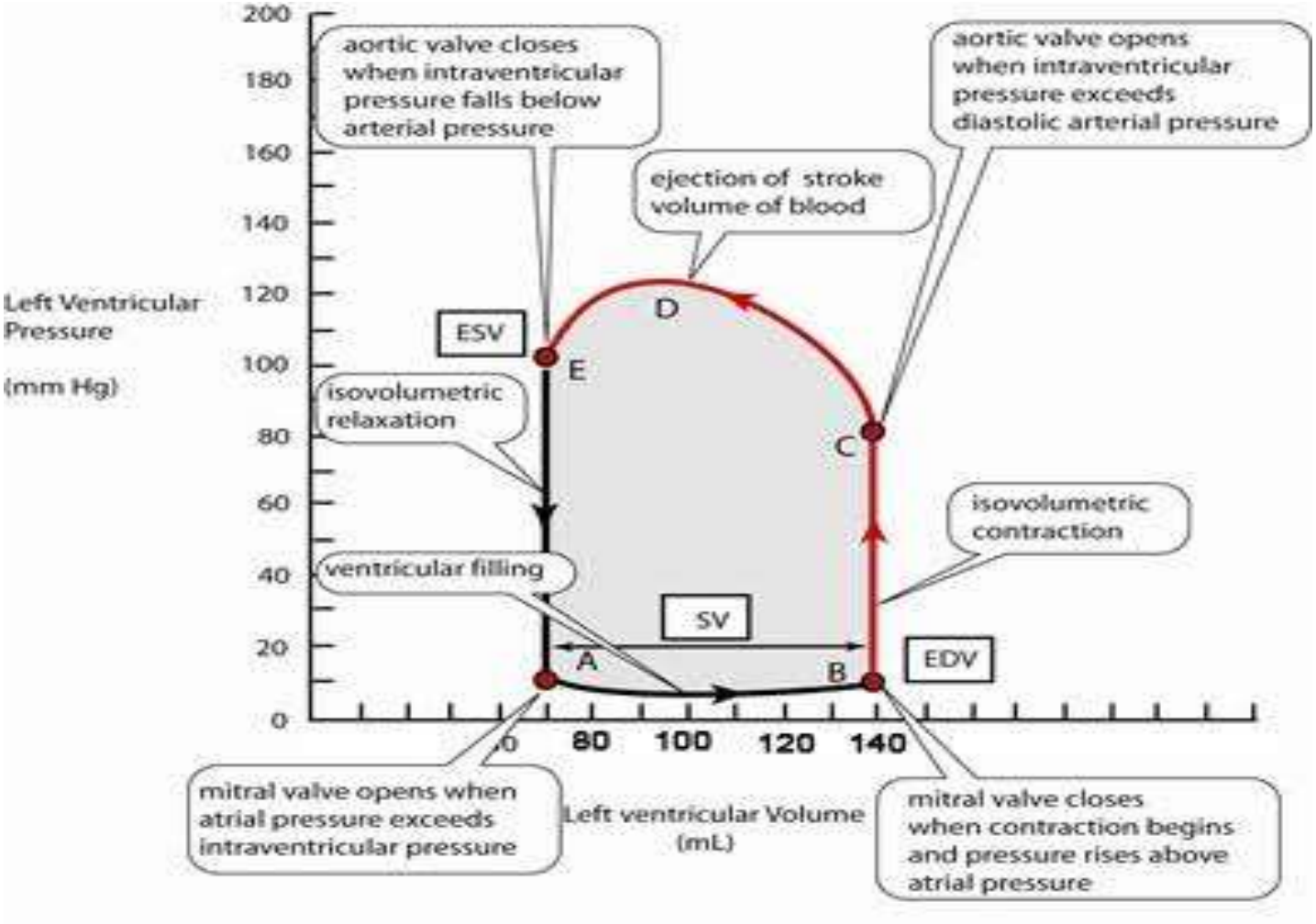
Complete cardiac diastole: (0.4s)

- Atrioventricular valve open deoxygenated blood enters right atrium and right ventricle
- Oxygenated blood enters left atrium and left ventricle

ATRIAL AND VENTICULAR EVENTS OF CARDIAC CYCLE



Volume pressure diagram



End diastolic volume:

volume of blood in the ventricles at the end of diastole is called end diastolic volume.

Normal EDV=120-130 ml

End systolic volume:

The amount of blood remains in ventricles even after complete ejection is called end systolic volume.

Normal ESV=30-50 ml

HEART SOUNDS

- Heart sounds are the sounds produced by mechanical activities of heart during each cardiac cycle.
- Heart sounds are produced by:

1. Flow of blood through cardiac chambers
2. Contraction of cardiac muscle
3. Closure of valves of the heart.

DIFFERENT HEART SOUNDS

Four heart sounds are produced during each cardiac cycle:

1. First heart sound
2. Second heart sound
3. Third heart sound
4. Fourth heart sound.

✓First and second heart sounds are called **classical heart sounds and are heard by using the stethoscope.** These two sounds are more prominent and resemble the spoken words 'LUB, (or LUBB) and 'DUBB' (or DUP), respectively.

✓Third heart sound is a **mild sound** and it is not heard by using stethoscope in normal conditions. But it can be heard by using a **microphone**.

✓ Fourth heart sound is an **inaudible sound**. It becomes audible in pathological conditions only.

First Heart sound (HS1):

first heart sound is produced by vibration set up by the sudden closure of AV valves at the start of ventricular systole.(LUBB)

Second Heart sound 2 (HS2):

It is caused by vibration associated with closure of the semilunar valves just at the onset of venticular diastole.(DUBB)

Third Heart sound (HS3):

It is caused by vibration set up in the cardiac wall by inrush of blood during rapid filling phase of ventricular diastole. it cannot be heard by ausculation with stethoscope.

Fourth Heart sound (HS4):

It is caused by vibrations set up during atrial systole.

NERVE SUPPLY TO THE HEART

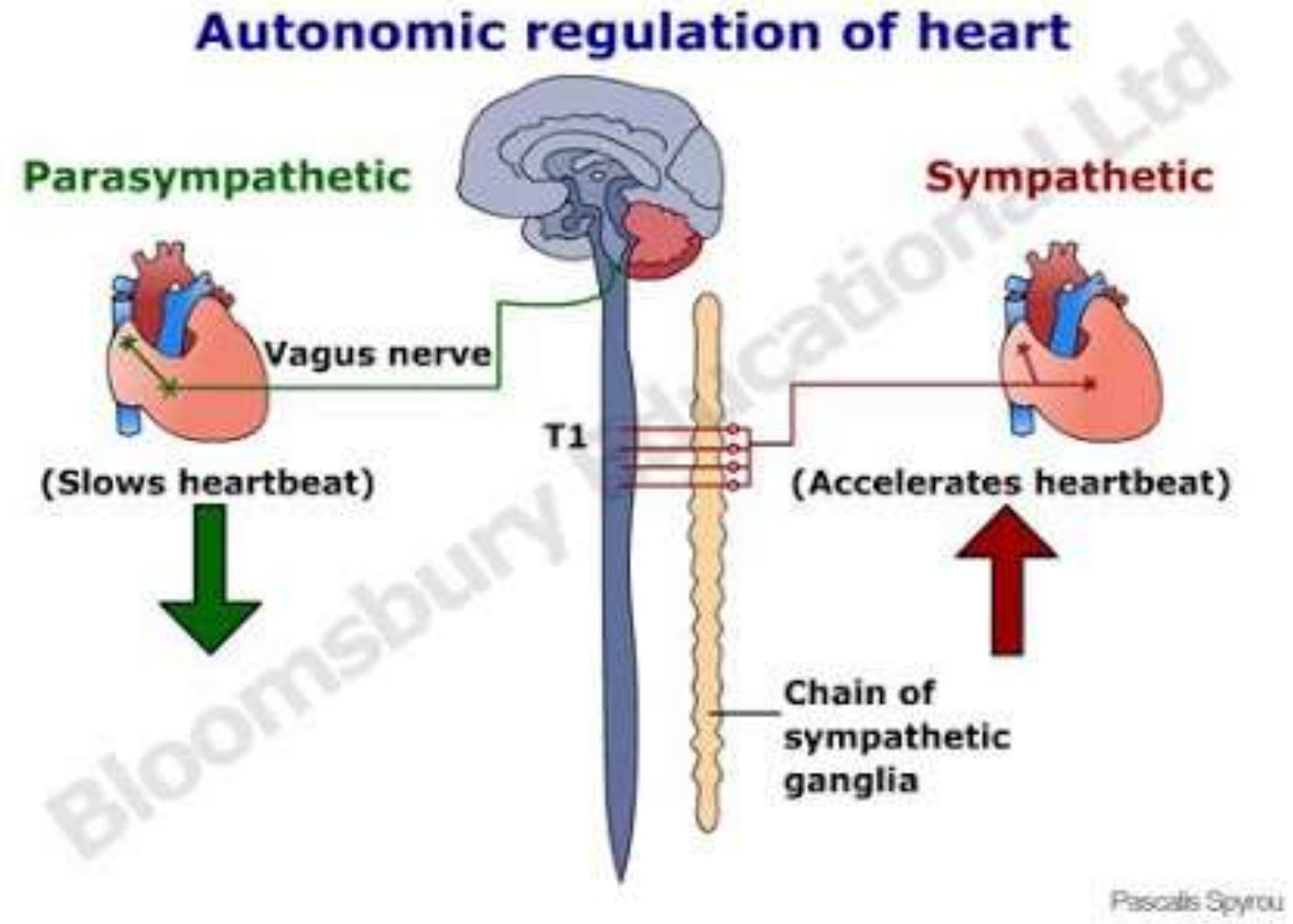
Heart is influenced by autonomic nerves originating in cardivascular centre in the medulla oblangata which reach it through autonomic nervous system.these consists of parasympathetic and sympathetic nerves.

The vagus nerve supply mainly to SA node,atrial muscle and Av node.

parasympathetic stimulation reduces the heart rate at which impulses are produced and decreasing the heart rate and force of contraction. sympathetic stimulation reduces the heart rate and force of contraction.

HEART RATE AND ITS REGULATION BY ANS

- Normal heart rate is 60-100 beats per min, average is 72 beats per min. in general heart rate is increased in infants, during exercise, emotions , pain, pregnancy and after meals
- Increased heart rate is called tachycardia(occurs during high fever, hyperthyroidism, haemorrhage, cardiac failure, cardiac arrythmias)
- Decreased heart rate is called bradycardia (occurs during heart block, myxedema, viral infection)


Autonomic regulation of heart
Parasympathetic
Sympathetic
Vagus nerve
T1
(Slows heartbeat)
(Accelerates heartbeat)
Chain of sympathetic ganglia
Pascalis Spyrou