

## UNIT 12

### CARDIOVASCULAR SYSTEM

The cardiovascular system is types of circulatory system. The purpose of cardiovascular system is to supply oxygen, nutrients and other essential substances to the tissue of the body and remove carbon dioxide and other metabolic end products from the tissues.

#### Components of Cardiovascular System

- |          |          |                  |
|----------|----------|------------------|
| 1. Blood | 2. Heart | 3. Blood vessels |
|----------|----------|------------------|

#### HEART

Heart is a vital organ which is a hollow, blunt, cone-shaped (conical), muscular pumping organ and it pumps blood to various parts of the body to meet their nutritive requirements.

The heart lies in the obliquely in the thoracic cavity in the mediastinum (space between two lungs). It is about 300 gm in males and 250 gm in females.

#### STRUCTURE OF HEART WALL

The heart wall is composed of three layer of tissue:

- |                |               |                |
|----------------|---------------|----------------|
| 1. Pericardium | 2. Myocardium | 3. Endocardium |
|----------------|---------------|----------------|

1. **Pericardium:** The outer covering layer of heart is known as pericardium. It is made up of two layers.

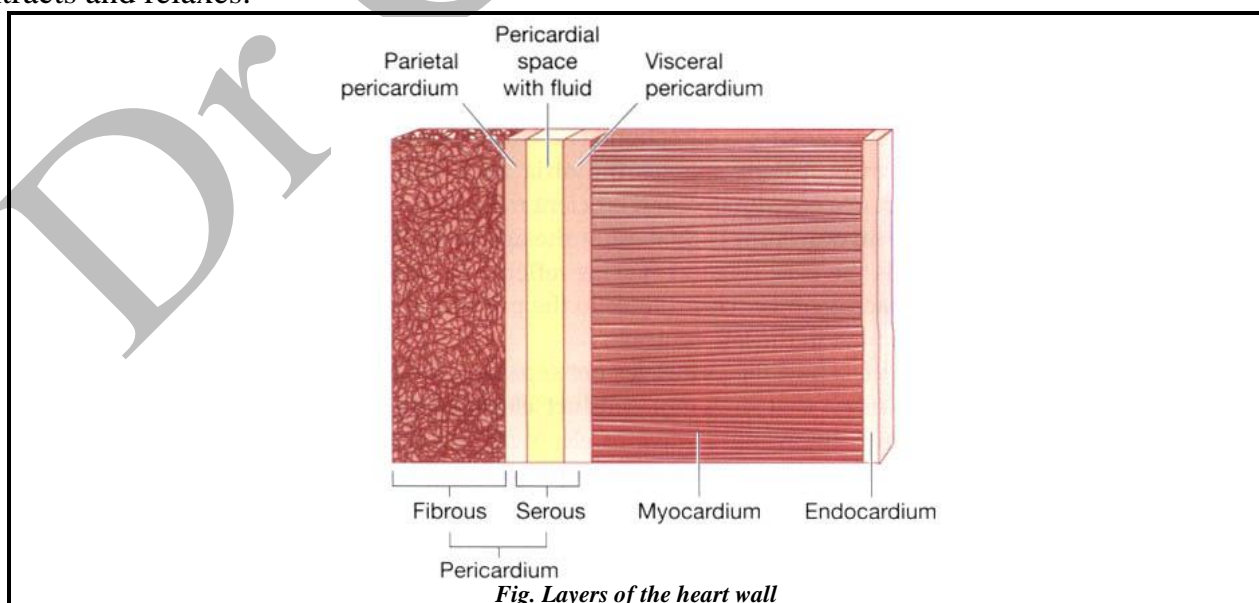
- |                        |                       |
|------------------------|-----------------------|
| a. Fibrous pericardium | b. Serous pericardium |
|------------------------|-----------------------|

a. **Fibrous pericardium:** The outer layer of pericardium is known as fibrous pericardium. It is formed by thick fibrous connective tissue.

b. **Serous pericardium** The inner layer of pericardium is known as serous pericardium. The serous pericardium consists of two layers:

- **Parietal pericardium:** The outer layer of serous pericardium is known as parietal pericardium.
- **Visceral pericardium:** The inner layer of serous pericardium is known as visceral pericardium. It is made up of flattened epithelium cells. The visceral pericardium is also known as **epicardium**.

Between these two layers of serous pericardium (parietal and visceral pericardium) present a narrow space known as pericardial space or pericardial cavity. The pericardial space filled with pericardial fluid. This fluid prevents friction and allows the free movement of heart within pericardium, when it contracts and relaxes.



*Fig. Layers of the heart wall*

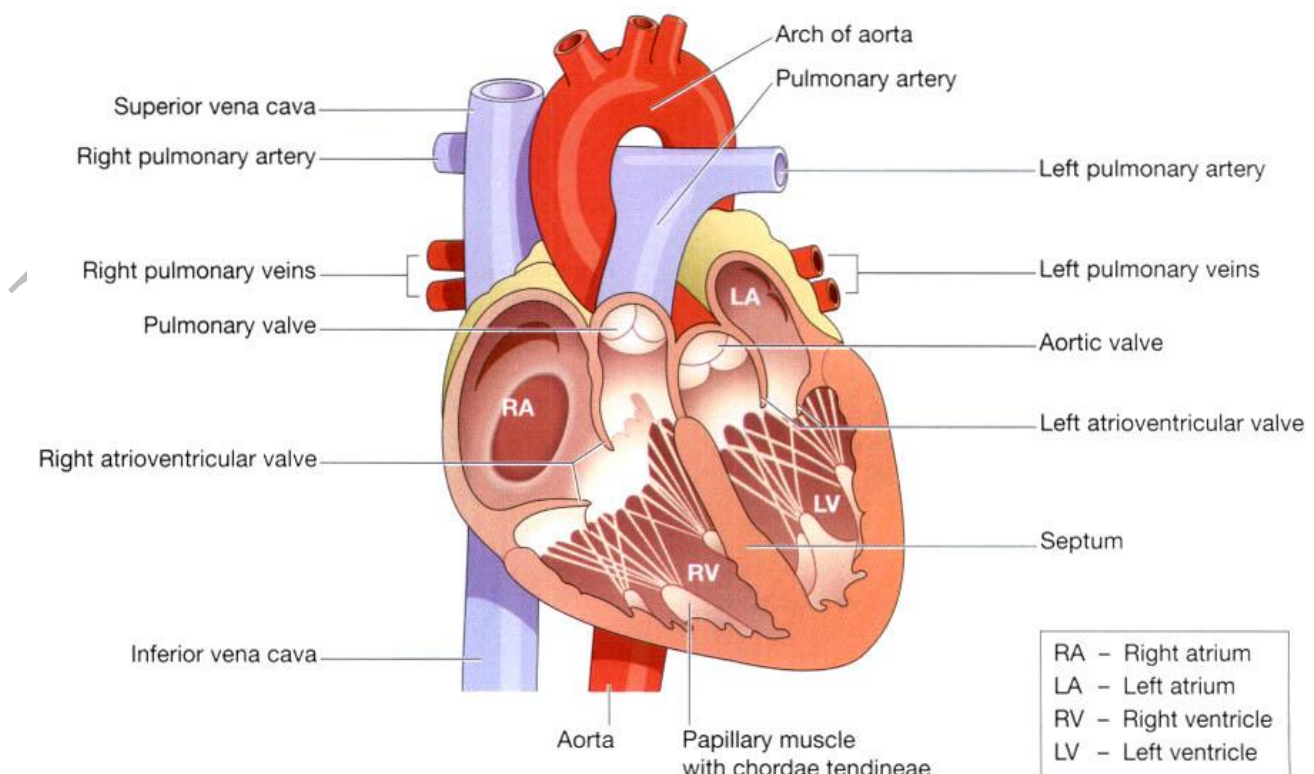
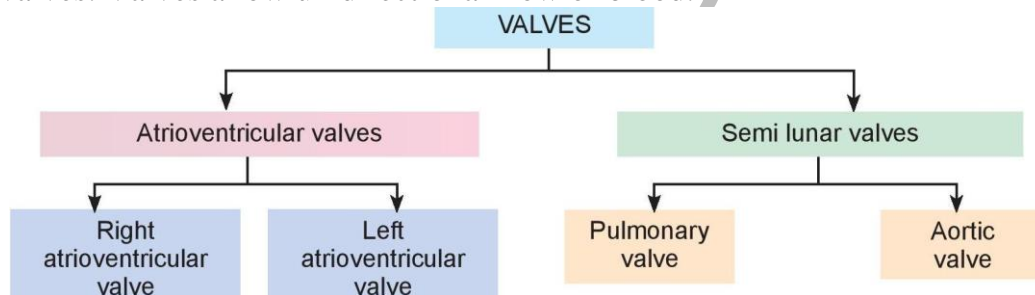
b. **Myocardium:** The middle layer of heart wall is known as myocardium (types of muscular tissue). It is also known as cardiac muscle or heart muscle. It performs the work of the heart.

- c. **Endocardium:** The inner layer of heart wall is known as endocardium. It is made up of epithelial tissue.

## INTERNAL STRUCTURE OF HEART

The internal structure of heart is made up of:

- Chambers of heart
  - Valves of heart
1. **Chambers of heart:** The heart is made up of four chambers. The upper two chambers are known as atrium (right atrium and left atrium) and lower two chambers are known as ventricles (right ventricle and left ventricle).
    - a. **Atrium**
      - The right and left atrium are thin walled chambers separated by inter-atrial septum.
      - The right atrium receives venous (deoxygenated) blood through the opening of superior venacava, inferior venacava and coronary sinus and left atrium receives oxygenated blood from the lungs through four opening of the pulmonary veins (two right and two left pulmonary veins).
    - b. **Ventricles**
      - The ventricles are thick wall chambers internally separated by inter- ventricular septum.
      - The left ventricle is thicker than right ventricle because it has to pump blood all over the body.
      - The pulmonary artery arises from right ventricle. It carries the venous (deoxygenated) blood from right ventricle to the lungs.
      - The aorta arises from the left ventricle. The left ventricle pumps the oxygenated blood to different parts of the body through the systemic aorta.
  2. **Valves of heart:** There are four valves in human heart, two atrioventricular valves and two semilunar valves. Valves allow unidirectional flow of blood.



*Fig. Internal structure of heart*

## BLOOD SUPPLY OF THE HEART

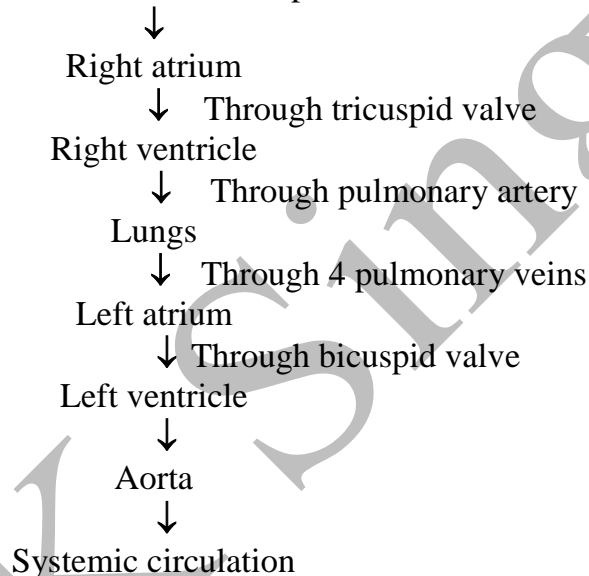
- Arterial supply:** The right and left coronary arteries supplied arterial blood (oxygenated blood) to the heart. They are first branches of the aorta.
- Venous drainage:** The most of the venous blood is collected into several small veins that join to form the coronary sinus, which opens into the right atrium. The remainder passes directly into the heart chambers through little venous channels.

## NERVE SUPPLY OF THE HEART

The cardiovascular centre lies in the medulla oblongata. The nerve supply to the heart by sympathetic and parasympathetic nerves (branch of autonomic nervous system). The sympathetic stimulation increases heart rate and parasympathetic stimulation decreases heart rate.

## FLOW OF BLOOD THROUGH THE HEART

The right atrium receives deoxygenated blood from the superior venacava and inferior venacava



## CONDUCTIVE SYSTEM OF HEART

The small groups of specialized neuromuscular cells in the myocardium initiate and conduct impulses causing co-ordinate and synchronized contraction of the heart muscle is known as conductive system of heart. The conductive system consists of following structures:

- Sinoatrial node (SA node)
- Atrioventricular node (AV node)
- Atrioventricular bundle (AV bundle or bundle of His)
- Purkinje fibers

## HEART BEAT

The one complete sequence of contraction and relaxation of the heart is known as heart beat. The normal heart rate is 72/minute. The average normal heart rate at rest for adults ranges from 60 to 100 bpm.

## CARDIAC CYCLE

The rhythmic contraction and relaxation of heart chamber in cyclic pattern is known as cardiac cycle. During each heart beat or cardiac cycle the heart contract and then relax. The period of contraction is known as systole and the period of relaxation is known as diastole. The complete cardiac cycle is of 0.8second.

## STAGES OF CARDIAC CYCLE

The cardiac cycle consists of three stages:

- Atrial systole = 0.1 sec.
- Ventricular systole = 0.3 sec.
- Complete cardiac diastole = 0.4 sec.

### i. Atrial systole

- Simultaneous contractions of both atria.
- Opens atrioventricular valves (tricuspid & bicuspid valves).
- Blood flows within the ventricles of respective sides.
- No heart sound is produced.
- It completes within 0.1 sec.

### ii. Ventricular systole

- Simultaneous contraction of both ventricles.
- Atrioventricular valves (bicuspid and tricuspid valves) get closed so that first heart sound (LUBB) is produced.
- Blood is forced into pulmonary artery and aorta.
- It completes within 0.3sec.

### iii. Complete cardiac diastole

- Relaxation of both atria and ventricles together.
- Both atria get filled with blood.
- Pulmonary and aortic valves get closed to prevent back flow of blood so that second heart sound (DUBB) is produced.
- It completes within 0.4 sec.

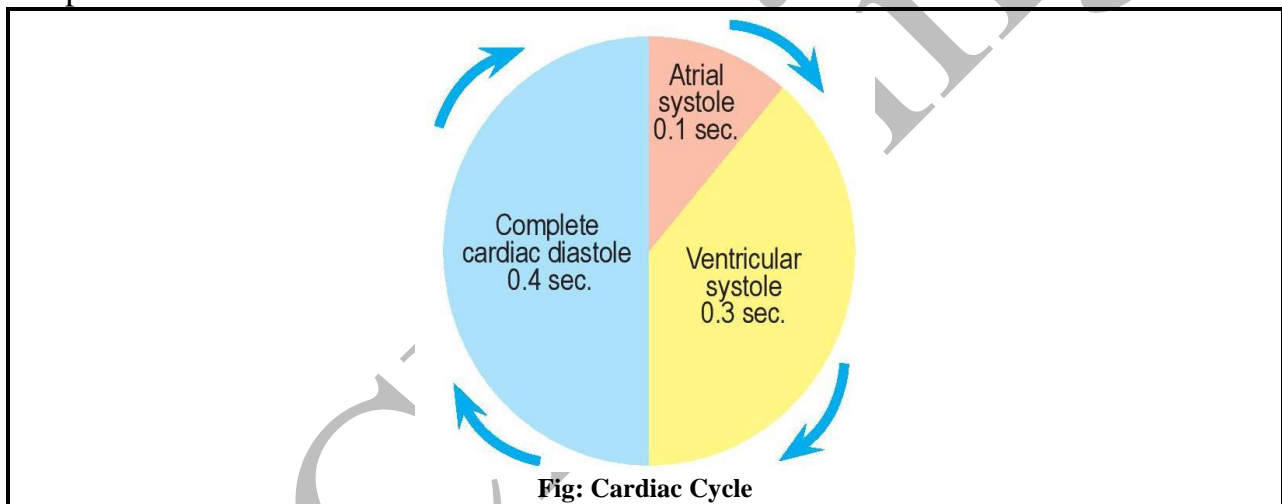


Fig: Cardiac Cycle

## HEART SOUND

The vibratory motions of the heart produced during the different events of the cardiac cycle are known as heart sounds. The two heart sounds are produced during each cardiac cycle:

1. **First heart sound (LUBB):** The first heart sound is produced during ventricular systole due to the simultaneous closure of bicuspid and tricuspid valves (atrioventricular valves).
2. **Second heart sound (DUBB):** The second heart sound produced during complete cardiac diastole due to the simultaneous closure of pulmonary and aortic valves (semi lunar valves).

## CARDIAC OUTPUT

The amount of blood pumped from each ventricle in per minute is known as cardiac output. The cardiac output is depends upon the stroke volume and heart rate.

$$\text{Cardiac output} = \text{Stroke volume} \times \text{Heart rate}$$

The normal value of cardiac output is about 5 liter/ventricle in per minute.

**Stroke volume:** The amount of blood pumped from each ventricle during each beat is known as stroke volume. The normal value of stroke volume is about 70ml (60 to 80 ml) when the heart rate is normal 72/minute.

## BLOOD PRESSURE

Blood pressure is the force of blood exerted by the wall of arteries. The normal blood pressure is 120/80 mm of Hg. Blood pressure is expressed in three different terms:

- 1. Systolic blood pressure:** This is the maximum pressure exerted in the arteries during the systole of heart. The normal systolic blood pressure is 120 mm of Hg or 16kpa.
- 2. Diastolic blood pressure:** This is the minimum pressure in the arteries during the diastole of the heart. The normal diastolic blood pressure is 80 mm of Hg Or 11kpa.
- 3. Pulse pressure:** This is the difference between the systolic pressure and diastolic pressure. Normally, it is 40 mm of Hg.

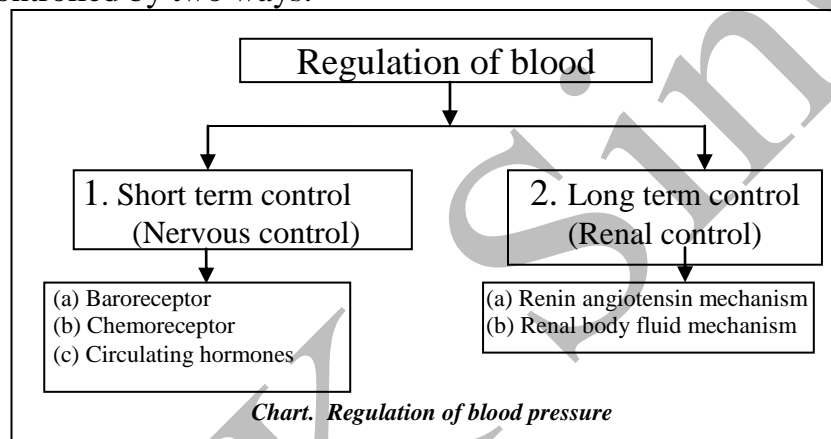
### FACTORS MAINTAINING BLOOD PRESSURE

Some factors are necessary to maintain normal blood pressure.

- Cardiac output
- Heart rate
- Peripheral resistance
- Blood volume
- Venous return
- Elasticity of blood vessels
- Velocity of blood flow
- Diameter of blood vessels
- Viscosity of blood.

### REGULATION OF BLOOD PRESSURE

Blood pressure is controlled by two ways:



### FACTORS AFFECTING BLOOD PRESSURE

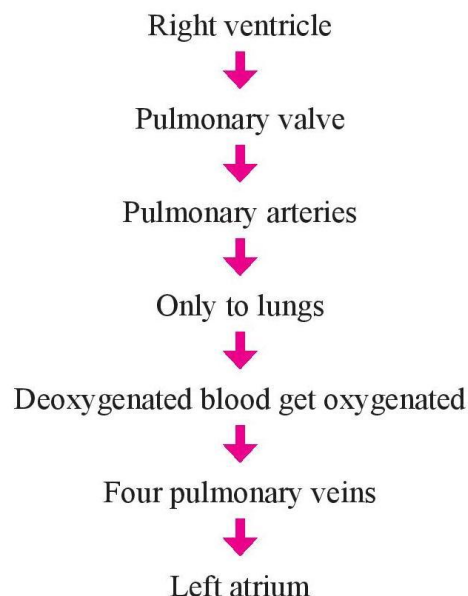
- Cardiac output
- Peripheral resistance
- Age: Blood pressure rise with age
- Sex: 10-20% less in female
- Exercise
- Emotion and Excitement

### BLOOD CIRCULATION

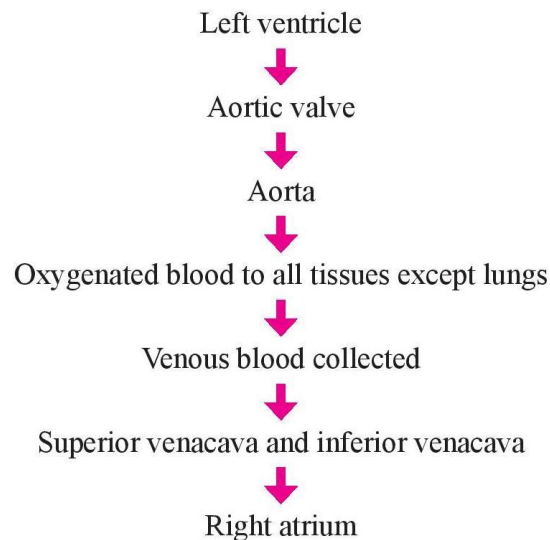
The circulation in which the blood leaving the heart flowing through the arteries, veins & capillaries and return back to the heart is known as blood circulation.

#### TYPES OF CIRCULATION

##### 1. Pulmonary circulation:



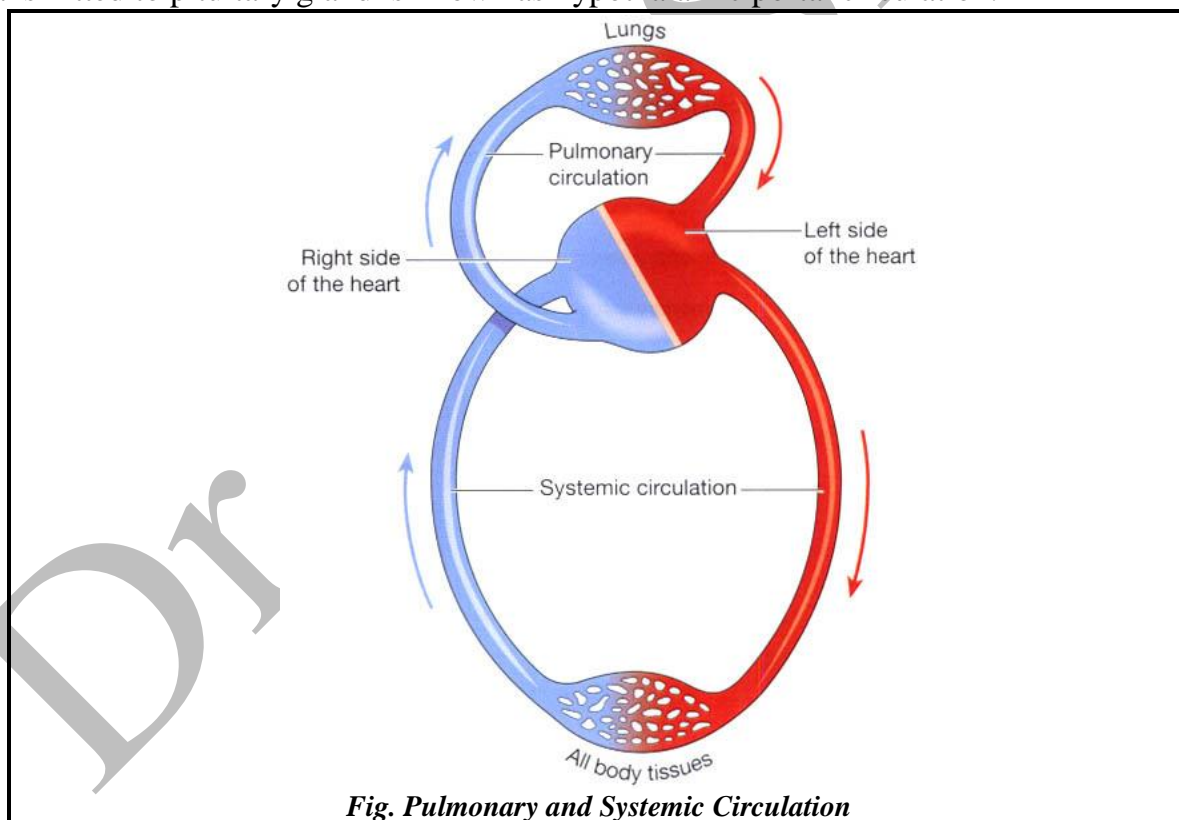
## 2. Systemic circulation:



3. **Portal circulation:** The blood from one organ is first transported to another organ through portal vein is known as portal circulation.

### Types of portal circulation

- **Hepatic portal circulation:** The nutrient rich blood from the intestinal tract is directly transmitted to liver for metabolism is known as hepatic portal circulation.
- **Hypothalamic portal circulation:** The hormones are released from hypothalamus is directly transmitted to pituitary gland is known as hypothalamic portal circulation.



*Fig. Pulmonary and Systemic Circulation*

## BLOOD VESSELS

The blood vessels are the part of the circulatory system that transports blood throughout the body.

### Type of blood vessels

The blood vessels are of three types:

1. **Artery:** Artery is a type of blood vessel, which carry blood away from the heart to different organs. Its diameter is 4 mm. The smallest parts of artery are known as arteriole.
2. **Vein:** Vein is a type of blood vessels, which carry blood towards the heart from different parts of the body. Its diameter is 5 mm. The smallest parts of vein are known as venule.

3. **Capillary:** Capillaries are the network of microscopic endothelial tubes interposed between the arterioles and venules. The average diameter of capillaries is 6-8 micron.

### Structure of blood vessels

The wall of blood vessels (arteries and veins) is composed of three layers:

1. **Tunica adventitia:** It is the outer layer of blood vessels, composed of fibrous tissue.
2. **Tunica media:** It is the middle layer of blood vessels, composed of smooth muscle and elastic tissue.
3. **Tunica interna:** It is the inner layer of blood vessels, composed of squamous epithelium known as endothelium.

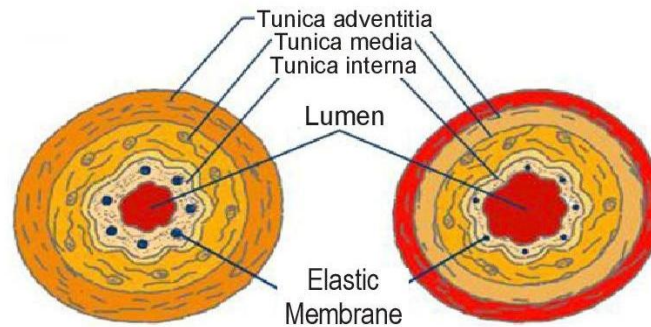


Fig.: Structure of Blood Vessels

### Differences between Arteries and Veins

No	Arteries	Veins
1.	It carries blood away from the heart to different organs.	It carries blood towards the heart from different parts of the body.
2.	Its diameter is about 4 mm.	Its diameter is about 5 mm.
3.	It is most deeply situated in the body.	It is superficial and deep situated in the body.
4.	It is thick wall.	It is thin wall.
5.	It passes narrow lumen.	It passes wider lumen.
6.	It is red in colour.	It is blue in colour.
7.	It has high elasticity.	It has low elasticity.
8.	The artery blood pressure is high.	The vein blood pressure is low.
9.	The internal valves are absent.	The internal valves are present.

### ELECTROCARDIOGRAM

A tracing of the cardiac impulses by an electrical instrument is known as electrocardiogram. This technique was discovered by Dutch physiologist, *Einthoven willem* who is called the father of ECG.

#### Waves of ECG

The waves of ECG recorded by Limb lead II are considered as the physical waves. The normal ECG has the following waves namely P, Q, R, S and T.

- P wave is the atrial complex.
- QRS waves are the initial ventricular complex.
- T wave is the final ventricular complex.

#### Propose or uses of ECG

The ECG is useful in determining and diagnosing the following:

- Heart rate
- Heart rhythm
- Abnormal electrical conduction
- Poor blood flow to heart muscle
- Heart attack
- Coronary artery disease
- Hypertrophy of heart

